RELACIONES EXTERIORES
SECRETARÍA DE RELACIONES EXTERIORES

UNIVERSITY OF CALIFORNIA
ALIANZAMX

US-MEXICO TASK FORCE

FOR THE ELECTRIFICATION OF TRANSPORT:

Diagnosis and Recommendations
for the Transition of Mexico's Automotive Industry

US-MEXICO TASK FORCE
FOR THE ELECTRIFICATION OF TRANSPORT:

Diagnosis and Recommendations
for the Transition of Mexico's
Automotive Industry

Ministry of Foreign Affairs
Marcelo Ebrard Casaubon, Secretary of Foreign Affairs

Martha Delgado Peralta, Undersecretary for Multilateral Affairs and Human Rights

Iker Jiménez Martínez, Director General for Global Investment (DGIEG)

Margarita Alcántara Alcalá, Head of the Undersecretary for Multilateral Affairs and Human Rights

General Direction for Global Investment
Jorge Jiménez Sólomon, Coordinador de Infraestructura y Energía, *Coordinator of the Task Force on the Electrification of Transport (GTE)*

Aurora Tenorio Dena, Coordinadora de Infraestructura y Energía, *Supervisor of Infrastructure and Supplier Development, GTE*

Belén Elizabeth Licona Romero, Coordinator of the Territorial-Industrial Prospective Atlas, *Human Capital Supervisor, GTE*

Alberto Chavéz Mejía, Institutional Liaison, *Innovation Supervisor, GTE*

Leonardo Castañeda, *Proyect Consultant*

Santiago Bolaños Signoret, *Proyect Consultant*

Gabriel López Nuñez, *Proyect Consultant*

Sebastián Ponce Landa, *Proyect Consultant*

Franco Fernández Rodríguez, *Proyect Consultant*

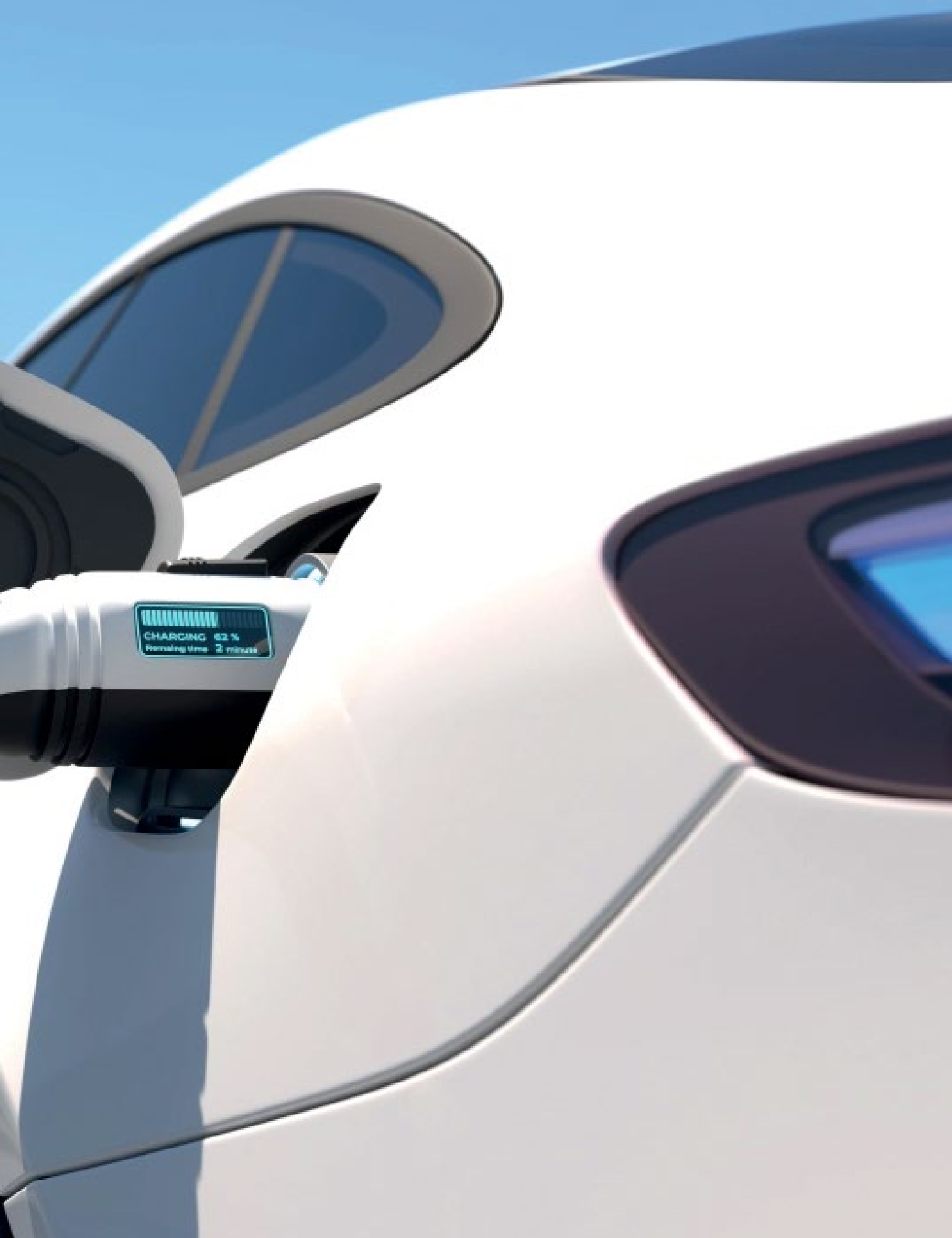
Alianza Mexico at the University of California
Isabel Studer, Director of Alianza Mexico at the University of California

External Consultants
José Zozaya, President of the Mexican Association of the Automotive Industry (AMIA)

Miguel Elizalde, President of the National Association of Bus, Truck and Tractor Truck Producers (ANPACT)

Document Design
Ana Paulina Ríos Pérez, *Consultant*, Secretaría de Relaciones Exteriores

Index


CHARGING 62 %
Remaining time 3 minute

Secretary of Foreign Affairs

MARCEL
EBRARD CAS

On February 8, the Government of Mexico, acting through the Ministry of Foreign Affairs, launched an unprecedented initiative for the electrification of transport in our country, touching off the most ambitious bi-national effort for the automotive industry since the negotiation of the USMCA, in order to guarantee that the industry stays current and attractive to foreign investment, and to promote it abroad.

Current global phenomena, such as Industry 4.0 and climate change, together with the disruption of production chains caused by the COVID-19 pandemic, are creating scenarios of uncertainty for our citizens, governments, and economies. The industrial transition towards electromobility is an example of the transversality required by the new technological solutions, with a focus in this case on the efficient use of energy and the use of green technologies. Particularly important is the transformation of the automotive industry, which is among the industries with the highest growth and greatest dynamism worldwide, and one in which our country seeks to maintain its leadership through our competitive advantages.

In recent decades, Mexico has consolidated its foreign economic policy as a result of the diversification of its trade agreements, regional integration and the implementation of measures focused on strengthening national industries. This has contributed to the consolidation of national capacities and has allowed us to position ourselves in high value-added industries that are evolving towards the so-called *mindfacture*, as is the case of the automotive industry. Today, the automobile industry is synonymous with jobs, the generation of prosperity, and, therefore, better opportunities for Mexicans, with tangible and quantifiable results.

For the regional integration of the automotive industry, it is of crucial importance that we work together with our trading partners, particularly the United States. Collaborative processes of this kind strengthen the economic and productive vision of the North American bloc, largely thanks to the mechanisms implemented by the Government of President Andres Manuel Lopez Obrador.

Now, the challenges of climate change demand that the automotive industry in Mexico not only covers basic mobility needs, but that it does so in a sustainable, safe, and accessible manner, without emissions that are harmful to human health. Achieving this goal involves transforming the industrial processes of the entire value chain of the industry to move towards a more competitive and resource-efficient economy.

In this context, the Ministry of Foreign Affairs has promoted this initiative that seeks to identify the challenges and steps required to ensure an orderly and efficient transition towards the production of electric vehicles in Mexico. Therefore, this document expresses the commitment of this Ministry to support the evolution of the automotive industry in a safe and environmentally responsible way, in keeping with international responsibilities such as the Paris Agreement.

I have the honor to lead this effort from the Ministry of Foreign Affairs, in collaboration with the University of California, and to present this document that summarizes an important initiative to join efforts and make Mexico a protagonist in this global transformation of the economy, the environment and society. We are convinced that this type of collaboration will allow us to make innovative decisions for the construction of industrial solutions that contribute to the well-being of each and every citizen of our country.

LO

SAUBON

Mexico is immersed in a global dynamic that challenges the foreign, economic and industrial policy that had been applied in our country for decades. For this reason, it is necessary to coordinate multilateral efforts and the triple helix - academia, the private sector and the government - with a vision for the future and a transformative direction. The Deputy Ministry for Multilateral Affairs and Human Rights of the Mexican Ministry of Foreign Affairs recognizes the value added that is created when academia, the private sector and governments join efforts to build a better country through the creation and implementation of specific public policies that meet the needs of the citizens and their economic industries.

Under this logic, in late 2021 we began a close collaboration with the University of California to address a very clear need of an industry that has been a source of prosperity for all Mexicans for decades: the electrification of the automotive industry. This global trend has required Mexico to align all possible efforts at every level to stand its ground in the transformation that is being experienced and will be experienced throughout the world.

The aforementioned collaboration resulted in the creation of the Taskforce on the Electrification of Transport. This initiative proposes an orderly transition to electromobility not only at the national but also at the regional level, by coordinating the integration of production with our most important trading partner, the United States. The goal is clear: in 2023 the University of California and the Ministry of Foreign Affairs will present a bi-national roadmap for the creation and implementation of clear and defined policies for the Mexican automotive industry towards the manufacture and use of electric vehicles.

The results of the work of the Task Force are reflected in this document, which is the product of sessions held in two different phases: the diagnosis of obstacles and the identification of proposed solutions for the transition of this industry. In this regard, I would like to highlight the importance for this initiative of the inclusion of women in the automotive industry, also a relevant component of our Feminist Foreign Policy.

To put the issue in context, in the United States women represent only 27% of the automotive manufacturing workforce, compared to 47% of the total general workforce. In Mexico, according to INEGI, women represent 37% of the personnel of the “transport equipment manufacture” sub-industry; and several studies indicate that only 24% of employees in the automotive industry are women. While the data shows that there are women in executive positions in the industry, they represent only 3% of leadership positions, so it is imperative to incentivize their participation for our representation to grow.

Our Feminist Foreign Policy permeates all the activities of the Ministry of Foreign Affairs, and this project is no exception, as it promotes the participation of women in the different stages of the value chain of the electric automotive industry. The Task Force on the Electrification of Transport seeks to make the industry more inclusive, one where there are equal opportunities for fair pay, training, and talent development. Finally, I would like to acknowledge the support of academia, particularly the University of California and its director in Mexico, Dr. Isabel Studer for her unwavering commitment to this important agenda. In addition, I want to recognize the automotive industry, civil society organizations and government entities of both countries that participated to make this important initiative come true, which will be a tool for the orderly transition to electromobility in Mexico and North America. In particular, we appreciate the important role of the U.S. Embassy, the Department of State, the Department of Transportation, the Department of Energy, and California state officials in making sure this effort will translate into a fruitful outcome for both nations.

Finally, I recognize and thank the team of the General Office for Global Investment led by Professor Iker Jimenez for their enthusiasm and efficiency in coordinating this task, which will bring environmental, social and economic benefits to our country.

MARTHA DELGADO PERALTA

Undersecretary for Multilateral Affairs
and Human Rights

Director of Alianza Mexico at the University of California

ISABEL STUDER NOGUEZ

Transportation is one of the main sources of both global carbon emissions and investment and job creation because of its contribution to manufacturing production and the overall economy. In the fight against climate change, the electrification of transport is essential if we are to limit the increase of temperature to less than 1.5°C. But the unavoidable transition to the electrification of transport also implies a systemic change, with significant disruptions, both from a technological perspective and in the production models of vehicles, their supply chains and the materials used, the workforce and the skills that are required, as well as in transport systems and the infrastructure associated with them. The transition towards the adoption of electric or zero-emission passenger or cargo vehicles also requires the design of new public policies and business strategies, and adapting the existing ones to ensure that internal combustion vehicles also contribute to reducing carbon emissions.

The rapid transition to the electrification of transport also represents the emergence of new players and production centers that invested early in the development of electric batteries, in the extraction of essential materials, in innovative business models and in an industrial infrastructure that has allowed them to gain an advantage in the global market.

This context of systemic transformation imposes joint challenges for Mexico and the United States, which in the last three decades have invested to ensure the competitiveness of the automotive industry by creating an integrated regional production system and developing an infrastructure that allows mobilizing more than 70% of regional trade using land transport. The complex transition towards the electrification of transport requires innovative cooperation frameworks to maintain the competitiveness of this industry, which is at the heart of the economic integration of Mexico and the United States. At the same time, the urgent need to reduce carbon emissions makes it necessary to consider the design of new transport systems in the cities, including zero-emission public transport, as well as regional regulations and standards for the internal combustion engine vehicles that will continue to predominate in the universe of vehicles in use for many years to come.

In this complex scenario of systemic transformation, the University of California, through the Institute of Transportation Studies and Alianza Mexico, has vowed to generate the knowledge that informs both public policies and business strategies, which contribute to the development of innovative technologies and methodologies that accelerate the transition towards the adoption of zero-emission vehicles, while maximizing the benefits and reducing the costs associated with that transition.

In order for science to meet to the needs of society, the University of California, in conjunction with the Ministry of Foreign Affairs, has committed to offer a neutral space for government, the private sector, civil society and academia in the United States and Mexico to find points of convergence and actions that favor the collective interest. The results of the dialogues of the five working groups that began in February 2022 and are presented in this report, as well as multiple interviews conducted by University of California experts with key players of the automotive industry, provided a wealth of perspectives and information that were crucial in the design of the research program. As a complement to the report presented here, the results of this first phase of the research will be announced In April 2023, through a Roadmap, which will serve be the basis to build the bi-national collaboration framework that drives the electrification of transport.

Being a systemic shift, the transition to zero-emission vehicle adoption requires a long-term effort from government as a whole and society. For this reason, the University of California has decided to create a longer-term research program. To this end, three major work agendas have been identified around passenger vehicles, cargo vehicles and public transport, as well as

electromobility in cities. In parallel, three new subject-specific working groups have been established around these areas, which have seen new partners and more experts from the different campuses of the University of California join in. In addition, opportunities have been conceived to take collective work towards a broader horizon that considers the use of new fuels, such as green hydrogen, the circular economy, and the imperative of having a more robust electricity infrastructure and zero emissions. This long-term program will also enable capacity building on both sides of the border to develop the talent and workforce this transition requires.

On behalf of the University of California, I express my deepest gratitude and appreciation to Minister Marcelo Ebrard for his leadership and vision leading a project of enormous strategic relevance for Mexico and the United States. It has been a privilege to work hand in hand with Martha Delgado, Undersecretary for Multilateral Affairs and Human Rights, who has been a pillar of this project, and to whom I express my gratitude for the trust placed in our institution to undertake this great task in a spirit of collaboration. I also want to thank Iker Jimenez, Director General for Global Investment, and his team for their great work. To all the partners who participated in the many dialogues, conversations and events held in recent months, my gratitude and admiration for your commitment to turn this agenda of the electrification of transport into a true effort of the entire government and of society as a whole.

The national electrical manufacturing industry and the electrification of transport

SALVADOR PADILLA RUBFIAR
Director General of the National Chamber of Electrical Manufacture

Many efforts have been launched on the subject of sustainability around the world, to reduce carbon dioxide (CO2) emissions and mitigate their effects, in a context where the reactivation of economic activities demands an increasing amount of energy. In particular, there is an accelerated process toward the electrification of commercial, industrial and service activities, which allows us to predict a high impact on electricity in the future.

Electromobility, defined as the set of land transport systems, whose propulsion and operation is partially based on the use of electric power, emerges as a magnificent alternative that will without question contribute to the reduction of CO^2, supported by a swift technological change that has make it possible to optimize costs, increase the storage capacity of batteries, and to develop more powerful and efficient recharging infrastructure.

This has been key for international development of the electrification of transport; according to information from the International Energy Agency (IEA), the number of electric cars circulating in the world tripled in just three years, up to around 16.5 million in 2021. Similarly, there was a significant growth in recharging infrastructure, even during the pandemic. Including both slow and fast recharging equipment, the number reached almost one million eight hundred public recharging locations worldwide in 2021.

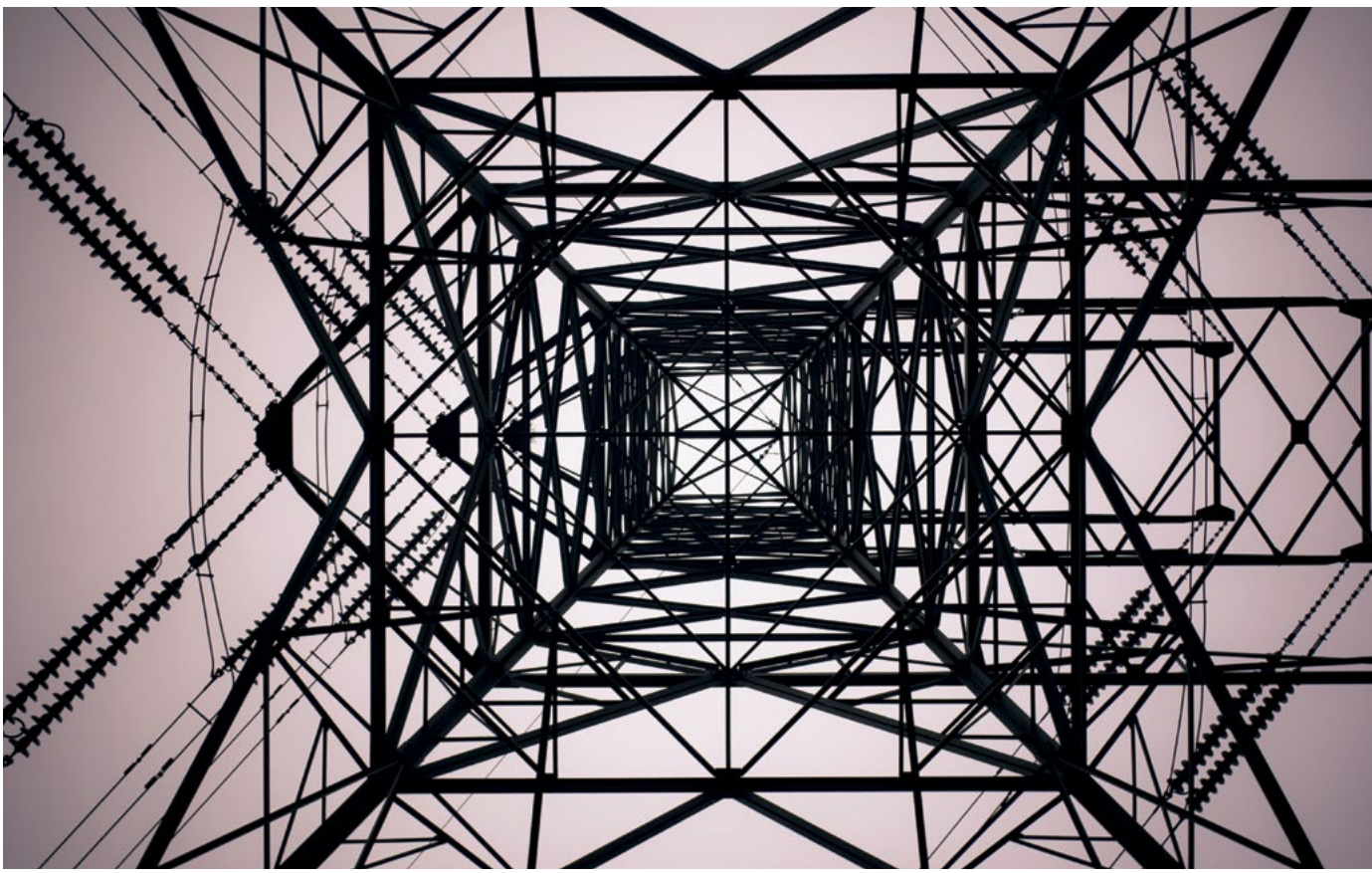
This global trend represents an exponential growth, and while it is more marked in certain regions, Latin American countries are not the exception. In the case of Mexico, the development of projects for the electrification of public transport and the incorporation of a greater supply of private cars, have driven an incremental adjustment of the projections for the coming years. In this sense, the 2022-2036 Program for the Development of the National Electric System (PRODESEN) contemplates that the expected energy consumption of electric cars by 2036 will be 13,283 GWh, which would represent 2.8% of the total energy consumption of the country.

The great opportunities that the development of electromobility will represent are evident, and the participation of key related industries, such as electrical manufacturing, is fundamental to maximize the impacts for the benefit of Mexico and its population.

An initial issue derived from the significant increase of car recharging infrastructure that is foreseen, is the clear need for the modernization of the national electricity system, not only in terms of increasing generation, transformation and transmission capacity, but also in terms of qualitative changes in the electrical equipment, to guarantee the optimal operation of the electricity networks, incorporating variable and distributed resources both for generation and for new recharging centers. This way, the electrical manufacturing industry is a major player in the innovation and ongoing development of new products in response to the modernization needs of the national electricity system. For this reason, some time ago, companies in the industry initiated major changeovers, moving towards digitization and automation, and prepared themselves to tackle this important challenge, using the productive and technological capacities available for this purpose.

Second, as we previously mentioned, recharging system trends clearly require increasingly powerful and efficient equipment, interconnected at the level of the distribution networks. For this purpose, the technology centers of each electrical manufacturing factory, and the alliances they have formed with research centers and academia, are already working to offer solutions in this regard, strengthening the value chain of national suppliers. In order to generate a greater demand, it will be necessary to fill existing gaps in terms of regulation and standardization. This will allow, on the one hand, to guarantee the safe and efficient operation of the equipment, and on the other, to establish the operating rules of the new business models with a link to the sale of energy for recharging purposes.

Third, electromobility implies substantial changes to the traditional value chain of internal combustion vehicles, because a large part of the components of electric cars are also electric, as is the case of: batteries, connection harnesses, internal chargers, engines and regenerative brake system generators, which are an essential part of their operation. This opens opportunities for the local development of these new components, which involves capacity expansion, job generation, engineering development, and other aspects that will give increased robustness to existing companies, attract national and foreign investment with new production plants in Mexico that can leverage the proximity to the North American market



and promote the integration of a regional value chain around electromobility, benefiting from the Trade Agreement between Mexico, the United States and Canada. Finally, it is necessary to emphasize that innovation will be paramount for success and to realize the opportunities presented by the electrification of transport in the electric power industry. Science, technology and creativity will play a key role and the application of the five-axis model will bring together the joint efforts of academia, government, industry and society, all from an approach of sustainability and preservation of the environment, to have a robust, reliable, safe and efficient electricity system. It is considered that the near future will be electric and companies in the electric manufacturing industry are ready to make it happen.

The Industrial Perspective of the Electrification of Transport

JOSÉ ZOZAYA
President of the Mexican Association of the Automotive Industry (AMIA)

I have had the wonderful opportunity to participate in various forums on behalf of the Mexican Association of the Automotive Industry (AMIA), in which I have said that electromobility or the transition to zero-emission vehicles is a fact in the international arena that will continue to move forward with or without Mexico. In the case of our country, the share of hybrid and electric vehicles in the domestic market has been gradually increasing over the last six years, but still remains at marginal levels, representing 4.4% of the total sales of light vehicles, a situation that reflects the need to accelerate the electrification of the vehicle fleet in the country.

In this sense, in recent times we have witnessed a series of announcements and strategies from the federal government that make us optimistic about the path to a Mexican automotive industry that gradually eliminates its carbon footprint. For example, the Ministry of Foreign Affairs, together with the University of California – Alianza Mexico, has initiated a study that will define a roadmap towards electromobility. The findings will be reported in early November 2022 during COP27, in Egypt.

This roadmap is based on the five pillars presented by this document. In addition, it is based on the experience of the state of California, therefore it offers a broader, more comprehensive vision. We recognize the importance of this electromobility initiative that addresses different aspects of the wide range of factors involved in the transition to electromobility and zero-emission vehicles.

However, we believe that it is necessary to have greater inter-ministerial coordination and to establish a transversal leadership that facilitates a conversation with the automotive industry, to offer certainty and guidance to attract new investments. In this context, the AMIA has initiated a study to determine the elements that will be the foundation of our recommendations to the Mexican government to achieve the implementation of a comprehensive public policy that promotes both sides of the equation of electromobility. On the one hand, to encourage demand through the use and acquisition of electrified vehicles for the development of the domestic market; on the other hand, to increase supply by promoting the manufacture of parts, components, batteries and vehicles to maintain our position of leadership

at the international level among light-vehicle manufacturing countries and particularly in the North American region, to take advantage of the opportunities offered by the USMCA.

No less important is the task of educating and informing the general public about the benefits of the use of new technologies, and identifying the new skills and competencies that collaborators must have all along the production chain of this industry. An indispensable additional element is to ensure the supply of electric power from renewable sources, in sufficient quantity and at competitive costs both for the value chain as a whole and for the recharging of vehicle batteries. If this condition is not met, the permanence of the auto industry in Mexico will be jeopardized because it will not be able to fulfill the global auto industry's commitment to ensure the use of clean energy and to eliminate the carbon footprint in the coming decades.

We are convinced that the collaboration between government and industry is indispensable for the development and implementation of public policies that promote an accelerated transition to the electrification of the vehicle fleet in Mexico. We will achieve it working together. At AMIA, we reiterate our commitment to continue working for the well-being and progress of our country.

MIGUEL ELIZALDE
President of the National Association of Bus, Truck and Tractor Truck Producers (ANPACT)

When we talk about electromobility, we think it is something recent, but in Mexico it started in heavy vehicles in 1900, with the first electric trams. It took 50 years before the same cable network was used for the first trolleybus in 1951. Later, the first battery-operated bus began circulating in Mexico in 2020. Months later, we had the first electric heavy-duty freight trucks and recently electric tractor-trucks. But Mexico, being a producing and exporting power, started exporting the first cargo trucks to the United States in 2018.

The Heavy Vehicle Automotive Industry is the world's leading truck exporter, the fourth-largest exporter and fifth-largest producer of cargo vehicles, and eighth-largest producer of buses. This leadership must be maintained in a challenging environment, where we must increase the value of regional vehicular content for the USMCA from 60% to 64% in 2024 and to 70% in 2027, at the same time as we are experiencing a reconfiguration of our supply chains, impacted by phenomena such as nearshoring. Faced with this reality, we will see a gradual transition towards zero-emission vehicles at different speeds, where we will see ultra-low-sulfur diesel, natural gas, electric and soon hydrogen vehicles coexisting next to each other in Mexico.

Electromobility is already a reality, and precisely because of Mexico's global leadership, our Industry, Authorities and Academia must work together. The best example of this is the work being led by the General Office for Global Investment of the Deputy Ministry for Multilateral Affairs and Human Rights of the Ministry of Foreign Affairs. At this office, we coordinated under different work groups ranging from energy infrastructure to the development of supply chains, with the participation of ANPACT, to accelerate the implementation of clean technologies.

As exporters, the challenge is to make our supply meet the requirements of the USMCA. For the domestic market, it is modernizing road transport to the same level of our main commercial partner, to avoid lagging behind, and strengthening ourselves as a region vis-à-vis other global economic blocks. Only in this way shall we maintain the global leadership of the Heavy Vehicle Automotive Industry, to continue on our Path for Mexico.


ELECTRIC
MLB 47B

Director General for Global Investment

IKER JIMÉNEZ

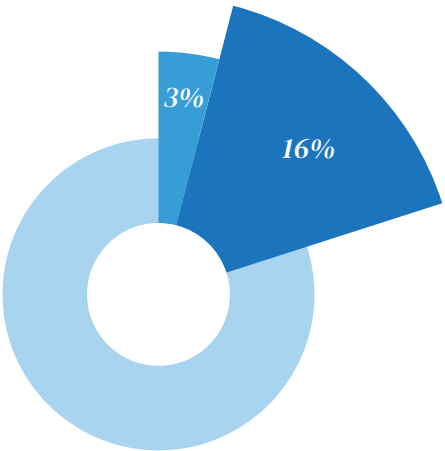
Introduction

In 1900, about 30 percent of cars in the United States were electric, but 100 years later, only 1 percent are. The introduction of Henry Ford's Model T - coupled with the discovery of oil fields in Texas - enabled lower fuel prices, which resulted in accelerated production and the adoption of gasoline-powered vehicles. The production of this type of cars has grown exponentially ever since (Department of Energy, 2014; Placek, 2022).

However, innovation, technology and electronic advances have reformulated the way society operates. For example, advances in semiconductor technology over the past 50 years have made electronic devices smaller, faster, and more reliable. Today it would be impossible to imagine the development of communications, the Internet of Things, artificial intelligence, healthcare systems, transportation, clean energy and countless other applications without the boost provided by semiconductors.

Alongside these technological advances, the world is experiencing an unprecedented environmental crisis. This is the juncture the automotive industry finds itself in. On the one hand, the industry has to follow the technological vanguard and optimization trends. On the other, transportation, one of the main culprits of CO2 emissions has to become an ally in the fight against climate change. According to a report by Greenpeace (2018), the carbon footprint of the automotive industry in 2018 accounted for 9% of the total greenhouse gas emissions globally. That said, the only way to make transportation and its energy consumption more sustainable is by electrifying it using renewable sources.

In Mexico there are currently about 50 million combustion cars. This posits questions such as: What kind of infrastructure will be needed in the future to boost domestic demand for electric cars? What will be the reconfiguration of the roads, the houses and the apartments we live in? What kind of training and transfer of skills will automotive human capital need? What vision do we need for the future to achieve this transition, and to avoid being left behind in an industry in which we are leaders today?



Automotive Industry

- GDP Total
- GDP country's manufacturing

INEGI, 2021

$5.4 BILLION

in foreign direct investment

Received by the domestic automotive and auto parts industry last year

Statista, 2022

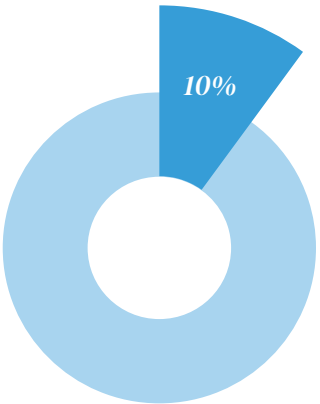
This overview of the sessions of the Task Force on the Electrification of Transport presents and answers questions like these.

1. MEXICO'S LEADERSHIP IN THE AUTOMOTIVE INDUSTRY

The automotive industry has been one of the main pillars of the economic development of the North American region and, obviously of Mexico, particularly in the 90s, after the conclusion of the negotiation of the North American Free Trade Agreement (NAFTA). The automotive industry played a fundamental role during NAFTA negotiations, since it was the industry with the biggest economic exchange for the three countries. The signing of NAFTA led to the gradual deregulation of the industry, creating business opportunities for foreign companies, and thus forcing auto parts manufacturers installed in Mexico to increase quality and reduce production costs (Miranda, 2007).

As a result, for almost three decades the country has been one of the leading nations in this industry, currently it is the fourth exporter and seventh producer of cars in the world (OICA, 2021). This industry represents 3.0% of the total gross domestic product (GDP) and 16.0% of the country's manufacturing GDP (INEGI, 2021). In addition, last year the domestic automotive and auto parts industry received about $5.4 billion in foreign direct investment (Statista, 2022).

Skilled labor, the country's geographical location and the network of free trade agreements have made the automotive industry an important export platform for Mexico, and they have driven regional economic integration in this industry.



of all cars sold are electric

with China accounting for half of that growth

IEA, 2022a

2035

HAS BEEN SET

for The European Commission

as the end of the sale of combustion vehicles and several countries are offering incentives

IEA, 2022

However, the outlook in 2022 has not been entirely encouraging: according to data from INEGI, in the first months of the year car sales were the lowest in a decade. The aspects that led to the low performance of the industry -and that will undoubtedly continue to affect its results -, at least the first quarter of 2023, include: i) the shortage of semiconductors and a drop in car production; ii) the recent issuance of licenses to use foreign used cars; and iii) the volatility in the price of automotive components, such as steel and aluminum (Deloitte, 2022a).

2. GLOBAL ELECTRIC VEHICLE OUTLOOK

The automotive industry is in a moment of disruption: the transition to electromobility. This, as explained above, is a consequence of the changes that society is experiencing due to the pandemic and other factors, and of the need to offset climate change with more sustainable and efficient means of transport. According to the Global EV Outlook, published this year by the International Energy Agency, in the best-case scenario, it is estimated that approximately 30% of new vehicles sold in the world will be electric by 2030. In addition, the global market value of this new industry is projected to reach $190 billion by that year (IEA, 2022a).

Here is a comparison to put this rapid growth in context: the number of electric vehicles sold in 2012 was around 120,000. By contrast, that figure in 2021 was the number of electric cars sold weekly. Today, nearly 10% of all cars sold are electric, with China accounting for half of that growth (IEA, 2022a). In the United States, which is another key market for electric vehicles, the federal government announced its first goals, which include 50% of electric vehicle sales by 2030 and the installation of 500,000 public chargers. The European Commission has set the year of 2035 as the end of the sale of combustion vehicles and several countries are offering incentives to increase the demand for electric cars (IEA, 2022).

On the other hand, economic growth and opportunities in this new industry have not been entirely equitable, as developing countries continue to lag behind in the manufacture and sale of electric vehicles, where few models are available or remain unaffordable.

3. UNITED STATES-MEXICO TASK FORCE ON THE ELECTRIFICATION OF TRANSPORT

The Ministry of Foreign Affairs (SRE) of Mexico, under its mandate to promote economic growth and to attract investment, understands that the country needs to accelerate the transition to the manufacture of electric cars and thus maintain a sustained growth in this industry. Therefore, the Ministry of Foreign Affairs, in collaboration with the Alianza Mexico of the University of California, has created the United States-Mexico Task Force on the Electrification of Transport. This initiative is a cornerstone at the global level, as it offers a comprehensive high-level and triple helix approach (academia-government-industry), with the aim of strengthening bi-national economic integration in the automotive industry under a single roadmap. The first output of this initiative was presented during the United Nations Framework Convention on Climate Change (COP 27) and the final version will be available in 2023.

On the part of Mexico, different ministries and government bodies have actively participated in the project, including the Ministry of Public Education; the Ministry of Economy; the Ministry of Infrastructure, Communications and Transportation; the Ministry of Labor and Social Security, and the Federal Electricity Commission (CFE). At the state level, different states have participated actively in the task force - including Nuevo Leon, Puebla, Yucatan and Queretaro - and there has been collective representation under the Mexican Association of Economic Development Secretaries. In addition, five national business bodies, fifteen automotive industry companies, six universities and several civil society organizations have been key players in the initiative.

The U.S. Government also participated in the development of this document through the U.S. Embassy in Mexico, the Department of State, the Department of Transportation and the Department of Energy, and California State officials.

The overview of the sessions of these working groups consists of two parts: the first provides a diagnosis of the obstacles and challenges presented by this transition at the national level. The second part provides recommendations based on the analysis carried out in the first phase.

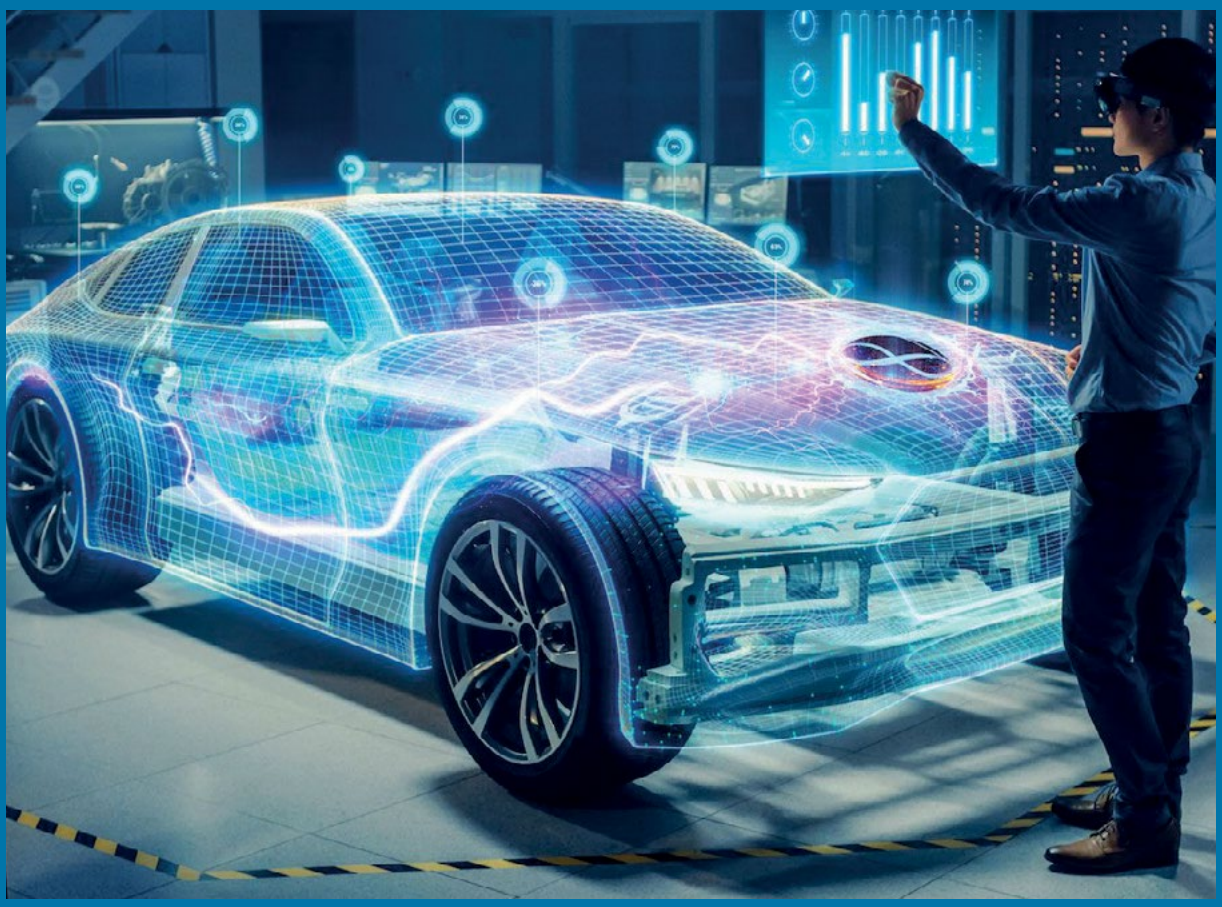
The results of the project are the result of an open and safe dialogue with the aforementioned actors. To achieve the identification of challenges and opportunities, the project has been conducted in different working sessions under five thematic axes, which are embodied in the chapters of this document: 1. Human capital, 2. Innovation, 3. Development of Suppliers, 4. Infrastructure and 5. Governance.

Finally, by way of conclusion, the document offers a section called “areas of opportunity”, which offers the reader a reflection on the challenges and gaps faced by this project in order to advance its findings and improve its analysis over time.

The work of the Ministry of Foreign Affairs is focused on achieving results that will boost the economic and social well-being of Mexico. This document lays the groundwork, raises the necessary questions and drives the critical analysis that industry, government and academia need to do to rethink the global economic and productive future. The country has all the tools to once again demonstrate its leadership in this industry, and in turn, to respond to the social demand for a more just and sustainable world, and to the complex challenges presented by the technological era. Let’s move into the future.

The Ministry of Foreign Affairs (SR
under its mandate to promote econ
and to attract investment, underst
to accelerate the transition to the n
and thus maintain a sustained gro

RE) of Mexico,
nomic growth
tands that the country needs
manufacture of electric cars
owth in this industry.



Inno-vation

Introduction

Technological innovation has always been a key element in the evolution of the automotive industry. From its beginnings, vehicle production transformed the manufacturing industry with technological advances, such as the development of new materials and designs, and new management methods, such as the production line. Over the decades, innovation in the automotive industry has made it possible to design vehicles that are increasingly safer, faster, more efficient and less polluting. Currently, the demand for the transition to electromobility presents a series of challenges that have, once again, the potential to blow up the innovation capacity of the industry.

In turn, beyond its contribution to industry, innovation itself is considered essential to realize the development of our society, and to sustain economic growth in a world of limited resources (Freeman, 1992). This is reflected in Goal 9 of the UN Sustainable Development Goals (SDGs); "Industry, innovation and infrastructure":

SDG 9.b. Support domestic technology development, research and innovation in developing countries including by ensuring a conducive policy environment for inter alia industrial diversification and value addition to commodities.

We often think of innovation in specific technological terms, and in the case of electric vehicles, it is often linked to concepts such as artificial intelligence, robotics and other cutting-edge technologies that expand the frontiers of industrial capabilities. However, innovation can also be understood as the process of adopting and updating technological advances developed in other countries by way of technology transfer, as well as investing in production in the country and applying imported technologies. These forms of innovation are relevant regardless of the specific product in which they are employed, because they can develop applications in other industries and in novel technological derivations.

The interrelationship of various factors such as trained human capital, regulations that promote entrepreneurship environments, adequate infrastructure to strengthen value chains and financial systems are key to fostering the development of innovation. In this sense, the thematic axis of innovation of this section refers to and is interrelated with the different thematic axes established in the project.

This chapter analyzes different areas identified in initial research with stakeholders from the industry, government and academia, which is complemented with secondary research, which resulted in a diagnosis of the main obstacles and solutions in this area. The output of the research is a series of recommendations or first steps in innovation for the development of the electric automotive industry in Mexico.

DIAGNOSIS

In order to understand the most important problems the industry faces in the transition to electromobility, this section analyzes the obstacles identified to promote innovation in the production of electric vehicles in Mexico. The analysis is done in relation to new forms of production and the capacities needed to carry them out, and to the development and adoption of emerging technologies.

These obstacles were classified in three sub-categories, which in turn group a series of challenges that reflect the main discussions on electric vehicle innovation around the world, which are: 1) innovation and development in the electric automotive industry; 2) innovation in circular economies, battery recycling and disposal, and 3) innovation and specialized human resources.

1. Innovation and development in the electric automotive industry

Year after year, around the world we see important technological advances in the manufacture of clean vehicles, particularly in electric vehicles, and a remarkable evolution in the technology of the batteries. Electric cars have an increasing number of digital components and interconnecting func-

$4.5 BILLION

dollars received for private investment in autonomous vehicles

tionalities that make them safer and smarter, allowing companies to constantly improve their services. As for batteries, we see constant improvements in charging speed, capacity and a reduction of their weight, the result of both consolidated technologies, such as lithium-ion batteries, as well as emerging technologies, which reflects the rapid and constant innovation in energy storage and its applications to mobility.

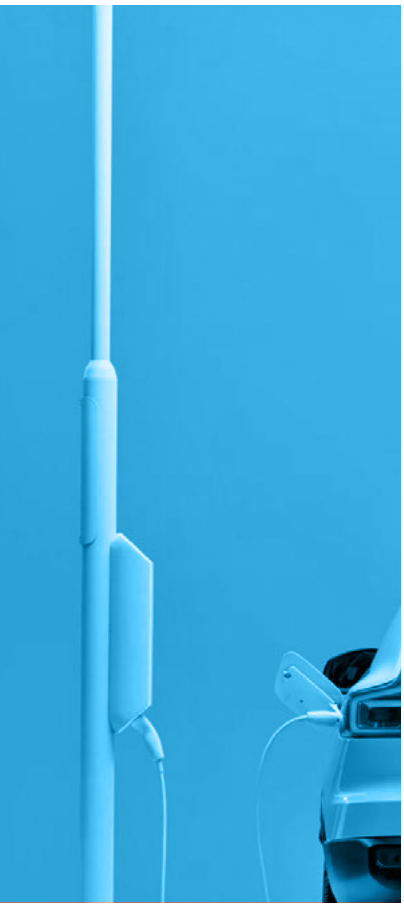
For this reason, the electromobility industry uses, invests in and contributes to the development of the main cutting-edge technologies. In artificial intelligence, for example, autonomous vehicles in 2020 were the second area with the largest private investment (after certain medicines), receiving 4.5 billion dollars (Stanford University Human-Centered Artificial Intelligence, 2021).

There is innovation not only in electric car technology as a viable mobility alternative, but also in the way in which electric cars are produced. To understand the innovation challenges in the manufacture of electric cars, the participants of the task force explained the similarities and differences with respect to the manufacture of internal combustion vehicles. They pointed out that the manufacturing stages of electric cars - and internal combustion cars - can be conceptualized in four phases: stamping, welding, painting and assembly. According to the participants, in the first three stages, direct human intervention is minimal, since production is highly robotic and automated. It is precisely in the last stage - assembly - that we find the biggest differences in production. Electric vehicles are made up of fewer parts, so they need a less participation from workers in their production.

Participants also noted that, in modern automobile manufacturing, parts are designed to be modular, and everything is manufactured under the *just-in-time*[1] and *just-in-sequence* modalities.[2] They pointed out that vehicle production in Mexico is already largely adapted to these conditions, as it competes in advanced automotive manufacturing at a global level. Industry 4.0 - also known as the "Fourth Industrial Revolution"— is characterized by automation and data exchange, so in this sense it is already a re-

[1] It refers to the strategy of delivering parts or materials to manufacturers at or near the time they are needed for assembly.

[2] It refers to the strategy that ensures that parts are delivered at the scheduled time and in the exact order required for assembly.



ality in this industry. However, they pointed out that not all plants have the same level of automation, particularly in smaller companies, which tend to be less automated. Automation involves everything from logistics, robotic manufacturing methods and modular design to the integration of plant information.

This new type of production increasingly requires the adoption of technologies associated with industry 4.0, particularly in terms of digitization and the implementation of the 5G network (see the Infrastructure chapter). This is done not only to optimize the entire manufacturing process, and to improve the traceability of the car throughout the production chain to guarantee and monitor the quality of the product all along the process, but also in relation to the sale and after-sales services of electric cars.

In this respect, the participants mentioned that production processes in factories currently need to meet a growing global demand and competition in a more efficient manner, therefore a failure to adopt these technologies in Mexico would make the country less competitive on the international stage. In turn, they pointed out that this will represent an obstacle in the medium and long term, as it will be increasingly difficult to comply with the requirements and technological standards that Tier 1 suppliers in the industry will require. Tier 1 companies are the link in a supply chain that supplies components directly to OEMs (original equipment manufacturers).

On the other hand, the participants highlighted shortfalls in infrastructure and investment in laboratories and test tracks that allow testing and validating the technology and innovation developed in Mexico, for example, the software embedded in electric vehicle components.

In this sense, and to summarize, the participants considered that the main obstacle to the development of innovation in production plants and in the production of specific supplies is the absence of an ecosystem of comprehensive public policies and a lack of adequate infrastructure to support the transition of the automotive industry in all its links: Tier 3 (raw materials), Tier 2 (parts), Tier 1 (components) and OEMs.

2. Innovation in circular economies, battery recycling and disposal

One of the topics highlighted throughout the sessions in all the thematic axes of the project, and in particular in terms of innovation, was the importance of the circular economy in the useful life of batteries, a model that contemplates the reuse of products and parts, including the recycling of components and the proper management of final waste. Participants considered that there are currently no suppliers - or at least not enough - of services of this kind. In this sense, the obstacles they identified were the lack of information on companies that can make the transition to provide circular economy services, as well as the absence of incentives to promote this type of industries.

To this end, they pointed out the need to accelerate the implementation of adequate waste management regulations that protect the environment and people's health. Recent literature on barriers and solutions in circular economies and electric vehicle battery recycling coincides with the findings of the participants and points out as main barriers the lack of safety standards and public policies, as well as the high costs of recycling (Sopha et al., 2022).

3. Innovation and specialized human resources

The creation or adoption of new technologies entails a need to have adequate human capacities available. During the first working session in this area, participants agreed that, in this new industry, substantive production processes will be based on the work of other professions. These new specialties will be different from the traditional professions of the industry, so other areas - such as data analysis, telematics, mechatronics, electronics, *software*, cybersecurity, artificial intelligence, among others - will become relevant.

Most of the interviewees agreed that the lack of human capital development constitutes an obstacle to innovation in all production links, and in the dimensions of services of this changing industry (see the Human Capital chapter).

In this regard, industry actors mentioned that it is very hard to hire people who have the skills required, so they often develop these skills internally in their companies. They pointed out that, in the case of medium-sized and small companies, the training is provided locally by consultants, while large companies prefer to send some of their staff abroad, with the idea that, upon return, they can train others.

The participants mentioned that developing training strategies at the company level is an inefficient measure, because this strategy doesn't have the scope to generate the human resources required at the industry level in an entire region. Second, they described that another obstacle is that, even if such capabilities are developed in the company and in the country, being highly demanded capabilities, companies often have to deal with "brain drain" when staff goes to other companies or even to other countries.

INNOVATION RECOMMENDATIONS

The following section presents a series of general and specific recommendations, which were taken from the information gathered in the second session of this thematic axis of the project with participants from government, industry and academia from both Mexico and the United States, in response to the obstacles and challenges previously identified in terms of innovation.

I. INNOVATION POLICY

Recommendation 1: Hold parliamentary forums for the drafting of a General Science, Technology, and Innovation Act, and other reforms that are required for the promotion of innovation in Mexico

Among the general recommendations to address the aforementioned obstacles, the participants highlighted the need to carry out a systematic review of the current regulations in order to involve key innovation stakeholders in Mexico. Regarding this, they proposed organizing regulatory innovation tables on research and development (R&D) policy, in order to identify the main needs to boost the development of innovation in the country in a collaborative way between government, academia and industry.

In this sense, an ideal forum for such regulatory innovation tables would be the National Congress. Therefore, the first recommendation would be for federal legislators to organize and convene a parliamentary forum through the figure of the Open Parliament, in which the various relevant stakeholders of the Federal Government, state authorities, different technology and innovation industries (including the electric automotive industry), academia and civil society participate. The main goal of the forum will be to develop a participatory Science, Technology and Innovation draft law, and to review other regulations that have impacts on innovation.

The aim is to develop an overarching innovation agenda that takes into account the opinion of the different stakeholders and aligns interests to promote research and development in Mexico. In addition, the intention would be for this space to establish the bases for the implementation of various policies that are mentioned in this chapter. It is worth bearing in mind that it is relevant to make a thorough review of whether the regulation of industrial and business activities creates or does not create incentives for innovation in Mexico, since there is evidence of how certain regulatory standards affect innovation (Aghion et al., 2021).

Based on the constitutional reform published in the Official Gazette (DOF) on May 15, 2019, article 73 section XXIX-F, gave Congress the authority to legislate in science, technology and innovation in order to establish the general bases for coordination with the states and municipalities, and for the participation of social and private industries for the consolidation of the National Science and Technology and Innovation System.

XXIX-F. *To issue laws aimed at the promotion of Mexican investment, the regulation of foreign investment, the transfer of technology and the generation, dissemination and application of scientific and technological knowledge required for the development of the country. Likewise, to legislate in the field of science, technology and innovation, establishing general bases of coordination between the Federal government, the states, Municipalities and the territorial authorities of Mexico City, within the scope of their respective competences, and the participation of the social and private industries, in order to consolidate the National Science, Technology and Innovation System.*

Although the current Federal Science and Technology Act has been reformed a couple of times since the constitutional reform of 2019 and has embraced relevant issues, the current law is restrictive of the ways states and municipalities can coordinate and participate, which are limited to agreements. However, following the constitutional text, broader and more dynamic bases of coordination could be established between the states, municipalities and the territorial authorities of Mexico City to implement innovation policies in a coordinated manner at all government levels.

There is also an opportunity to adopt best practices for the promotion of innovation and development, for example by providing specific tax and/or non-tax incentives for the development of innovation. This can encourage the promotion of specialized migration programs and investment in

training in STEMS (science, technology, engineering and mathematics), as well as facilitate funding for research and development in this area.[3] Finally some of the recommendations that are made later in this chapter may be reflected at the legislative level in this law, or others that may be reviewed.

RECOMMENDATION 1

Hold parliamentary forums for the drafting of a General Science, Technology, and Innovation Act, and other reforms that are required for the promotion of innovation in Mexico.

RELEVANT ACTORS

The Ministry of Foreign Affairs, the National Congress, the Federal Government, state and municipal authorities, industry, academia, civil society.

[3] See for example Bloom et al., 2019.

Recommendation 2: Workshops for the development of industry-specific technology centers for innovation, as well as the development of the electric automotive industry

The need to design and develop one or more technological hubs in the country was raised in the sessions of the working group on innovation (both for the electric vehicle industry and for general industry). Based on the ideas expressed in these sessions regarding the characteristics that a technological hub may have, the participants of the working group identified an instrument that literature and international organizations refer to as "Technological centers" or "industry-specific technology centers" (CT or CTS). In this sense, the CTS can be seen as the mechanism to achieve the development of a hub, whose conceptual definition is the agglomeration of technology companies. IDB experts shared that:

According to the OECD (2013), the two arguments that justify CTs are: (a) Generation of knowledge that is considered a public asset, correcting market deficiencies related to the low private appropriation of the generated knowledge. (b) Meeting of systemic failures that affect the development of interactions between institutions and private agents involved in R&D and innovation (Crespi, n.d.).

These types of centers can have a variety of characteristics and forms of intervention, both public and private, but in general they fulfill these three basic functions: i) generation of industry-specific knowledge, ii) acceleration of the dissemination of technology and iii) strengthening of the coordination between supply and demand (Crespi, n.d.).

Additionally, the purpose of the hubs can be understood as concentrating efforts focused on technological development not only to accelerate it, but also to promote cooperation and joint creation between different industries. In general, innovation hubs can be conceptualized as spaces where barriers to the co-creation of solutions are reduced and where collaboration and creativity are fostered (Toivonen et al., 2015). Innovation hubs can also be spaces for participatory experience in the development of technology skills and digital literacy (Gathege et al., 2013, cited in Sambuli et al., 2017). The actors of the project pointed out that having institutions and spaces for the development of human capital - through training schemes in which industries, academia and government participate - could be included as a potential component in a hub of this nature.

The technological innovation hubs can include everything from incubators and accelerators to laboratories and collaborative workspaces (Sambuli et al., 2017). In this regard, industry participants specifically noted the need to promote investment and schemes to develop testing infrastructure, such as tracks and labs, which could be conceived as part of a CTS.

There are several examples of innovation hubs for vehicle testing. One of them, mentioned by a participant, is the autonomous village of Millbrook in the United Kingdom, a center built to promote the development of connected and autonomous vehicles in order to provide mechanical support, integration and development of software for private and public transport vehicles (Millbrook, n.d.).[4] Millbrook is not the only testing space of its kind, as it was inspired by the Milford, Michigan test facility created by General Motors in 1924, the first of its kind and which today continues to be one of the largest and most comprehensive automotive testing facilities in the industry (General Motors, n.d.).

On the other hand, in subsequent interviews with the IDB, specialists in competitiveness, technology and innovation shared various examples of CTS that have been implemented in the Latin American region. They explained that these models are useful to identify best practices, types of interventions and collaborative strategies between government and industry to foster industrial innovation. They cited the example of Colombia, which, although it belongs to another industry, illustrates one of the possible models for a CTS: the "Fondo de Fomento Palmero". This fund uses the money from a specific tax that is paid into an industry fund that finances national research centers, which are science and technology institutions for the genetic improvement of palm and the development of palm oil.[5]

On the other hand, Chile - under the National Agency for Research and Development (ANID)— has created a series of programs for the development of technology centers, and to attract international centers of excellence to carry out R&D activities, promote technology transfer and market the results. These are implemented with the participation of a local partner, which can be a university, a technological institute or a technology company.[6] So far, the program has installed centers from Germany (Gesellschaft), Australia (Csiro), France (Inria) and Holland (Wageningen).[7] This is a model that could also be explored in Mexico for the promotion of innovation and technology transfer.

A third Latin American example is Brazil's EMBRAPII[8] -or Brazilian industrial research and innovation company, per the acronym in Portuguese-, which are public companies that, with co-financing from private sector, develop centers of excellence in R&D, that develop technical skills and abilities in modern facilities focused on the promotion of industries with a technological focus. There are 42 EMBRAPII units around Brazil engaged in different activities, including information technologies, chemical materials, biotech-

4 See EIT (2020).

5 See Fedepalma, n.d.

6 It refers to companies whose business model is based on the development and application of new scientific or technological discoveries for the generation of new products, processes or services.

7 See ANID, n.d.

8 See EMBRAPII, n.d.

nologies, mechanical manufacturing and applied technologies. Some of the activities carried out by these centers include the development of intelligent systems, software and computer systems, digital communications, embedded systems and intelligent automotive systems, among many others. EMBRAPIIs have a tripartite financing model (EMBRAPII, 2020).

According to various project participants, the participation and leadership of the government is required to be able to develop innovation hubs with some of the elements indicated here (such as capacity building spaces, with specialized infrastructure for testing, laboratories and others). Because there are many possible models -and because the type of hub to be implemented must respond to the needs of the relevant actors and that consensus must be reached between the different interests within the industry itself, the public sector and academia- the recommendation is to hold worktables to define the goals, interests and intervention mechanisms to implement CTS or hubs for the automotive industry in Mexico.

The recommendation of the participants is to propose holding worktables between government, academia and industry actors for them to jointly propose the development of CTS or innovation hubs for electric vehicles. Among the core points in the design of this type of space stands out the importance of ensuring the governance of technology centers through a significant representation of the private sector and private co-financing mechanisms that also guarantee their permanence and sustainability over time (Crespi, n.d.).

RECOMMENDATION 2
Workshops between government, industry and academia; Industry for the development of industry-specific technology centers for the electric automotive industry.
RELEVANT ACTORS
The Ministry of Foreign Affairs, the Ministry of Economy, the Inter-American Development Bank, industry, academia.

II. CIRCULAR ECONOMIES, BATTERY RECYCLING, HANDLING AND DISPOSAL

The importance of this regulation for the electric vehicle industry is to anticipate and avoid potential environmental problems arising from the end-of-life and recycling of batteries in the future. To achieve this, it is necessary to generate a comprehensive policy that includes protocols on the recycling, transportation, handling and disposal of the hazardous polluting materials contained in batteries. In addition, it is necessary to establish obligations and responsibilities, so that industry, users and authorities together contribute to mitigate risks and generate innovative business opportunities.

There are several key strategies to consider as part of the overall review of circular economy regulations, to implement simultaneous strategies for this purpose, including the promotion of innovative business models, economic incentives, standards for electric vehicle batteries, environmental responsibilities and certifications.[9]

Recommendation 3: Review of standards and programs for the proper handling and disposal of electric vehicle batteries

This recommendation refers to making a diagnosis of the existing regulations that impact on the circular economies of batteries, their recycling and adequate disposal, which can result in specific reforms to ensure an optimal waste management and safety. The regulations that must be reviewed include the standards and plans for comprehensive waste management, as well as other applicable regulations.

A series of concrete proposals were made during the solution sessions of the project to anticipate and address in a timely manner the challenges posed by the use and disposal of electric batteries, considering that the main barriers usually include inefficient public policies, lack of safety standards and high recycling costs (Sopha et al., 2022).

In accordance with the General Law for the Prevention and Comprehensive Management of Waste (LGPGIR), the Federal Government is responsible for formulating, conducting and evaluating the national waste policy, and for the development of the National Program for the Prevention and Comprehensive Management of Waste (PNPGIR) and the National Program for the Prevention and Comprehensive Management of Special Waste (PNPGIRME) based on the Basic Diagnosis for the Comprehensive Management of Waste (DBGIR) (SEMARNAT, 2020).

[9] See Sopha et al., 2022.

As instruments of the Policy for the Prevention and Comprehensive Management of Waste, these programs are based primarily on the information contained in a basic diagnosis, which identifies the generation and management of waste, the existing infrastructure, as well as the needs and problems associated with the entire comprehensive waste management system. The special programs —PNPGIR and PNPGIRME— establish the national waste policy through objectives, strategies and goals to prevent the generation and to improve the management of these, as well as actions, projects and financing aimed at driving government action in this area.

Based on these policy instruments, states and municipalities can learn about the current situation of waste generation and management in their territory, as well as plan the actions of their competence under a comprehensive approach that allows a transition towards sustainability in waste matters. In accordance with article 26 of the LGPGIR, states and municipalities, within the scope of their respective competences and in coordination with the Federal Government, must develop and implement local programs for the prevention and comprehensive management of municipal solid and special waste, in accordance with the LGPGIR, with the DBGIR and other applicable provisions.

Recommendation 4: Amendment to NOM-052-SEMARNAT-205 on hazardous waste

Now, while the LGPGI generally defines and categorizes the types of waste and prescribes differentiated treatments for them, the specific qualification of the types of waste is delegated to the Official Mexican Standards (NOM), which are issued by SEMARNAT. In this sense, the main recommendation identified by the participants of the working groups is to reform the standard that deals with battery waste, that is NOM-052-SEMARNAT-205, in which lithium-ion batteries currently appear under the category of "special" waste. In this sense, the participants of the working groups propose changing this category to consider this type of batteries as "hazardous waste".

Updating this classification in the standard is relevant for various purposes, including their transportation, storage, safety conditions in the workplace, consumer and environmental protection, as well as for better and more efficient recycling. [10]Treating batteries ass "hazardous waste" is supported both by academic sources and waste management industry practices - as well as on international regulations and the comparative experience of other countries, where lithium battery waste is considered hazardous and specific obligations are established for its handling, recycling and disposal.

At the international level, for example, the *UN Recommendations on the Transport of Dangerous Goods* (2019) classify lithium batteries and their

[10] See for example DSV, n.d.

waste as “class 9”, which corresponds to dangerous miscellaneous substances and items, including substances that are harmful to the environment, in which specific nomenclatures are assigned to various types of lithium battery components for their specific treatment:

(UN 3090 — Lithium metal batteries (including lithium alloy batteries), UN 3091 — lithium batteries contained in or packed with equipment (including lithium alloy batteries), UN 3480 — lithium-ion batteries (including lithium-ion polymer batteries), UN 3481 — lithium-ion batteries contained in or packed with equipment (including lithium-ion polymer batteries), UN 3536 — lithium batteries installed in load carrying units) (UN, 2011).

As to comparative experience, UK Standard No. 1935 establishes obligations for the collection and recycling of batteries and accumulators, to prevent them from ending up incinerated or in garbage dumps. It also restricts certain substances used in batteries and accumulators, thus establishing general and environmental responsibilities for battery producers in order to facilitate their reuse, recycling and the recovery of materials at the end of their useful life (United Kingdom, 2015).

In summary, the recommendation is to review and update the regulations relating to battery disposal, in accordance with international best practices, starting by reforming the current NOM-052-SEMARNAT-205 that classifies different batteries, including lithium-ion batteries, as “special waste”, unlike international best practices, which treat them as “hazardous waste”.

Recommendation 5: Certification and directory of recycling, management and disposal companies

The need to create directories of certified companies that collect and treat lithium batteries was raised during the Recommendations session. Although SEMARNAT[11] already has directories of authorized companies for the management of hazardous waste, as noted above, lithium batteries are currently not considered by the regulations as such, so these directories do not specifically include companies that handle this type of waste.

One of the consequences of the reclassification of batteries as “hazardous waste” will be the need for such certification, as part of the specific management plan for electric vehicle batteries that includes obligations for industry companies, as well as a directory and a certification of companies that handle electric vehicle batteries.

In conclusion, the section recommends that SEMARNAT, within its competences, develops a specific management plan for electric vehicle batteries (lithium-ion) in which they are classified as hazardous waste. It was also

[11] See SEMARNAT, 2022.

suggested by the participants that this plan shall establish obligations and include a directory and certification of companies that use batteries for cars of this kind. The latter is of utmost importance due to the increase we will see in this kind of waste, and because of the size and weight of the batteries.

RECOMMENDATION 3

Review standards and programs for proper waste management, and to design and implement plans for the handling, recycling and disposal of electric vehicle lithium-ion batteries.

RECOMMENDATION 4

Amend the classification of waste from lithium batteries in NOM-052-SEMARNAT-2005.

RECOMMENDATION 5

Directories and certification of authorized companies for the handling, recycling and disposal of lithium-ion electric vehicle batteries.

RELEVANT ACTORS

The Ministry of Foreign Affairs, the National Congress, SEMARNAT, academia, industry.

III. HUMAN CAPITAL AND INNOVATION

Finally, the lack of human capital in STEM (science, technology, engineering and mathematics) disciplines and in specific skills such as programming languages, robotics and data analysis was pointed out as an obstacle to innovation in the field of electric vehicles in Mexico. The needs of the industry as a whole and human capital solutions will be discussed in greater detail in the following chapter, since this section focuses specifically on innovation.

Recommendation 6: Mapping of human resource needs for the transition to electromobility

Participants in the obstacle identification sessions pointed out the need to update curricula and development programs and to update or improve the technological skills of automotive industry professionals for the transition to the manufacture of electric cars and services associated with this industry. To do this, they proposed as a first step that their companies and industry chambers identify and inform the human capital needs for innovation, so that universities and training centers can use that information as an input to develop curricula that meets the demands of the electric automotive industry.

Recommendation 7: Digital platform for the identification of human capital needs, updating university curricula and continuous training programs

A second step, also discussed in the sessions, was to create a digital platform that allows industries, chambers and companies to inform the skills that they identify as necessary for their industries, so that universities and training centers may have updated knowledge on the needs of the industry and adapt their curricula to offer professional training that is in line with the needs of the labor market. In addition, they proposed organizing and teaching courses and training relevant to the industry through this platform, while it also acts as a job placement site that serves both professionals and companies.

To this end, they referred to the European Union's capacity-building programs as an example. One of them, the European Software Skills Alliance Alliance (Essa) focuses on developing software capabilities. Moreover, in the European Union there is also another program and platform focused on developing emerging skills in advanced manufacturing called Skillman or Sector Skills Alliance Project.

ESSA receives funding from the European Union's Erasmus program and from twenty-six industry and academia partners. Its mission is to provide update or expand training for workers in order to meet the future needs of society (Essa, n.d.). ESSA, for example, has a project to develop a European strategy for software training and to design a Vocational Education and Training (VET) curriculum.

Skillman in turn was launched in 2014 by a network of VET vocational education and training providers, the aeronautical and automotive industry, research centers and other organizations from various countries. The project started receiving support for education and training activities from the European Commission in 2015, making it the region's largest multilateral network in this field. Skillman combines knowledge of the needs and type of training required based on the organization and systematization of an information system related to the industry (Skillman, n.d.).

In this regard, the recommendation is that, based on the examples of the European Union and others (see the Human Capital chapter), Mexican industry, academia and government jointly develop a platform where companies can inform their human capital needs and based on this information, the country's higher and technical education institutions update their academic curricula. It can also serve as a platform for recruiting workers and to provide training and certifications. During the innovation sessions of the project, the University of California stated that this institution is ready to support Mexican universities and implement these measures and that it has the capacity to do so.

Although this type of platform can receive public funds, the idea is that industry must play a predominant role in financing mechanisms for the development of human capital through this type of initiatives in Mexican educational institutions.

Finally, the possibility that this type of collaboration platforms and schemes between industry and Mexican and international universities is based on the previously mentioned technological innovation hubs is worth considering.

RECOMMENDATION 6

Mapping of human resources needs for the transition to electromobility as an input for the update of university curricula and technical training in Mexico.

RECOMMENDATION 7

Development of a digital platform for the identification of human capital needs, and to update university curricula and continuous training and recruitment programs.

RELEVANT ACTORS

The Ministry of Economy, the Ministry of Foreign Affairs, the Ministry of Public Education, the Ministry of Labor and Social Security, industry, national academia, the University of California.

Human Capital

Introduction

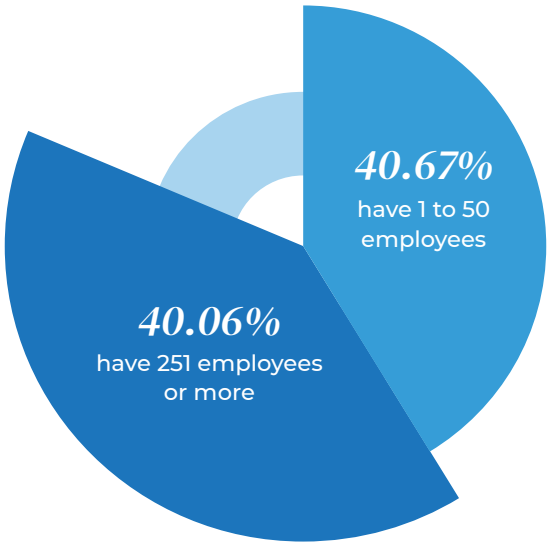
Human capital is the fundamental factor of every industry: it is the workers who make production possible at every stage of the processes. That is why its role is fundamental in the transition to electromobility.

This document has an industrial transition approach, therefore it mainly uses the concept of *human capital* as a factor of production (although it will use concepts, such as *human resources*, which has an administrative approach, or others such as *available workforce*) to refer to the set of people who have the skills and knowledge necessary for the development of the industry and not only those employed or trained specifically for it.

A redefinition of the role of human capital is necessary to adapt it to the big trends in the process automation manufacturing industry and for the implementation of technological advances in production. This is important in order to increase the level of staff training that enables workers to operate and maintain digitized machinery and interpret the results of information systems. This will make it possible to face the huge challenges that an increasingly global and integrated industry poses to international value chains, the requirements of technological innovation and increased productivity to have the flexibility to adapt to new consumption patterns and regulations.

In Mexico, the automotive and auto parts industry employs approximately 824,000 people (INEGI, 2018) and has followed a virtually uninterrupted upward trend since opening to free trade with North America in 1994. This has made it possible to increase exports of finished vehicles and fully integrate the industry into the region's value chains. The huge impact of the regional integration of the automotive industry has turn it into one of the most dynamic and successful manufacturing industries in the country.

of the
2,135
ECONOMIC UNITS
that manufacture parts for motor vehicles



Importantly, there are elements that characterize the human capital structure of the automotive industry in Mexico, in which nine out of ten employed people are workers (INEGI, 2018). Today, of the 73 economic car and truck manufacturing units registered in the National Statistical Directory of Economic Units (DENUE), 38% have 1 to 50 employees, while 48% have 251 employees or more (INEGI, 2022b). Similarly, of the 2,132 economic units that manufacture parts for motor vehicles registered in the DENUE, 40.67% have 1 to 50 employees, while 40.06% have 251 employees or more.

In both cases, we can see there is an active participation of companies with 50 employees or less, with percentages comparable to large companies with over 251 employees, therefore it is necessary to take into consideration the diversity in the size of economic units as well as the current composition and the composition required for the transition to electromobility in any human capital strategy that is implemented. This is relevant, because we must aim to strengthen a significant pool of suppliers of auto parts and economic units for the manufacture of cars and trucks.

It is clear that talking about human capital is a core issue in the transition to electromobility. Therefore, the following pages explain the diagnosis on this thematic axis, which is based on the opinions of experts from the public sector, industry and academia that participated in the task force, and on individual interviews and complementary research that corroborates the relevance of the obstacles analyzed.

DIAGNOSIS

This section analyzes the obstacles identified in this thematic axis, with the aim of understanding the most important problems that the electric automotive industry faces with respect to the personnel employed in its production processes. The methodology used to identify these obstacles consisted of analyzing the results of the human capital session held on June 27, 2022, and subsequent interviews with representatives of industry, the public sector and academia that took place between July 4 and 8 of the same year.

These obstacles were classified in four sub-axes that group a series of identified needs, which underline the importance of specific aspects: 1) specialized workforce; 2) labor conditions and inclusion in the industry; 3) international collaboration, and 4) Public policy, governance and legislation.

1. Specialized workforce

This analysis identified a need for a greater number of available specialized labor for the electromobility industry, which implies influencing three sources of capacity generation: 1) an improved educational offer focused on STEMS academic disciplines; 2) technical careers with specialized knowledge, and 3) updating the curricula with industry roles.

One of the main challenges identified was a need for technically trained personnel to meet the current needs of the industry. Another perceived concern was the need to have clarity in the profiles and skills required for the different positions in the industry - both for technical and professional personnel -, because they have yet to become fully defined for the transition to electromobility and the changes it implies.

With regard to training, it was emphasized that there are technical careers being taught at higher secondary education institutions, such as the National College of Technical Vocational Education (CONALEP) and other specialized institutions. However, industry participants identified that educational programs are detached from the needs of their industry. This is a common perception within the academic sector, which pointed out that it is necessary to reappraise this type of education and adjust it to the needs of the labor market to make it more attractive to students.

The academic literature highlights that the programs currently being taught by public institutions are not a main source of trained personnel for Mexican auto parts companies, since they have a very limited scope due to the low number of graduates and the gap that exists between the training received in these institutions and the current needs of the industry. Because of this, only large companies have used these workers in specialized jobs, while small companies hire them for machinery maintenance (Sancak, 2022).

The need for specialized personnel in all phases of the manufacture and maintenance of electric vehicles is in opposition with the dynamics identified by research in the automotive industry, which indicates that the trend is moving towards a demand for less qualified labor, with the associated decrease in wages that are paid for this type of work (Calderon-Villarreal, 2017), therefore it is very necessary to define the profiles required for the transition to electromobility.

Regarding the training of personnel in academic disciplines of science, technology, engineering and mathematics (STEM), there was mention of the need for an accelerated transition to professions and capabilities in this category. This coincides with academic analyses that have segmented the new value chain of electromobility into processes ranging from the transformation of raw materials, manufacturing, charging infrastructure, services to transversal activities, which require a wide range of professions in technology, data science, administration and management (Larios, 2022).

It was pointed out that it is necessary to retain the current personnel of this industry in the face of the need for new profiles, so the participants of the working group suggested creating a strategy to reorient the profiles of these personnel and thus reduce the impact the transition will have

on employment. The studies consulted project that - although there are no exact quantitative forecasts - the jobs created in the value chain of the electromobility industry in Europe will outnumber those that will be lost in the automotive manufacture of internal combustion, even in the worst-case scenarios (The European Association of Electrical Contractors, 2019). However, although projections indicate that there is a significant need for staff at this new stage, the percentage of current employees who can transition to the new work structure without support from formal retraining training programs is still unclear.

2. Working conditions and inclusion in the industry

The work session and subsequent interviews indicated the need to improve working conditions with measures such as: increasing labor flexibility; reducing staff turnover; developing competencies, mainly through training; gender inclusion; developing urban infrastructure and services as part of the improvement of working conditions.

Regarding the working conditions in the automotive industry, it was identified that workers are highly dependent on their employers for both skill development and employment. Factors that exacerbate employee dependence on employers include remote plant locations, lack of opportunities and alternatives to join the labor market, inaccessibility, and the price of transportation services in and to/from the areas where plants are located and where operators live. These conditions, along with weak company unions, restrict the bargaining power of operators in the industry, which leads to substantially low wages in the industry (Sancak, 2022).

It was also noted that one of the obstacles that were often mentioned during the first session of the working group of this sub-axis was the need to develop skills and training. Additionally, the need came up to improve workers' salaries and working conditions in general in the Mexican automotive industry, in particular in the context of the establishment of industrial links in the region and the USMCA, which establishes regulations in related labor matters.

Another challenge that was identified in practice is that, although the training strategies are in compliance with the legal regime established by the Federal Labor Law (LFT), research shows that the use of the trial period of up to 180 days provided for in article 39-A of the LFT is a common practice. This reduces the costs for new hires, as it allows the company to get acquainted with employees before offering them a permanent position and the possibility of ending the employment relationship without having to follow an expensive dismissal process. In addition, it offers the opportunity to give them very basic training at very low cost, which implies that they don't acquire the rights of a permanent worker during this period, therefore they receive lower salaries and are subject to the possibility of dismissal without compensation.

On the other hand, the sessions highlighted the low participation of women in the automotive industry in Mexico, as shown by the *Men and women in economic activities* Economic Census (INEGI, 2019), which it points out that in the "Manufacture of transport equipment" sub-industry, men represent 63.5% of the personnel employed, and women 36.6%. In the "Retail trade in motor vehicles, spare parts, fuels and lubricants" sub-industry, the same census determined that 72.3% of the people employed are men and only 27.7% are women.

At the global level, studies have been carried out (Deloitte, 2022b) to find out the causes of such low participation, as well as the main reasons why women are not attracted to a career in this sector, with the following highlights: lack of diversity and inclusion (64%); lack of a personal life / work balance (53%), and inflexible working hours (43%). These reasons coincide with the concerns expressed in the first session, as they represent obstacles to increasing inclusion with a gender perspective in the industry.

Regarding the presence of women in management positions in the industry globally, according to data from *Catalyst*, in 2018 there were only 16 women (8%) in the senior teams of the top 20 *Fortune Global 500* automotive companies, which represents an increase of only 1% compared to the 14 women included in the same list in 2014 (Deloitte, 2022b).

3. International collaboration

International collaboration within human capital is a key factor to be taken into account in the transition to electromobility in Mexico and the United States. That is the reason that the decision was made to create a specific sub-axis for it. Two major needs were found in this regard: first, a need to encourage the training of personnel in institutions both in Mexico and in the United States, with the aim of consolidating specialized regional human capital. Second, there is the need for action to meet the SDGs.

With regard to the training of specialized regional human capital, the academic and private sectors argued that it is necessary to develop bi-national programs in which Mexican and US industries participate to move towards the training of personnel in support of the transition to the electrification of the automotive industry. This is seen in conjunction with the establishment of a regional learning center to consolidate the development of human capital that responds to the regional and global nature of this industry.

To achieve this result, the recommendation was made to strengthen the collaboration between the academic hubs and the industry, in order to facilitate the establishment of regional networks and the coordination of curricula that contemplate the needs of the industry in both countries. As previously mentioned in the Innovation chapter, including environmental engineering for battery management and circular economy was considered of utmost importance.

Likewise, mention was made of the need to take into account the circularity of personnel in the region, in other words, the integration of workers into regional value chains both in Mexico and in the United States. Therefore, the training of workers who are already present in the production lines was identified as a priority to continue with the transition to electromobility in North America.

Regarding actions to comply with the SDGs, mention was made of the need to encourage joint efforts between industry and government that are aligned with these commitments. Some examples of actions are the use of clean energy, the implementation of circular economy strategies, as well as implementing measures to promote and obtain certifications for socially responsible companies.

This statement is confirmed by analyses carried out by the Economic Commission for Latin America and the Caribbean (ECLAC), which concluded that a dialogue between government, civil society and private sector is essential for the fulfillment of SDG 7 (affordable and non-polluting energy), particularly for the transition towards electromobility, the generation of local and regional production chains, as well as for the diversification of production (ECLAC, 2019).

On the other hand, it was highlighted that there is a need to encourage more women to participate in STEM areas, particularly by promoting greater inclusion in engineering positions, and that both government and industry make efforts aligned with the fulfillment of SDG 5 (on gender equality and empowerment of all women and girls, and in general the protection and empowerment of all vulnerable groups).

In this sense, it is estimated that tangible benefits can be obtained in terms of social inclusion in a ten-year scenario, provided that the increase in the personnel required for the operation and maintenance of electrical units allows promoting inclusion programs that contemplate the participation of a greater number of women (Carrillo et al., 2020).

4. Public policy, governance and legislation

The subject of the fourth sub-axis is Public policy, governance and legislation, in which two major needs were identified. The first concerns the updating of the regulatory framework to validate skills, labor flexibility and industry development; the second concerns the establishment of links with government programs for the inclusion and development of personnel, as well as academic exchanges and investment in specialized human capital training.

Regarding the first need, it was identified that the public sector needs to design training plans in accordance with the Federal Labor Law, and to include the certification of the development of skills in the associated policies and regulatory framework. Similarly, it was suggested that the legislative branch address aspects such as labor flexibility. In this sense, in order to implement a gender perspective in this industry, it was explained that it is important that these initiatives improve the balance between personal life, professional life and duties of care, and of promoting access to nurseries.

As to the second subject, it was highlighted that there is a need to increase the links between companies and government programs for the insertion of human capital in the production industry. Examples included the "Jovenes construyendo el futuro (Youth Building the Future)" program of alumni - a project created by the Ministry of Labor and Social Security (STPS) at the technical level - which helps companies to find available human capital, and the National Employment Service, which holds job fairs and training scholarships.

Regarding the above, a mention was made of the need to follow up on the Science and Technology Act -which is currently being reviewed by the Mexican Congress-, because the link with the National Council of Science and Technology (CONACYT) was considered to be of utmost relevance for the transfer of skills and academic exchanges, particularly with the United States, in order to strengthen the integration of the electric automotive industry in the region.

In conclusion, in light of the national and international context, the diagnosis of human capital conditions in the automotive industry in Mexico dictates the need for a comprehensive personnel management strategy that is aligned to the new characteristics and conditions of the industry, including the reformulation of profiles in the industry and the redefinition of labor relations.

Due to the nature of this problem, it is proposed that this strategy be the result of a coordinated effort between private companies, employers' and workers' organizations, specialized government offices of different jurisdictional areas, including international ones, to comply with Mexican regulations, international treaties and/or commitments on the matter, including the USMCA and the SDGs.

HUMAN CAPITAL RECOMMENDATIONS

The second session of this thematic axis, held on August 1, 2022, aimed to respond to previously identified obstacles with recommendations based on the expertise of the actors involved in the project, and on complementary research and best practices. After this session, the following recommendations covering various public policy proposals were issued.

Some of the initiatives proposed by the participants of this event are also best practices for human capital in the manufacturing industry worldwide. These include strategies to offer training with mechanisms to establish links with other actors, including governments and academic institutions, to promote curricula that adapts to the needs of the industry (see the Innovation chapter). Other issues that have been addressed in these experiences are the inclusion of female staff or persons with disabilities in training strategies. In general, they offer a platform for the industry to take the lead and coordinate both internally and with authorities to address these crucial issues for industrial development.

As addressed in the previous chapter under the Innovation axis, one of the comparative policy strategies focuses on the development of software capabilities through a joint public-private scheme and digital platform, known as the European Software Skills Alliance (Essa) in the European context. Likewise, the session reviewed another example of a European Union program and platform focused on the development of emerging skills in advanced manufacturing called *Skillman* or industry Skills Alliance Project. Both programs stand out as modern and flexible responses to the new requirements for trained personnel in the industry.

Likewise, there is a program created by the Inter-American Development Bank (IDB) that considers additional elements, such as the formulation of a strategy based on a self-diagnosis, the creation of roadmaps and the self-definition of implementation strategies. This project is very useful for the coordination of various actors for industrial development, starting with a program called Industry Upgrade Strategy, in which participants were chosen by an industry skills council made up of industry representatives with the aim of designing an industry improvement system. In particular, they defined the sectors, goals, scenario, trends and advantages of each participant.

Then a plan was made to achieve the goals identified by the strategy. Therefore, it is important to note that the main objective of the Global Services industry (GSS) project implemented in Jamaica, is to improve the skills development system and to provide trained personnel to the industry.

In this sense, it must be taken into account that part of this strategy is based on another experience carried out in Singapore, where there is an initiative called Skills Framework. This project is considered to be an integral component of the Industry Transformation Maps and was created by employers, industry associations, educational institutions, unions and government to strengthen the workforce of the country. This tool provides key industry information: career paths, occupations and positions, emerging skills required for them, as well as a list of skills improvement training programs.

Once both the industry skills council and the Industry Upgrade Strategy had been established, the methodology followed by these institutions is to design the skill maps and the career pathways framework. This allows information on the careers available in the industry, the growth and better salary prospects to be publicly available to guide actions in the search for profiles. One of the main achievements of this strategy is the creation of a network of participants and industry-specific skill councils made up of the strategy directors of the companies, as well as a mechanism for capturing real time information, which allowed them to define priorities in a more efficient way, with information that is up-to-date.

I. SPECIALIZED WORKFORCE

Recommendation 8: Development of a strategy to promote specialized careers in the industry

The need for a greater number of available specialized personnel for the electromobility industry was identified as part of the diagnosis carried out in the human capital axis. The first step identified was to make a diagnosis of the quality in the training of human resources by country region, in order to identify areas of opportunity through dialogue and triple helix alliances.

The project experts suggested considering the IDB strategy of Industry Upgrade Strategy, because in the Mexico automotive industry there is already an organization that is defined internally by industry clusters and organizations. The next step of the strategy is to identify obstacles and the specific profiles that the industry requires. The career pathways framework must

then be developed taking these variables into account, as a mas of job positions and potential paths to make the information required by decision makers or people who want to study a technical or university career, among others, publicly available. These maps have the potential to provide information about the career growth opportunities, salaries and benefits for various positions.

Likewise, specific actions could be proposed through a decision-making process within the joint industry, academia, authority and academic institution councils to address any obstacles identified. In some cases, incentives have been implemented to train specialized personnel, and to provide opportunities for capacity conversion to the personnel already working in the industry, both through the dissemination of information using the career pathways framework and with specific training actions.

It was recommended that this effort to define, design and implement the profiles required in this industry be coordinated by the Ministry of Labor and Social Security (STPS) in conjunction with industry, academia and the public sector consulting with the IDB (a key player of the project that has shown interest in collaborating in initiatives of this kind). In particular, we would like to highlight the role of the Office for Sector-Specific Academic Development of the Ministry of Public Education (SEP), the institution that updates curricula and works to harmonize and include them in the National System of Competencies. This coordinated effort can identify all the knowledge and skills that are required for these professions and propose their potential career paths as maps, as in the successful experiences mentioned above.

With regard to the academic sector, the recommendation was made to reform curricula in collaboration with universities to meet the needs of the industry. The implementation of said curricula will enable the development of more suitable profiles and a closer relationship with the automotive industry, with whom it could promote enrollment in these careers through scholarship programs, professional internships and follow-up of job placement programs.

RECOMMENDATION 8

Development of a strategy to promote specialized careers in the industry, and to harmonize the training provided by educational institutions with other national and international certifications, in particular through the National System of Competencies.

RELEVANT ACTORS

The Ministry of Labor and Social Security, the Ministry of Public Education, the Ministry of Foreign Affairs, development banks, the National System of Competencies, industry, national academia, the University of California.

II. WORKING CONDITIONS AND INCLUSION IN THE INDUSTRY

Recommendation 9: Strategy to improve job opportunities and for the inclusion of women and vulnerable groups in the industry

Regarding the inclusion and participation of women and other underrepresented groups in the automotive industry, the proposal was presented during the second session of the working group in the human capital axis to promote economic incentives with public and public-private funds for the training of women, gender minorities and people with disabilities.

This strategy could be aligned with the Industry Upgrade Strategy which, according to the characteristics offered by the career pathways framework, can give increased visibility to the most attractive career paths and personnel requirements, which would encourage people to receive training and to be better prepared to meet the requirements of the industry and, consequently, to achieve better wages and working conditions that meet

Mexico's SDG commitments with well-paid and stable jobs. Similarly, this exercise, with the information provided by these instruments, would allow people to choose career profiles and paths that meet their needs and interests, bringing about, for example, more flexible schedules so that people can dedicate time to duties of care and increased physical adaptability of spaces to promote the inclusion of people who have special needs as a result of a disability that restricts their mobility.

Strategies for gender equality have been promoted through the implementation of the Industry Upgrade Strategy, where different industries have managed to address the gap in women's labor participation by applying incentives using "competitive funds", which, in other training projects are financed 50% with company contributions and 50% by the international development bank. However, in some cases, incentives have been implemented to promote the inclusion of women in training projects, which increased the coverage of international development banking by up to 70%, which in turn increased the interest of companies from different industries in promoting the training of female personnel and gender diversity.

In the case of the inclusion of women in the automotive industry, a diagnosis could be made to find out the baseline of their participation in industry-related technical careers and science and technology university careers, and then execute different strategies, such as:

Identifying the technical and administrative needs of potential employers within the automotive industry using an industry upgrade strategy to communicate them to universities and students.

Designing specific mechanisms that facilitate the inclusion of women in the industry, such as economic incentives with public and industry funds to invest in the training and recruitment of women, considering their specific needs and interests.

A communication strategy to raise the appeal of technical professions to girls and women of school age, to allow them to find out about the experiences and opportunities in this industry.

RECOMMENDATION 9

Design of strategies to improve job opportunities and for the integration of women and vulnerable groups into the industry, with a focus on inclusion and diversity in the automotive industry.

RELEVANT ACTORS

The Ministry of Labor and Social Security, the Ministry of Public Education, the Ministry of Foreign Affairs, development banks, industry, national academia, civil society organizations working on labor inclusion issues, the University of California.

III. INTERNATIONAL COLLABORATION

Recommendation 10: Bi-national educational programs

International collaboration on human capital issues is a fundamental part of this working group. In regard to this issue, the project participants determined that an important step in this transition in Mexico and the United States is the development of bi-national educational programs both at the technical, undergraduate, and graduate level, as well as training courses in areas such as robotics, new technologies, electromobility, use of software, circular economy, infrastructure, and others.

This type of bi-national educational programs must be designed with the main goal of contributing to the strengthening of profiles and to increase access to quality jobs, with the participation of the industry to receive first-hand information on the specific skills and abilities that are required for this transition. Therefore, the project participants recommended strengthening the collaborative work with the main automotive companies and, in general, with companies interested in attracting specialized human capital in this field.

These programs can be presented in various modalities, for example, under training programs and academic student, faculty and postgraduate student exchanges between Mexico and the United States. Likewise, they can seek to design bi-national programs with courses taught by academics from universities of the other country, where the curriculum is periodically updated with academic support at the technical, middle-higher and higher levels.

In this sense, the participants recommended starting these programs with medium-higher and higher educational institutions, and to do refresher courses in companies based in the member states of automotive clusters, including the states of Bajio and the northern region of Mexico. This is because the Bajio -specifically in the states of Guanajuato, Aguascalientes and San Luis Potosi— produced 43.57% of all light vehicles in Mexico during the first half of 2022 (Industrial Cluster, 2022). On the other hand, during 2021, Coahuila (in the north of the country) received 1.7 billion dollars in investments from twenty projects of the automotive industry, the highest amount in all of Mexico that year, of which nine correspond to the construction of new plants or industrial parks, and the other eleven correspond to the expansion of existing plants (Industrial Cluster, 2022).

With regard to job training and the updating of the skills of the personnel already working in this industry, the participants of the working group recommended working hand in hand with the General Office for Work Training Centers (DGCFT) of the SEP, which has institutions and programs such as the Industrial Work Training Centers (CECATI), Work Training Institutes (ICAT), POETA Centers, that have infrastructure to receive people with disabilities and the Institute for Support to Technological Development through the High Technology Training Centers (INADET-ICAT Chihuahua).

One of the good practices that can be replicated bi-nationally with the United States is the Skills for Prosperity Mexico collaboration agreement of the International Youth Foundation that Mexico has with the United Kingdom, which aims to promote inclusive economic growth through education for employment.

Skills for Prosperity incorporates the so-called green skills to support educational institutions in Mexico, and particularly technical education institutions, to develop green skills and abilities, linked to the clean energy and sustainability industries. These areas are: i) energy efficiency, ii) electromobility, iii) circular economy, iv) solar energy and water heating systems and v) specialized technical English. The courses have a total duration ranging between 15 and 32 hours.

This type of initiatives can be replicated in different regions of the country with the collaboration of universities in Mexico and the United States and they can be led by the SEP, with support from the automotive industry. In this regard, the DGCFT has initiatives with the business sector in which they develop curricula based on the training needs of companies, and in which they seek to incorporate the Dual Training Program (General Office for Work Training Centers, 2022). In this sense, the recommendation was made that the Ministry of Foreign Affairs coordinate the liaison between the companies interested in the design of these programs and the DGCFT within the framework of the working group presented in this document.

Some Mexican universities already have a presence in the United States, such as the Universidad Nacional Autonoma de Mexico (UNAM), which has four Mexican Studies Centers (CEM) in Boston, Tucson, Seattle and Los Angeles, and two extension schools in San Antonio and Chicago (UNAM, 2019). Similarly, the University of California has a presence in Mexico through Casa de la Universidad de California in Mexico and the UC Institute for Mexico and the United States (UC MEXUS). This institute collaborates in academic programs and exchanges under the UC-CONACYT Agreement for Cooperation in Higher Education and Research, as well as the UC-Mexico Initiative, which develops alliances between the university and various Mexican institutions, such as the Autonomous University of Guadalajara, the Autonomous University of Baja California and UNAM (University of California, 2021).

These established networks, as well as other institutions that implement similar initiatives, can be used for the development of bi-national educational programs, which would be taught both in person and under a mixed-modality and to promote academic exchanges between Mexico and the United States.

Likewise, it is proposed that the University of California and other universities in the United States provide training to Mexican educational institutions at the middle-higher and higher levels for the improvement and updating of their curricula, hand in hand with the relevant authority from the SEP.

Collaboration with Alianza Mexico of the University of California is considered strategic for the design, promotion, and implementation of these bi-national educational programs, particularly for higher education, including graduate programs. This university has programs that can be used as reference, such as the Master of Engineering at UC Berkeley, which has majors such as Data and Systems Sciences, Robotics and Software, and Electronics and Integrated Circuits (Berkeley EECs, 2022). Likewise, the Electrical and Computer Engineering program can be found at the San Diego, UC Davis, Irvine, Los Angeles, Riverside, Santa Barbara and Santa Cruz campuses.

Likewise, the recommendation was made to develop programs that involve or are included within the Remote Training Program for Workers (PROCADIST) implemented by the Ministry of Labor and Social Welfare, which consists of an online educational platform to develop skills and increase labor productivity, employability and which is supported and validated by that office (Ministry of Labor and Social Welfare, 2021).

RECOMMENDATION 10
Design and implement bi-national educational programs in a collaborative manner between the automotive industry, the government and academia.
RELEVANT ACTORS
The Ministry of Labor and Social Security, the Ministry of Public Education, the Ministry of Foreign Affairs, industry and academia in Mexico and the United States.

IV. PUBLIC POLICY, GOVERNANCE AND LEGISLATION

Recommendation 11: Bi-national job placement opportunities

As part of the diagnosis on the liaison with government programs for the inclusion and development of personnel, a recommendation is submitted to implement a bi-national job board for students, graduates, researchers and teachers of the bi-national educational programs mentioned in the previous recommendation, and for the professional profiles interested in vacancies in this area.

The actors of the project recommended that this job placement board be carried out jointly with the STPS, in order to rely on their experience, good practices and support. Similarly, this initiative can be integrated and updated with the existing databases of that office. This will make it easier for staff to find verified and secure employment opportunities in both Mexico and the United States within this industry.

In addition, one of the functions of this platform would be to allow companies to have easier access to human resources that meet the profiles for any available vacancies. In this regard, the recommendation was made to clearly include the name of the position, location, salary, benefits and activities to be carried out in the vacancy postings.

This board could be accessed online and in person. The first form of access seeks to facilitate and expedite both the posting of vacancies and the professional profiles by being accessible from mobile devices. Likewise, the registration and access could also be carried out in person at the central and state offices of the National Employment Service (SNE), which already have infrastructure and means for this purpose.

This exchange can be strengthened through the different functions of the SNE which has been serving the public seeking employment, and employers who need personnel (National Employment Service, n.d.), since 1978. Among the existing programs that can be incorporated into this initiative is the Labor Mobility Mechanism, under which the SNE, in collaboration with the State offices of the STPS, make global alliances to offer employment options abroad.

This way, this service will connect the staff in a legal, orderly and safe way with employers, which reinforces the enforcement of labor rights. These alliances can be formed as a result of the networks consolidated within the working group project. Likewise, this job board can also be advertised by the *Online Employment Journal (Periodico Digital de Empleo)* of the SNE, which is free to access and is updated biweekly with detailed job information.

On the other hand, this proposal can be strengthened with the job liaison, advice and occupational guidance offered by the General Office of the SNE. In particular, this recommendation also includes the organization of online and in-person bi-national job fairs under the coordination of the STPS.

Likewise, aid job fairs could include human resources offices from Mexico and US-based companies in the automotive industry. These in-person fairs could bring together people in search of employment to be heard by company representatives, which would allow them to contact the potential employer directly and to advertise job skills and abilities, in order to secure employment opportunities (Job Fairs, n.d.). Online fairs, on the other hand, would enable the consultation of job offers directly with the human resources officials of the companies, without the need to travel physically, and with the support of the STPS.

RECOMMENDATION 11
Organization and publication of bi-national job boards and job fairs.
RELEVANT ACTORS
The Ministry of Labor and Social Security, the Ministry of Public Education, the Ministry of Foreign Affairs, industry, national academia and the University of California.

Develop-ment of Suppliers

Introduction

Since the entry into force of the North American Free Trade Agreement (NAFTA) in 1994, the automotive industry in Mexico has grown exponentially to 3.04% of the national GDP in 2020 (Statista, 2022), which consolidated the country as a global competitor in vehicle and auto parts manufacturing. Between 2010 and 2017, in real terms, the industry grew by 12 percentage points compared to a growth of 3% of the national GDP and manufacturing industry GDP growth of 3.4%. In this sense, the automotive industry has had an outstanding performance that has only been interrupted during the 1995 and 2008 economic crises (INEGI, 2018), and by the covid-19 pandemic in 2020.

The economic integration of this industry in the region, first with NAFTA and now with the USMCA, is such that on average eight out of ten light vehicles assembled in Mexico are exported to North America, so the industry has come to represent 31% of all manufacturing exports in the country (INEGI, 2018).

Over almost three decades, Mexico has strengthened its supply chains for the manufacture of internal combustion cars and became the seventh country in terms of production and the fourth country in terms of export of light, cargo and passenger vehicles in 2022 (INA, 2022). However, the transition to electromobility radically changes the components used in the vehicles, and the country will have to reconfigure the supply chains of this industry.

The supply landscape in the automotive industry is undergoing an important moment, not only as a result of technological changes, but also driven by environmental goals and, in recent years, due to disruptions to supply chains caused by phenomena such as the covid-19 pandemic, the current geopolitical tensions -particularly between the United States and China— and the war in Ukraine in 2022. These events had humanitarian consequences, contributed to inflation, and led to readjustments of energy strategies around the world.

All of the above has created significant challenges for global supply chains, impacting the electric car industry. As an example, this context led the United States to enact the 2022 Inflation Reduction Act (IRA), which contains a chapter to incentivize the purchase of clean vehicles through subsidies so that manufacturing, components and raw materials progressively come from the North American region (IRA, 2022).

This law, together with the provisions of the USMCA regarding tariff exemptions for rules of origin for vehicles, is a major incentive for the establishment and development of electric vehicle suppliers. The IRA also establishes subsidies for advanced manufacturing, including for battery components of these cars to be manufactured or assembled in a staggered manner in the United States, which imposes significant challenges for Mexico.

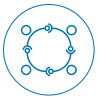
On the other hand, in the domestic context, it is important to note that Mexico has issued rules for the nationalization of lithium production chains, one of the main raw materials in the manufacture of electric vehicle batteries. Lithium-ion batteries, as mentioned above, are the most valuable component in electric cars and, under Article 10 of the USMCA, are subject to rules of origin and to particular rules concerning essential parts of both light vehicles and heavy trucks (see Tables A.1 and E of Article 10 of the USMCA).

These factors necessarily lead Mexico to rethink and seek the most resilient supply chains for the manufacture of electric vehicles, in order to maintain its status as a relevant player in the automotive industry. To this end, this chapter focuses on the weak points or obstacles identified in the work sessions and interviews of this and other thematic axes with government, industry and academia participants of the project.

A list of relevant topics and obstacles in the subject of supply was drafted, based on the participation of the guests in the first rounds of thematic conversations. The challenges identified resulted in a list of questions that guided the in-depth interviews with industry actors, who were particularly vocal in the first part of the research process and in the subsequent solutions session.

The issues mentioned include the physical distance of new suppliers to vehicle manufacturing centers and their integration into the production chain; the availability of some crucial elements for electric cars, such as batteries, and the so-called “semiconductor crisis” that caused the automotive industry to record estimated losses of 210 billion dollars in 2021 alone (Deloitte, 2022c), and finally the lack of alignment of national public policy.

DIAGNOSIS



1. Proximity to suppliers and distance from production centers in the integration of the production chain

The first highlight in terms of supply was the need to bring the production of components closer to the vehicle production centers. In this regard, the project participants considered that the distance between industry and suppliers is an obstacle. The electric vehicle industry’s high growth projections underscore the need for companies to accelerate the creation of a supply chain that helps them achieve their goals. To do so, both traditional suppliers and new entrants will need to define their role in the new supply chains (Robbins and Sullivan, 2021).

This means different things for established manufacturers and for new electric vehicle companies. On the one hand, large manufacturers will seek to balance the simultaneous production of internal combustion cars with electric ones. For that purpose, they need to develop partners who are of batteries and other specific components for this new industry, while continuing to foster relations with the current suppliers of the traditional automotive industry. On the other hand, new manufacturers must build new supply chains from scratch - something that took automotive giants decades to build - and put in place the structure to manage supplier performance and quality (Robbins and Sullivan, 2021).

Participants also highlighted the importance of considering SMEs in the different steps of the production chains, particularly for Tier 2 (parts manufacturers) and Tier 3 (raw material suppliers) companies, since they will be the ones that will find the greatest financial difficulties to transform their production to serve the new market.

In the current geopolitical context and given the supply chain disruptions that have occurred because of the covid-19 pandemic - such as saturated ports and blocked channels - it has been seen that globalization resulted in an excessive concentration of production centers of certain products and components in specific regions of the world. In the particular case of the automotive industry, this became evident in the production of semiconductors,

with 60% of the production concentrated in East Asia (Deloitte, 2022c). Something similar happens in the manufacture of batteries and their components, as will be seen in the next section.

This showed the need to diversify and decentralize extremely localized manufacturing of specific components, in order to avoid dependency, disruption and the resulting lack of resilience. It was noted that as a result of this, the companies using semiconductors are currently redesigning their long-term production strategies. Some of them, for example, could move from a just-in-time ordering model, which helps minimize inventory costs, to one in which semiconductors are ordered well in advance of assembly (Aboagye et al., 2022).

Regarding the concepts of distance and proximity, the participants stressed that these have different meanings depending on the vehicle sub-industry, and they differentiated between light and heavy vehicles in particular. They argued that the central difference between the two lies in the scale of manufacture, since the volume of production of heavy vehicles is generally much smaller and does not always justify the establishment of suppliers nearby. For larger-scale manufacturers, such as those of light vehicles, the proximity of suppliers is ideal if they are in the same state or municipality, but it is perhaps more important that they are in the same region. The difference between light and heavy vehicles is also relevant in the way they are built; either using components of the vehicle's brand, or, as in the case of trucks, using components from third parties.

In this context, participants highlighted concepts that are being increasingly used, such as *nearshoring* and *allyshoring*. Nearshoring refers to the outsourcing strategy in which a company transfers part of its production to third parties in nearby destinations with a similar time zone, despite being located in other countries. These practices arose in response to offshoring, which aims to reduce costs by looking for suppliers in other destinations, usually in Asia (Thomson Reuters Mexico, 2020). Similarly, allyshoring consists of relocating industrial processes to countries that share fundamental coincidences, like commercial alliances and international politics (Mendoza, 2021). In this context, it was mentioned that under nearshoring and allyshoring policies, Mexico has great potential to receive companies from around the world, due to its proximity to and the treaties signed with the rest of North America.

2. Development of battery suppliers

Why develop Batteries in Mexico? This was one of the most recurring questions in the meetings and interviews of the task force. There was broad consensus among the participants about the (logistical and economic) suitability of manufacturing these supplies in the vicinity of the raw material suppliers as one of the most important reasons to consider the development of batteries in Mexico as part of the general development of the electric vehicle industry and supply. It was highlighted that transporting batteries results in high economic and environmental costs because they are one of the heaviest components in electric vehicles.

In addition to weight, batteries are one of the most expensive parts of electric vehicles, representing 30% to 40% of the car's value (IEA, 2022). For that reason, several participants mentioned that companies that produce them will be generating one of the highest value-added components and, as a result, the highest profit margin in the production chain of this new industry.

In this sense, they pointed out that proximity to raw material sources is crucial because approximately 56% of the value of batteries is found in their chemical components used for anodes, cathodes and electrolytes. Cells, packaging and manufacturing constitute 25% of their value, and only 19% corresponds to other components (APCUK, 2019). For the participants, the fact that Mexico has deposits of lithium and other minerals that are used in the manufacture of batteries is a comparative advantage in terms of battery supply.

The interviews that followed the first phase of this thematic axis, reiterated the importance of developing batteries in Mexico and the relevance this business would have in terms of export, since about 80% of vehicle production

700%
INCREASE

price of lithium

The general obstacle facing the industry as a whole is the scarcity and high prices.

IEA, 2022b

200%
INCREASE

price of cobalt

The general obstacle facing the industry as a whole is the scarcity and high prices.

IEA, 2022b

in Mexico is destined for the United States (Department of Commerce, 2021b). They commented that manufacturing the batteries in the country will have a very relevant impact on compliance with the Regional Value Content (CVR) rules established in USMCA, which defines batteries as a core part. Also, in terms of labor, there is a requirement that no less than 40% of the value of the car comes from paid work in the region, with salaries of at least 16 dollars per hour (Modesto, 2020).

In the opinion of one of the interviewees, despite the entry barriers to compete against consolidated manufacturers around the world -which will be explained later in this document-, the possibility of producing the batteries in Mexico must be analyzed in consideration of the rules of origin, because in certain scenarios, complying with CVR could compensate for certain tariffs, environmental and transport costs incurred when importing them from other regions.

In terms of obstacles, the industry considers that having remote suppliers is not only more expensive in terms of logistics and makes them less resilient when faced to supply chain disruptions, but it can also affect the rules and facilities granted by USMCA. On the other hand, they identified a number of general (worldwide) and particular (in Mexico) obstacles to the development and manufacture of lithium-ion batteries. The most relevant general obstacles include the scarcity and price of lithium and other key minerals, while particular obstacles include regulatory uncertainty regarding raw materials in this industry and the difficulty of developing innovation and businesses that compete in a highly developed market in other countries.

The general obstacle facing the industry as a whole is the scarcity and high prices of lithium and other minerals: between early 2021 and May 2022, the price of lithium increased over 700%, the price of cobalt over 200% and the price of nickel almost doubled (IEA, 2022b). According to the International Energy Agency (2022b), these unprecedented increases are the result of a combination of factors including huge growth in demand. For example,

in 2021 alone the demand for batteries for electric vehicles doubled. In addition, there is a growing pressure on supply chains and concerns about the contraction of supply, which in turn were caused by the covid-19 pandemic, the conflict in Ukraine (because [Class 1] nickel comes from Russia) and finally by the reduction of investment in new supply capacities during the three years leading to 2021, when prices were relatively low.

Additionally, it should be noted that most of the minerals that are essential for the manufacture of electric vehicle batteries come mainly from Australia, Chile and the Democratic Republic of Congo, and are mainly handled by a few multinational companies (IEA, 2022b).

Regarding the particular challenges facing Mexico, uncertainty regarding the participation of private initiative in lithium extraction, enrichment, processing and marketing was considered an obstacle. The Mexican territory has lithium deposits and, given the growing global demand and the limited number of countries that supply this mineral, the Federal Government took the decision in 2022 to nationalize the lithium industry by reforming the Mining Law to declare it "of public interest," as it is a strategic resource for energy security for the country, restricting the right to explore, exploit, benefit and use this mineral to the State (Mining Law, 2022). In turn, it was established that lithium value chains shall be administered and controlled by the State through an office referred to in subsequent regulatory decree as Lithium for Mexico or LitioMx. With regard to lithium mining, the law establishes verbatim that "no concessions, licenses, contracts, permits or authorizations will be granted on this subject" (Mining Law, 2022).

Finally, the lag and the difficulty for Mexico to compete in this highly developed and consolidated market at a global level was pointed out as a major obstacle in the first session of this axis as a considerable entry barrier to innovate and develop lithium-ion batteries in the country. Currently, most electric vehicle batteries are manufactured in Asia (APCUK, 2019). For example, China alone produces three-quarters of all lithium-ion batteries, has 70% of cathode production capacity and 85% of anode production capacity (essential components for all batteries). In addition, China has more than half of the processing and refining capacity of lithium, cobalt and graphite (IEA, 2022b). Europe, in contrast, although it is responsible for 23% of electric vehicle assembly, has a minimal participation in battery supply chains, except for processing 20% of cobalt, a mineral that is mainly mined in the Democratic Republic of Congo (IEA, 2022b).

In addition, the participants mentioned that Mexico also lags at the regional level, because even though North America is lagging behind other regions, both Canada and the United States are already developing lithium mining and battery development strategies in their territories. The United States, for example, produces 10% of electric vehicles globally and 7% of batteries (IEA, 2022b).

3. Low availability of digital and technology components, including electronics, semiconductors and software

In relation to electric vehicles, semiconductors are necessary both at the production plant and for the operation of vehicles, the development of infrastructure and countless associated services that allow them to operate to their full potential. Similarly, semiconductors are especially critical for the implementation of 5G network infrastructure, and the associated services, since they enable the transmission of radio signals by connecting to the devices and acting as a backbone through which data is transmitted and exchanged (SIA, 2020).

The semiconductor industry will grow exponentially in the transition to digitization, it is estimated that by the end of 2023 it will grow 50% with respect to the year 2020 (Deloitte, 2022c). Part of this growth will occur in the places where the best consolidated manufacturers are located, such as Taiwan and South Korea, but participants such as the United States, China, Japan, Singapore and Europe have already and are expected to invest private and public resources in relocating chip production to bring their supply chains closer and make them more resilient (Deloitte, 2022c). In this regard, seeking to accelerate this transition, the United States Congress approved a 52-billion-dollar aid package for the semiconductor industry in July 2022 (Foran and Barrett, 2022). In this regard, the participants recommended that Mexico moves from the usual discourse of attracting investments towards concrete public policy actions.

4. Lack of public policy alignment

Participants pointed to a number of government actions and omissions that they believe affect the electric vehicle industry's supply chains. This section covers the lack of a clear alignment between public policy at the different government levels and the interests of this industry (issues that are also addressed to a different extent in the Governance chapter).

Several participants noted that there is a general perception of a lack of legal certainty in the country. They explained that this is partially the result of government actions that are interpreted as contrary to law, which negatively impact the appeal of the country for investment and suppliers. In particular, they expressed their concern that, if existing permits, contracts, laws, agreements and international treaties are not respected, this will result in a climate of uncertainty that represents risks for investment.

In this regard, the participants highlighted certain concerns regarding actions taken in the energy industry. They pointed out that, while electric power is one of the most important supplies for any industry, but it is particularly relevant for electromobility, particularly if it comes from renewable sources to make it a true sustainable mobility solution. In this context, they mentioned the impact that government decisions have had on clean energy and, they specifically highlighted the lack of clarity of the new rules relating to clean energy certificates (CEL). This issue was particularly sensitive for automotive industry participants, who stressed that the major multinational companies demand that clean energy be part of their production processes.

On a different topic, participants noted the lack of incentives - or clear incentives - for attracting investment as an obstacle to supplier development. They also pointed out that existing incentive policies, such as the Interoceanic Corridor, do not necessarily align with the needs of and the existing electric vehicle and auto parts production centers in the north of the country (more about this subject in the Governance chapter).

Likewise, they pointed out the lack of customs, fiscal and environmental instruments that seek to facilitate and encourage the import of supplies and vehicles into Mexico within the commercial and manufacturing promotion policy of the country as an obstacle to the optimization of supply chains.

In this sense, the program that stood out most among the participants was the Automotive Tax Deposit (DFA) because of recent changes that made it mandatory to obtain a waybill. The Tax Deposit is a benefit granted by the Tax Administration Service and can be granted automatically to vehicle manufacturers that meet the criteria established in the "Automotive Decree" (*DOF*, November 30, 2009). The DFA allows authorized car assemblers to import auto parts or temporary machinery that integrates Mexican parts at a percentage close to 20% for the process of assembling the vehicles, exempting the imported auto parts from paying VAT, under the

condition that they are exported again. This tax exemption was designed to avoid double taxation and also to avoid having to pay VAT and then request a refund at the time of export. This exemption is contemplated in tax and customs legislation.

As of January 1, 2022, it became mandatory to have a waybill, as a means to have a detailed identification of the goods being transported, to know the routes they follow, and their origin and destination, for random checks that preempt risks or threats in the shipment, and thus obtain information to establish safety strategies on the different routes, and other measures (SAT, 2021). In this regard, the participants argued that this new requirement generated a huge administrative burden for customs authorities and raised the time and economic costs for companies, because what previously was done in days, now takes weeks.

More specifically, the participants considered that this requirement generates enormous costs for the transfer of goods between plants (and not only at the customs) because they need to have a detailed record of the pieces being transported, the value of the goods, serial numbers, and other data, which in turn may create windows of opportunity for discretionary decisions and corruption.

Finally, participants identified programs that, while beneficial to the industry, in practice have certain operational deficiencies that need to be reviewed. Some examples are the Manufacturing, Maquiladora and Export Industry Program (IMMEX), which is perceived as inaccessible; the Industry-Specific Promotion Program (PROSEC), which generally works adequately, and, last the Clean Transport program, which in their opinion needs to be reviewed and adjusted to operate adequately, as well as an incentive mechanism.

RECOMMENDATIONS

The following section summarizes a series of recommendations based on the contributions, opinions and actions submitted in the second session of the supplier development thematic axis, held on August 29, 2022. The session was attended by industry, government and academia actors from Mexico and the United States. In turn, the recommendations were corroborated with academic evidence, best practices and subsequent interviews with project actors.

I. PROXIMITY TO SUPPLIERS AND INTEGRATION OF THE PRODUCTION CHAIN

Recommendation 12: Census of existing suppliers and development of a national directory of electric automotive industry suppliers

The first of the obstacles identified in the previous section is related to having integrated supply and production chains at the regional level and throughout Mexico. Participants in the solutions session under this thematic axis were asked what strategies could be implemented jointly between the government, the academic sector and the private sector to encourage the development of regional suppliers near the production centers. While most suppliers in the industry today can provide supplies for both internal combustion and electric vehicles, in many cases they will have to gradually transition to manufacturing specific components for the new electric vehicles.

In response to that question, several participants agreed that a necessary first step to solve this obstacle is to identify all existing automotive industry suppliers in a national level census, in order to understand what processes are currently available, as well as their location. The product of this recommendation would be, on the one hand, having more complete information for decision-making and, on the other, creating a national directory of suppliers available to the industry.

This type of census and directory can be developed jointly between government, industrial chambers, *original equipment manufacturers* (OEM) and Tier 1 (equipment and auto parts supplied to OEMs), Tier 2 (parts) and Tier 3 (raw materials) suppliers, with support from the academic sector. This will allow companies to obtain information in other states of the country outside their clusters, and thus incorporate other states to this industrial field. In the short term, this would also make it possible to take advantage of Mexico's capacities, for example, in electrical manufacturing, while in the medium term, it would adjust the production of components that will be increasingly demanded by OEMs.

That said, the participants recommended developing an electronic catalogue with industry supplies consisting of a list of electric automotive industry goods and services, which could be managed and updated by the Ministry of Economy.

RECOMMENDATION 12
Carrying out a census and creating directory of existing suppliers with information provided by the industry to identify what is currently available and where are the areas of opportunity to attract new industries. This will make it easier for other industry players to find suppliers to increase their domestic market.
RELEVANT ACTORS
Industry, the Ministry of Economy, the Ministry of Foreign Affairs.

Recommendation 13: Identification of supply needs, conversion of existing industry for the transition and requirements to attract new suppliers

The second recommendation consists of a detailed analysis of the mapping and catalog of existing suppliers mentioned in the previous section. Having an updated database of the currently existing supply chain in the country, the industry and the academic sector suggested carrying out an analysis that identifies the components - mainly from Asia - that still have to be imported into Mexico to strengthen the regional supply chain for the manufacture of electric vehicles.

This analysis will define which suppliers need to be developed locally for supply chain resilience, and which existing suppliers could manufacture components that are not currently supplied to the automotive industry. The reconfiguration and transition of companies is a process in which the Ministry of Economy participates, and which it has used to identify which suppliers meet the requirements of the transition to electromobility, as well as the tools and support they need to carry it out successfully.

A similar case took place in the United States, based on an executive order by President Biden to analyze six production chains of the manufacturing industry that depend on imports. Following this review, a report was prepared with diagnostics and strategies to strengthen the industries under review, including that of semiconductors. In addition, they carried out a panel and a created a specific working group for each of the industries under review (White House, 2021a).

For the development of Mexican supply, mainly from micro, small and medium enterprises, the need was emphasized to have increased availability and more flexibility in credits from development and commercial banks, so that these companies can invest in technological development and growth to adapt to the needs of the electromobility industry.

In this regard, it was also mentioned that it would be even more desirable to create new mechanisms that facilitate investment towards Mexican Tier 2 suppliers, for example, with the creation of investment mechanisms similar to FIBRA (real estate investment trusts). These trusts are responsible for investing, managing and operating large scale and high-quality properties; they can belong to different industries, such as factories, offices, malls, hotels, energy and telecommunications companies, among others (BMV, 2021). The recommendation mentions that the mechanism could initially be based on best practices of these trusts and then be adapted to the automotive industry.

RECOMMENDATION 13

Based on the census of suppliers in Mexico (from the first recommendation), the recommendation is made to identify the potential for the conversion and transition of the current supplier to the electric automotive industry. And in turn, to promote mechanisms, incentives and financing for investment.

RELEVANT ACTORS

The Ministry of Economy, the Ministry of Finance and Public Credit, the Ministry of Foreign Affairs, the National Banking and Securities Commission, development banks, commercial banks, industry and academia.

II. DEVELOPMENT OF RAW MATERIALS FOR BATTERY PRODUCTION

Recommendation 14: Round tables to hear the key actors in order to create strategic programs, policies and guidelines

Although this obstacle was identified before the publication of the decree for the creation of LitioMx in the *Official Gazette of the Federal Government* on August 23, 2022, a significant degree of uncertainty remains with regard to the mechanisms and forms of participation of the private sector in this industry after the issuance of the decree.

On the one hand, the decree establishes that LitioMx may be associated with the private sector for the production, processing and distribution of lithium products (article 6 section VII). As far as this chapter is concerned, the office will have the mandate of "[r]esearching and developing the technology required in the industry related to the use of lithium", as mentioned in article 6 section II (DOF, 2022). However, uncertainty remains an obstacle identified by the actors, since the organic law of this state body is yet to be issued. Its duties will include developing strategic programs, policies, guidelines and vision, as well as determining its operational budget and the criteria it will use to partner with others.

In this way, participants reiterated in subsequent interviews that the scant existing regulation does not give provide clarity in regards to the scope and the ways in which the private sector could participate in battery supply chains, and thus, to how they can attract suppliers. Therefore, the need to attract investments is still necessary, not only for the exploration, extraction and refining of lithium in Mexico, but also for the development of an ecosystem in the country (in addition to batteries, for example, for alloy manufacturing or for the pharmaceutical industry).

As noted in the Obstacles section (and other chapters of this document), battery manufacturing is highly strategic for the electric vehicle industry. The existence of lithium deposits in the country, as well as the intention expressed by President Lopez Obrador to use national lithium for the automotive industry, (Gobierno de Mexico, 2022b), signal that there is movement in the right direction, exploiting Mexico's potential comparative advantage in the field of batteries.

In this sense, the recommendation is not only to ask for the pending regulatory framework to be issued as soon as possible, but to listen to different key actors in the industrial, social and environmental industry in the process of creating it. Having rules and plans that reflect different points of view will make it possible to design forms of participation that respond to different interests, attracting investment, technology and innovative business models that facilitate the insertion of Mexico in battery supply chains.

Therefore, project actors recommended convening a participatory forum that informs the pending regulatory framework on lithium as fully as possible, ensuring the greatest benefits for Mexico, its inhabitants and industries, and evaluating the technology that will be necessary for the extraction and processing of the mineral, according to the specific characteristics of Mexican deposits.

This forum would provide greater clarity to the regulatory framework, taking into account the different opinions and requirements to extract and process the mineral efficiently. The recommendation was made to follow the Chilean example for this purpose, where they built a roadmap to establish lines of work, research and development both in the medium and long term (Alta Ley, 2022). This will facilitate the attraction of battery development companies that have expertise in the development of these components. In addition, it will promote collaboration and knowledge transfer agreements for Mexico to develop this type of technology in the country.

Finally, the participants stressed that it is prudent to focus attention not only on lithium, but also on other raw materials, for which they recommended carrying out round tables focused on other strategic components for the manufacture of batteries and also for other important parts for electric cars. They also considered it important not to focus all efforts exclusively on the manufacture of batteries, but to consider a holistic approach to the entire value chain of the industry.

RECOMMENDATION 14

Hold round tables focused on identifying strategic components for the manufacture of batteries and other essential components for the electric vehicle industry. Likewise, to hold participation tables in which LitioMx, through its representative body, hears the key actors in lithium matters, including academia, industry and public bodies not represented in the governing body to draw up a roadmap and include these recommendations when issuing strategic programs, policies, guidelines and vision.

RELEVANT ACTORS

LitioMx, the Ministry of Energy, the Ministry of Economy, the National Geology Service, the Ministry of Foreign Affairs, industry, academia.

III. AVAILABILITY OF DIGITAL TECHNOLOGY COMPONENTS

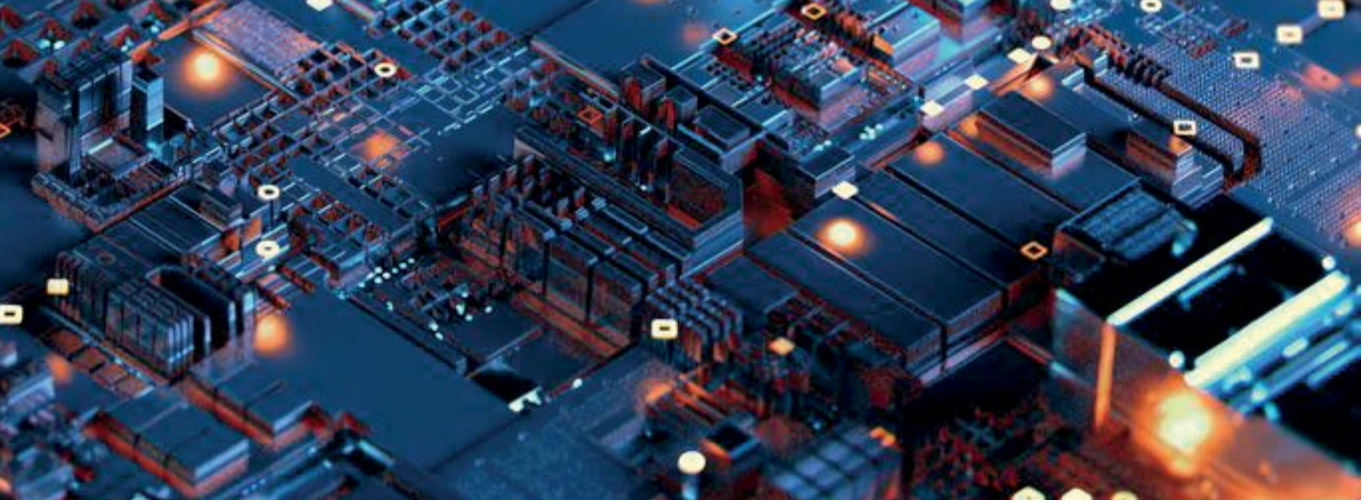
Recommendation 15: Creation of an industrial roadmap and financing mechanisms for Mexican suppliers

The shortage of semiconductors, as mentioned earlier in this chapter, is a major concern of the automotive industry globally. One of the recommendations to face this challenge is to attract semiconductor manufacturing companies to Mexico.

To this end, the recommendations session of this thematic axis included that the Ministry of Economy actively works with semiconductor companies - such as Intel and Vishay Intertechnology, for example - to accelerate the establishment and production of its plants in Mexico (Morales, 2022). This would reduce the dependence on the import of these components at the regional level and move Mexico forward as a pole of innovation in the region, strengthening the complex semiconductor supply chains in the world. An example of this vision is the Intel Design Center in Guadalajara, as well as the signing of a collaboration agreement between this company and the Ministry of Economy in April 2022 to strengthen the transfer of innovation resources and the long-term training of highly-specialized Mexican talent in technology (Ministry of Economy, 2022).

In this sense, project participants recommended that the initiatives of the Ministry of Economy for the installation of digital technology projects must continue, scale and attract more companies and investment for the development of digital technology supply for the manufacture of semiconductors, which are a basic element for a growing number of industries.

This translates into the recommendation to develop an industrial policy-based roadmap that links suppliers and developers, in order to increase the content of Mexican (and North American) value in electric vehicles in the medium term. In addition, participants recommended that this map focus mainly on micro, small and medium companies, which will benefit from the increased demand for manufacturing processes driven by the trends in



nearshoring and *allyshoring*, and by the USMCA, specifically in regards to the regional content value.

In order for Mexican suppliers to increase their capacity and take advantage of the new demand, they must also have financing and investment attraction facilities, so it is important to provide them with the necessary tools to adapt to the new era of electromobility.

RECOMMENDATION 15
Develop an industrial roadmap linking suppliers and developers, that establishes concrete objectives, and the steps for their implementation in order to achieve 100% regional content value in a period to be determined in the roadmap. Design mechanisms for investment and a proposal for public-private financing to support and encourage industrial expansion.
RELEVANT ACTORS
The Ministry of Economy, the Ministry of Foreign Affairs, National Foreign Trade Bank, U.S. Department of State, U.S. Department of Commerce, local governments, technology and semiconductor industries, academia.

IV. POLICY ALIGNMENT

Participants mentioned multiple obstacles that can be grouped together in a “lack of alignment of public policies”, which will be addressed in more detail in the Governance chapter. However, it is important to mention some recommendations that address both supplier development and public policy.

Recommendation 16: Organize working groups with stakeholders to include their perspective and experience in developing a public policy that encourages supplier development

To begin with, participants identified the perception of a lack of legal certainty in various areas that impacts the attraction of both investment and suppliers. They referred in particular to electric power and the policy followed by the Federal Electricity Commission (CFE), in particular in relation to renewable energies, which are fundamental for the transition of this industry. In this area, they also mentioned a perception that the Federal Government doesn't have a unified project to work on a coordinated electromobility policy.

Due to the above, the proposal is to create an inter-ministerial task force to hear and incorporate the views of each of the agencies, industry actors and academia, to develop a unified and consistent public policy that encourages the development of suppliers in the electromobility industry. This information must be included in the roadmap of the previous recommendation in order to generate a comprehensive document that includes the perspective of the aforementioned actors.

RECOMMENDATION 16
Involve the different ministries and relevant organizations in the development of the industrial roadmap, listening to the voices of industry and academia actors, to evaluate the most suitable mechanisms to attract investments to the industry.
RELEVANT ACTORS
Ministry of Economy, the Ministry of Foreign Affairs, the Ministry of Environment and Natural Resources, the Federal Electricity Commission.

Recommendation 17: Regulatory innovation tables to review critical advocacy areas with industry experts to improve customs and tax instruments

On the other hand, the participants of the working group considered that the current operation of incentives and customs schemes is not efficient, and recommended to the relevant bodies to carry out a comprehensive review to identify measures that can improve the operation of the instruments. It is advisable that this be carried out without neglecting the legitimate control and inspection purposes for which they were intended, such as, for example, the prevention of the smuggling of goods.

Participants also mentioned making the IMMEX scheme more accessible and improving the so-called automotive tax deposit. To do this, it is important

to hold participatory forums where the proposals and concerns of industry participants are heard in order to align critical impact points.

Participants argued that, broadly speaking, the implementation of reforms to prevent tax crimes have caused the industry to have to temporarily pay VAT and then wait months to receive refunds, which affects the liquidity of companies and results in the problematic lack of financing to invest in the demands of the new automotive markets. In addition, industry players consider that merchandise inspections and counts are also very time-consuming for authorities.

On the other hand, they also pointed out that the Automotive Decree (the Decree to Support of the Competitiveness of the Terminal Automotive Industry and to promote the development of the internal car market published in 2003 and reformed in 2009) does not contemplate electric vehicles, so there is an opportunity to issue a new decree that does include them in order to support the industry in its transition to electromobility.

Participants also recommended reviewing policies for tax exemptions on the import of electric vehicles for public transport, since the import of auto parts for the domestic manufacture of such vehicles is currently not exempt from taxes.

They suggested that all these reviews should be done with the participation of tax experts from industry, government and academia, with the aim of supporting and leveling the playing field for domestic automotive suppliers.

RECOMMENDATION 17

Round table on public policy innovation with the participation of technical experts, to identify critical failures and solutions in customs and fiscal regulations that affect the import of supplies for car manufacturing. Enactment of a new automotive decree that incorporates benefits for electric cars and addresses the critical points identified by the industry.

RELEVANT ACTORS

The Ministry of Economy, the Ministry of Finance and Public Credit, the Ministry of Foreign Affairs, the Tax Administration Service, customs, industry, academia.

Infrastructure Development

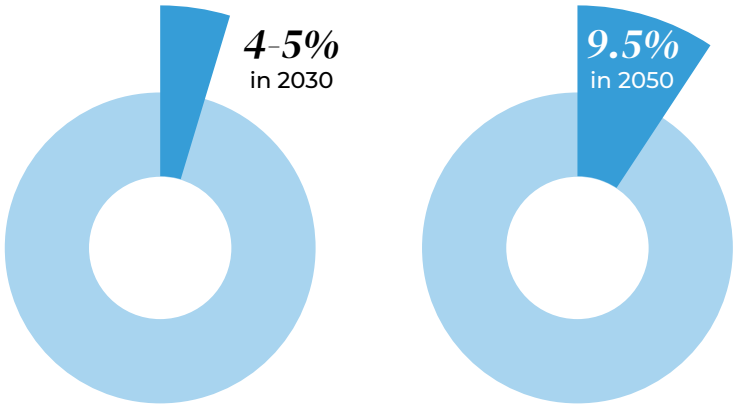
Introduction

To begin this chapter, it is important to define what type of infrastructure the document refers to, taking into account the context of the electric automotive industry. To do this, we propose dividing the topic into two different areas: charging infrastructure and network infrastructure. The first refers to the types of chargers and the deployment of charging stations that will be required for the operation of electric cars. The second has two lines, first, the telecommunications network that will be key in the efficiency processes of the industry, followed by the network and electrical matrix that will provide power to the stations.

According to IHS Markit forecasts for electric vehicle charging infrastructure, the global deployment charging stations will increase at an annual rate of 31% up to over 66 million units by 2030. Preferences for the type and location of charging infrastructure vary across the industry's major promoting regions, with China accounting for over 60% of the growth in public charging stations deployed worldwide by that year (IHS Markit, 2021).

In the case of the United States, the International Council on Clean Transportation (ICCT,) prepared a study that proposes a scenario in which, in states that promote the industry (such as California), all vehicle sales will be electric by 2035, while for the rest of the nation it would happen in 2040. Based on this scenario, the report estimates that the United States will need to install 2.4 million public (outside homes) chargers by 2030, an elevenfold increase with respect to the 216,000 chargers installed and registered by the end of 2020 (Bauer et al., 2021).

On the other hand, the cumulative deployment of electric vehicle charging stations in Europe is estimated to increase by 24% during the 2020-2030 period. By 2030, around 20 million homes on this continent are expected to be equipped with charging stations, while there will be eight times more public stations than those installed as of 2020 (IHS Markit, 2021).



percentage of total energy consumption

from electric vehicles
in the European Union
EEA, 2021

The increase in demand for electric vehicles, accompanied by the installation of charging stations, will generate substantial changes in energy consumption and generation. For example, in the European Union the percentage of total energy consumption from electric vehicles is expected to rise from about 0.03% in 2014 to around 4-5% in 2030 and 9.5% in 2050 (EEA, 2021).

Given international commitments to address climate change, it can be expected that the additional energy needed to meet increased demand from society at large will come from renewable sources. Comprehensive plans will be needed to change the grid structure, however, as most electric cars are currently recharged with energy from fossil fuels. To put this into perspective, the International Renewable Energy Agency (IRENA) explains that, if all light cars in the United States were electric today, they would represent 24% of the total electricity demand of that country. Given that the total amount of electricity produced from renewables in the United States ranges between 18 and 22%, the energy demand of all light vehicles could not, even theoretically, be met with clean energy (IRENA, 2019).

Infrastructure changes will also need to be accompanied by digitization, particularly the adoption of the 5G network. Interconnectivity and digitization offer different advantages to the industry. For example, they can help the user accurately determine the available (battery) range of their vehicle to the nearest charging stations. Or data collection at different charging locations can support distributors in planning network expansion to ensure sufficient capacity is available to meet the growing demand for electric vehicles (Muttaqi et al., 2019).

In most markets, charging infrastructure is nascent, difficult to manage, geographically limited and expensive. Fleet owners who organize mass re-

charging must pay for expensive network upgrades and suffer extended downtimes. Standard charging has its difficulties, which new technologies are trying to overcome. In addition, there is an ongoing debate regarding the installation of recharging infrastructure, with differences of opinion regarding which entity should be the one that invests in its development. There are multiple alternatives; for example, that the main investors are the government, vehicle manufacturers or partnerships between both parties through tenders and subsidies. Analyzing supply chains has shown that the most advisable option to increase the demand for electric vehicles is government investment accompanied by subsidies to users, as well as the construction of infrastructure by vehicle manufacturers that have government support to promote their use (Kumar et al., 2021).

It is clear that infrastructure is a core issue in the transition to electromobility. The following pages explain the diagnosis, which is based on the opinions of the experts from the working group for electrification in this thematic axis, and on additional individual interviews and research that corroborates the relevance of the obstacles analyzed.

DIAGNOSIS

1. Charging stations

One of the main issues mentioned during the first session of the working group of this thematic axis was the need to install charging infrastructure for light and heavy electric vehicles both at homes and in public access locations and roads.

Participants mentioned that one of the main obstacles is the lack of standardization of the chargers, since there are different types for use at home, which use the residential electrical grid, as well as stations that can manage higher voltage and current levels, leading to reduced charging periods. These stations are commonly known in Spanish as “charging stations” (Sanchez Vega et al., 2020) a portmanteau of the word “electricidad” (electricity) and “gasolinera” (gas station).

Regulations have been issued in different countries for the different types of chargers, to facilitate their installation and use. However, there is no global consensus on what type of chargers should be used. Because of this, there are three different types for alternating current (AC), and three more for direct current (DC). The United States and Canada use type 1, Europe uses type 2 and China uses GB/T for alternating current (Hove and Sandalow, 2019; Mobility Insider, 2021). In the obstacle session it was mentioned that, given that the United States is Mexico's main trading partner and because of the proximity to that country, a good option would be to regulate the adoption of type 1 chargers.

The installation of electric vehicle infrastructure was also highlighted as a challenge for the transition to electromobility. This entails, in turn, several aspects that it is important to mention in this chapter. The first is the lack of a reliable study that shows the currently existing chargers, in order to geolocate, according to demand, the areas that need to be prioritized for the installation of charging infrastructure. There is currently a CFE study that indicates that there are 2,090 chargers in Mexico (RENAEL, 2021). However, experts noted that the information has not been updated and it doesn't include existing private chargers.

As an additional step to the aforementioned obstacle, they brought up the technical issue of voltage adequacy for the correct operation of the chargers, especially with the growth in number of vehicles to be charged. To this end, the participants highlighted the need to develop an infrastructure implementation plan that takes into account the estimated demand and charging levels projections. There are different charging levels; level 1 can be used with regular current; it takes many hours to charge a vehicle and it is normally used overnight. Level 2 charging is considerably faster, but requires the installation of a charging station, also known as electric vehicle

supply equipment (EVSE). On the other hand, DC fast charging is the fastest, and requires additional installation at the charging stations (California Clean Vehicle Rebate Project, 2020).

Likewise, they considered it necessary to take into account different factors for the successful regulation of the installation of the infrastructure, since it must consider, for example, how will access to the charging stations take place, what guidelines must be met to ensure their correct operation, the characteristics that locations where the stations are installed must have, as well as the business and charging schemes for suppliers and users both in cities and on roads. Best practices from the most advanced markets - such as China, Europe and the United States - can be analyzed for this purpose, although the characteristics and context of the country must be considered and the recommendations must be adapted to the specific needs of the market. Some of these practices are modifying building, housing and parking construction codes, the Open Charge Point Protocol (OCPP) and the implementation of incentives and subsidies (Hull and Lutsey, 2020).

Last, project actors stated the importance of prioritizing the attraction of investment for the implementation and deployment of the infrastructure, and they stressed that both the industry and the government must provide funds to achieve this development, ideally, through modernization, innovation and eco-friendly energies that support Mexico's compliance with international emissions goals. In subsequent interviews, the participants mentioned a CFE case study in which chargers were installed in parking lots under agreements with shopping stores and automotive industry actors, thus achieving a win-win operation.

2. Cities vs. Roads

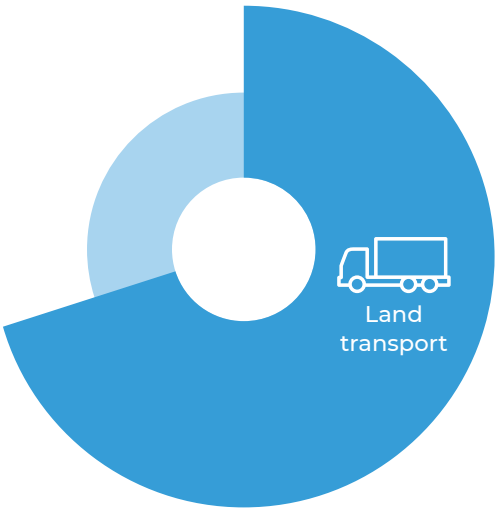
On the same subject, a debate was opened during the aforementioned working session on the order of priorities for the deployment of charging infrastructure in cities and roads. In the first instance, it was pointed out that electromobility is initially an urban phenomenon, so it was suggested that infrastructure development start in cities, particularly in public places, such as parking lots and shopping malls.

On the other hand, it was argued that, although electromobility emerges in cities, most electric cars will be able to be recharged in residential areas, which will give them sufficient autonomy to circulate. Having said that, they mentioned that the biggest obstacle lies in the reconfiguration and adaptation of residential electric supply. They pointed out that one of the main challenges of electric cars is the ability to move from one city or state to another, so it was recommended to start with the deployment of charging station networks on roads. To reinforce this point, during the individual interviews following the aforementioned session, government and industry actors explained that over 70% of trade between Mexico and the United States is carried out by land and that, given the adoption and promotion of

over 70%

OF TRADE BETWEEN MEXICO AND U.S

is carried out by land and that, given the adoption and promotion of electric trucks



electric trucks in President Biden's administration, together with the transition of multinational company fleets, the installation of recharging plants in border areas should be prioritized.

Around the world, different countries are implementing strategies for the deployment of charging stations. While these strategies include the development of infrastructure in cities and roads, the methods of prioritization or the incentives to develop this infrastructure are usually different. For example, Chile launched its national electromobility strategy in 2021, and it explained that the location of charging points was to be based on vehicle flows and the availability of the electric network, so, the Chilean government has focused more on the development of the urban infrastructure part to date (Government of Chile, 2021).

On the other hand, and by way of contrast, the development of infrastructure from a regional point of view prioritizes the installation on roads, as in the case of the European Green Deal strategy of the European Union, which presents a regulation for the deployment of electric recharge with the goal of installing a station every 60 kilometers (about 4 million recharging points by 2030) along the main communication roads between the countries of the area (European Commission, 2021). The above suggests that charging station planning will depend on geographical position, regional integration, population size, economic situation and demand for electric cars in each country.

57 MILLION

people, in 2015, were internet users

IFT, INEGI

88 MILLION

people, in 2020, were internet users

IFT, INEGI

3. Telecommunications networks

According to data from the Federal Telecommunications Institute (IFT) and INEGI, about 60% of the population in Mexico in 2015 - 57 million people - were Internet users. Five years later, the number of users increased to 88 million. This means that today 78% of the urban population and 50% of rural areas have internet coverage. On the other hand, this is the main medium for the connection of smart phones, at 96% (IFT, 202 INEGI, 2021).

Technological evolution, falling prices, the implementation of reforms and industry competition have supported the rapid digitization of Mexico and various countries in the last decade. Due to the above, the telecommunications industry has made ever greater strides in the mobility ecosystem. For example, the development of autonomous vehicles and interconnected services depends on digital networks. The 5G network, for example, will make it possible to connect a hundred times more devices, which will enable the massive Internet of Things (IoT), which means a million connected objects per square kilometer. As electric vehicles become “smarter”, the interrelationship between these two industries will be even greater (ITU, 2018).

That is why one of the most relevant topics discussed during the working session was the need to accelerate digitization in the automotive industry, in particular the adoption of the 5G network, to improve the user experience and to make manufacturing and automation processes more efficient. In this sense, the intermediate interviews with telecommunications industry experts in Mexico identified two obstacles for the adoption of the 5G network in the country: the deployment of infrastructure and the cost of the spectrum.

With regard to the former, they mentioned that - unlike 4G systems - the 5G network includes greater data transmission capacity, greater bandwidth and shorter waiting time or latency (IFT, 2020c). Since high-frequency waves have more difficulty traveling distance and through objects, 5G systems will be built with small cell technology with separate antennas and in

greater proximity to each other, so the number of base station antennas will increase considerably (ITU, 2021). This will require the coordination of different levels of government, as well as decision-making and urban-territorial planning in municipalities to expedite the installation and deployment of this type of network in the country.

Second, they emphasized the need to reduce the cost of spectrum. According to data from various international organizations and consulting firms, the cost of spectrum in Mexico is the highest in Latin America, as it represents 12% of the annual revenue of the telecommunications industry; almost twice that of countries such as Germany and the United States (BNamericas, 2021; GSMA, 2020). The increase in capacity and data speeds enabled by the 5G network will require more spectrum, therefore the high cost may represent a barrier to the development of this digital network in the country in the short and medium term.

4. Electric network

As mentioned at the beginning of this chapter, the power grid infrastructure was identified as a priority obstacle in the deployment of charging stations. The reason for this is the need for reliable infrastructure that can withstand the increase in energy demand for recharging - light and heavy - electric vehicles and which would ideally come from clean energy.

Two main factors were mentioned in this respect: the first was electricity generation and the second was transmission and distribution infrastructure. Electricity generation, whose planning is beyond the scope of this project, plays an essential role in meeting the environmental goals of international automotive industry players. For example, during COP26 thirteen car manufacturers committed to reach 100% of new vehicle sales with zero emissions in major markets by 2035 (UK Government, 2022).

In addition, according to the National Energy Control Center (CENACE), 10,926 GWh will be used by 2035 to meet the increase in demand for electrical energy destined for electromobility, which represents 2.3% of the consumption of the National Electric System (Sen) (CENACE, 2021). Additional power generation, as stated in the working groups, should ideally consider Mexico's international commitments in terms of emissions. Some solutions mentioned were microgrids and generation for self-consumption.

Electrical transmission and distribution, on the other hand, are concerns that were expressed on several occasions during the aforementioned session. In Mexico, the SEN consists of 53 transmission regions that are connected to each other by high-voltage electrical networks (corridors), known as national transmission networks (RNT), which allow the exchange of electrical energy between them. In turn, within each transmission region there are distribution networks, which connect each and every one of the substations to each other (Chacon et al., 2021). This system must be in optimal

operation; otherwise, it runs the risk of collapsing. Likewise, the network must be able to respond to the new operating conditions effectively and safely and, at the same time, guarantee access to energy (WRI Mexico, 2021).

On the other hand, it was emphasized that one of the main challenges facing the country in terms of energy security is the transmission network, since it has not received the necessary investment for maintenance. In addition, it was noted that there are interconnectivity challenges, for example, in the isolated systems of Baja California and Baja California Sur and in the Yucatan peninsula (Ocampo, 2022). In this sense, vehicle charging can aggravate the persistent problems in the electricity network if there is no coordination between the actors, since there will be greater pressure on the network as supply and demand peaks.

In addition, the experts identified the challenge the deployment of fast chargers will represent given the pressure they exert on the network. This coincides with several studies, which say that this type of chargers can present adverse effects because of the voltage profile, as well as energy and power losses in the transformers (Hall and Lutsey, 2020; Shariff et al., 2022).

It is necessary to identify the critical points of the network to proactively seek solutions. This will require investments in infrastructure, technology and innovation, which were pointed out as an additional obstacle by group experts. There are new solutions, such as the one known as vehicle to grid, in which the control and management of energy is facilitated at a certain time of the day, based on demand. Over time, both the development and deployment of such technologies will allow vehicles to connect to smart chargers to contribute to the balance of the system (IEA, 2022c). In this regard, they mentioned a need to define a path to attract investments, accompanied by a regulatory framework that allows an efficient use of the network.

I. GENERAL INFRASTRUCTURE RECOMMENDATIONS

The following section presents a series of recommendations based on the contributions submitted during the second session of this thematic axis of the project, held on September 2, 2022, with participants from the industry, government and academia of Mexico and the United States. These solutions and steps were corroborated with evidence, best practices and subsequent interviews with project actors.

I. CHARGING STATIONS

Recommendation 18: Carrying out a census to identify the current supply of chargers and their status

As mentioned in the previous chapter, one of the main challenges identified for the success of the installation of the recharging infrastructure in Mexico is the absence of a reliable study showing the current offer of chargers. Participants noted that, despite the existence of some databases and approximations by the industry and the Federal Electricity Commission (CFE), there is no single reliable census prepared by an authority that lists the number of private chargers.

In addition, they commented that currently it is not possible to know the status of installed chargers, so their first recommendation was to develop an updated database of chargers. Second, they suggested analyzing existing technology options to identify the operating status of the chargers, highlighting the importance of developing a charger maintenance strategy.

In this regard, there are several alternatives to monitor the operation of chargers using telecommunications solutions. However, its implementa-

tion will require a review of the existing infrastructure. The importance of such information is that using such data as a baseline would make any forecasts of the number of chargers that will be required in the future more accurate. This would also provide greater clarity as to the demand for electrical energy (Gartner, 2021).

Likewise, knowing the location of public chargers facilitates the use of electric vehicles and, therefore, accelerates their adoption. According to the Center for Sustainable Energy, a recharging infrastructure database helps both utilities, states, and entrepreneurs maximize the return on infrastructure investments and avoid underutilized assets (Gartner, 2021).

In summary, the recommendation identified in the second session revolves around the development of a solid database, with a census of electric vehicle charging infrastructure that includes the information and geolocation of chargers both for private and public use. It was also suggested that this database be updated periodically and include infrastructure information for both light and heavy-duty vehicle charging.

RECOMMENDATION 18
Prepare a census of the existing public and private charging infrastructure, to have a baseline that allows establishing the future demand for chargers, as well as the priority area in the medium term.
RELEVANT ACTORS
The Ministry of Foreign Affairs; the Ministry of Infrastructure, Communications and Transport; the Federal Electricity Commission; the automotive industry.

Recommendation 19: Create a roadmap to establish a common standard for unified charging infrastructure across the North American region

The second major obstacle in terms of charging infrastructure is the lack of standardization of electric vehicle chargers. As mentioned previously, there are various types of chargers that use different plugs and voltages. During the recommendation session, industry representatives expressed mixed opinions. However, most agreed with the implementation of a charger standard aligned to that of the United States and Canada to ensure the ease of transit of private and commercial vehicles in North America. To this end, they suggested sharing both lessons learned and case studies from the region that could facilitate such standardization.

In turn, they recommended drafting a document that outlines the path to be followed for the standardization of electric chargers in the country, seeking that the type that is chosen benefits as many users as possible. Participants noted that this will also facilitate the transition to electromobility and generate an increase in the country's domestic demand. They also mentioned that this will benefit the manufacturing industry, since the number of import and manufacturing components will decrease once there is a regulation to install and use a single type of chargers, as this will reduce costs and allow greater commercial development.

On the other hand, they stressed that it is advisable that the route map seeks, in addition to the type of charger, a standardization of software and payment systems, so that any user can use the public chargers available. In this regard, they noted the importance of regulating the way in which users would pay to use said public infrastructure.

This concept of standardization is closely linked to interoperability. From the consumer's point of view, this refers to the possibility that users can use any public charging infrastructure point, which must have different payment methods available, and adequate outlets to charge the vehicle. In addition, policies implemented in other countries recommend that public charging stations communicate with each other and with the entire ecosystem. Interoperability not only improves the user experience, but also facilitates infrastructure management, minimizes costs and increases infrastructure utilization (Ministry of Energy of Chile, 2021).

Regarding voltage standardization, experts agree that the existing voltage regulation for Mexico should be followed. In this sense, they mentioned that its adoption and standardization for electric vehicle chargers would avoid the need to make voltage adjustments, a common practice today to install European or Chinese chargers that use a different standard. These adjustments result in additional costs and can be problematic as they involve a higher energy demand.

It was also recommended that the roadmap include actions to lower the increase in demand due to the installation of recharging infrastructure. One case that has been successful in other countries is to implement a preferential rate for night charging and a higher rate in peak demand hours during the day. In certain regions, this alternative depends on different electrical grid operators (EAFO, 2021), so an advantage for Mexico is that it would only have to be coordinated by the CFE. Establishing different rates would reduce the stress on the electricity network and, in turn, map the areas in which it will be necessary to strengthen the network in collaboration with the CFE.

In Canada and the United States, 30% of the causes of peak electricity consumption are attributed to the residential sector. Residential charging of electric vehicles will contribute to peak consumption periods if it takes place within critical periods of the grid. To mitigate network overload, scheduling plans known as load shifting strategies are being devised, which seek to shift peak demand to lower demand periods. However, these strategies require a significant amount of information (e.g., customer behavior) to optimally meet the energy needs of users and the electrical grid. (Cardenas et al., 2021).

It should be mentioned that this recommendation has to be executed in collaboration with the Ministry of Economy, which must review the legal framework related to the standardization of charger types and the demand shifting strategies mentioned above, and provide a timely follow-up with other federal agencies to ensure the correct implementation of a new NOM.

RECOMMENDATION 19

Develop a roadmap focused on seeking recharging standardization in terms of the type of chargers, the voltage required, the operating systems and payment methods to facilitate the use of said infrastructure at the regional level, and to accelerate the national adoption of electromobility systems.

RELEVANT ACTORS

The Ministry of Foreign Affairs; the Ministry of Infrastructure, Communications and Transport; the Federal Electricity Commission; the Ministry of Economy (General Office for Standards); the United States Department of State, academia, industry.

II. CITIES AND ROADS

Recommendation 20: Prepare a study to obtain information to determine the order of priority to install charging stations on roads

Project actors agreed by consensus that roads are the priority for the deployment of charging station infrastructure. In this regard, they argued that the first reason for such prioritization is that in the cities electric cars will be mainly recharged at home and that these vehicles still don't have sufficient autonomy to travel long distances. They also mentioned that the heavy vehicle fleets in Mexico and the United States are moving towards electrification to move goods domestically and abroad, which is of utmost relevance, since trade between both countries takes place mostly by land.

However, participants pointed out that there are different aspects of the installation of charging stations, both on roads and in cities, that must be taken into account before carrying out the first steps of this recommendation. For example, they stressed that the challenge in housing areas lies in the remodeling of vertical housing, particularly in terms of adapting electrical capacity and the availability of the recharging spaces that will be needed. In addition, they recommended that the new permits to build offices and vertical housing include infrastructure with the additional energy capacity to meet the future electricity demand and that they set the requirement to establish a minimum number of parking spaces exclusively for vehicle recharging.

As to the roads, they explained that over 50% of heavy vehicles in Mexico belong to micro and small companies (SICT, 2021), so charging their fleets and adapting the electric charging time compared to diesel will represent a challenge for them.

As a first step to prioritize the deployment of charging infrastructure in the roads, they recommended carrying out a study to obtain quality information to support decision-making in this area. It was suggested that this study consider the prospective demand and current capacity of the CFE. In addition, it should consider the installation of 4 and 5G telecommunications antennas on the roads to interconnect the vehicle with the different charging points and thus improve user experience and safety. In this sense, it was pointed out that interconnectivity will help the collection of data for maintenance and monitoring of both the electrical grid and the charging stations.

In this regard, several cities in the United States are taking advantage of the use of technology on the roads to increase safety, reduce traffic and improve road operations and interconnectivity. For example, the Georgia state government, in collaboration with the Department of Transportation of the state, developed a smart highway corridor located on North Avenue in the city of Atlanta. The corridor has internet coverage, travel time equipment and Bluetooth origin-destination systems, as well as sensors to enable IoT.

50%
OF HEAVY VEHICLES
in Mexico
belong to micro and small companies.
SICT, 2021

This strategy has enabled the state to collect and analyze data that supports both short- and long-term transportation planning (SNC Lavalin, 2018).

On the other hand, it was recommended that the proposed study consider the requirements to speed up the installation of charging stations with fast chargers, highlighting that these should include stops where the user feels safe while waiting for their car to recharge. Finally, participants presented various existing mechanisms and projects that can serve as a starting point to execute this recommendation. For example, it was mentioned that the CFE prepares prioritization studies using the transit information generated by toll booths.

They also pointed out that the Institute of Engineering of the UNAM has origin-destination studies of the metropolitan area of the Valley of Mexico that gave the characteristics of the trips of both people and cargo transport (UNAM, 2017). The methodology used in this type of exercises can be implemented or replicated to analyze specific roads.

RECOMMENDATION 20

Develop a study to obtain quality information to prioritize the installation of charging stations on the roads. It is recommended that this study consider the installation of safe stops, as well as reliable internet networks to improve user experience and ensure the monitoring of charging points.

RELEVANT ACTORS

The Ministry of Foreign Affairs; the Ministry of Infrastructure, Communications and Transport; the Federal Electricity Commission; UNAM; highway concessionaires; industry; the academic sector of the United States.

III. TELECOMMUNICATIONS NETWORKS

Recommendation 21: Review the telecommunications regulatory framework to expedite the installation of 5G networks. Create urban-territorial planning guides and promote incentives for the deployment of this type of networks

By way of context, it is important to note that the telecommunications industry falls under federal legislative jurisdiction under article 73, section XVII of the Constitution. In exercise of this power, Congress issued the Federal Telecommunications and Broadcasting Act (LFTR), which establishes in article 5 that any issue related to telecommunications infrastructure shall be managed by federal authorities. It also establishes that the three levels of government are obliged to collaborate to allow their deployment, in compliance with state and municipal provisions (which have jurisdiction for urban development and street infrastructure matters). However, various project participants were of the opinion that federal powers are different in practice, since municipalities and mayors are the entities that grant permits to install equipment for the transmission of 5G network, because of the regulatory heterogeneity of the different states and municipalities of the country.

On the other hand, before delving into the recommendations in this area, it is important to explain that because it uses 3.5 GHz, the 5G network belongs to the C band, which is the portion of the radio spectrum allocated for mobile transmissions in the frequency range between 4 and 8 GHz. Operating on a medium frequency, this band has a range of approximately two kilometers, compared to that offered by other networks, such as 3G and 4G, of ten to twenty kilometers.

That said, the 5G network will need to deploy a much larger number of cell sites (antennas) than the cellular frequencies used on a daily basis. Compared to other types of networks, an advantage of the 5G network is that, because it operates on a higher frequency, it uses a smaller antenna, so it requires less space and energy to operate. Given these characteristics, the installation of this new network in cities and industrial parks around the world should not present greater challenges, as long as there are clear strategies for deployment.

In this regard, experts in the field recommended reviewing and/or, where appropriate, reforming the regulatory framework as a first step to provide greater regulatory certainty to make 5G deployment more efficient, without ruling out homogeneous rules in which the Federal Government has a greater weight in decision-making for local deployment, which may make this process less bureaucratic and less prone to corruption risks. They also recommended that the Federal Government establishes procedures and guidelines to accelerate the installation of the 5G network at the local level.

On this last topic, during the recommendations session of this thematic axis, as well as in subsequent meetings, the Ministry of Agricultural, Territorial and Urban Development (SEDATU) was interested in promoting the creation of guides by the National Mobility and Road Safety System, chaired by that office since October 11, 2022. The above is with the aim of strengthening the urban-territorial plans for the deployment of the 5G network in states and municipalities.

To complement the above recommendations, project actors suggested that the Federal Government offer incentives (such as more funds for public works) using a transparent mechanism for municipalities to accelerate the installation of telecommunications infrastructure. In this regard, the Ministry of Infrastructure, Communications and Transport (SICT) is the one that, under article 9 section XVII of the LFTR, must promote investment in telecommunications, broadcasting and satellite infrastructure and services in the country (LFTR, 2021).

Last, they suggested adopting best practices for the implementation of these suggestions, such as those outlined in the 5G Plan of the Government of Colombia, published in December 2019. This plan states that regulations were modified in 2015 to speed up the deployment of telecommunications in local governments:

Article 309 of the PND 2018-2022 amended the first paragraph of article 193 of Law 1753, providing that mayors may carry out any actions necessary to implement the modification of the territorial planning plans and other district or municipal regulations that present barriers to the deployment of infrastructure for the provision of telecommunications services (MinTIC, 2019a p.26).

Following this modification, the 5G Plan proposes that the Ministry of Information and Communications Technologies (MinTIC) prioritize the deployment in the territorial entities that have eliminated such barriers. In turn, the strategy recommends that the Communications Regulatory Commission (CRC) of the country periodically update the code of good practices for the deployment of telecommunications networks. The constant updating of this code will serve the country as a support and consultation tool to facilitate and encourage the proper deployment of the 5G network in local governments (MinTIC, 2019a).

RECOMMENDATION 21

Review the regulatory framework to strengthen Federal Government decision-making on the installation and deployment of 5G networks in states and municipalities. Likewise, that State Ministries prepare guides in coordination with states and municipalities to implement urban-territorial plans that expedite the installation of this type of infrastructure. Finally, the recommendation is made to promote federal incentives for local governments to accelerate the adoption of telecommunications.

RELEVANT ACTORS

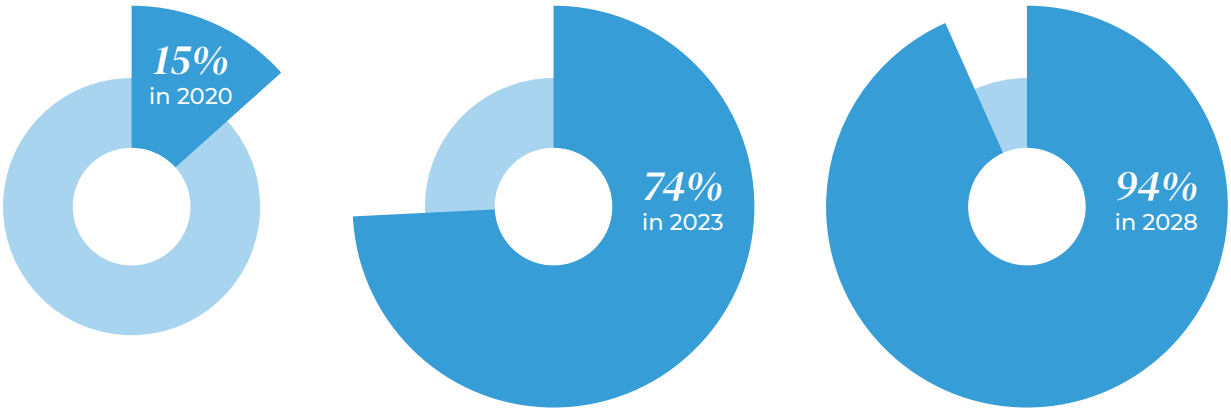
The Ministry of Foreign Affairs; the Ministry of Infrastructure, Communications and Transport; the National Asset Administration and Appraisal Institute; the Ministry of Finance and Public Credit; the Ministry of Agricultural, Territorial and Urban Development; local governments; telecommunications industry.

Recommendation 22: Reduce the cost of spectrum and implement the first 5G corridor in Mexico

In Mexico spectrum concessions last about twenty years. They involve the payment of an initial fee, colloquially known as “glove”, and then annual amounts that are proposed by the tax authority and ratified by Congress in the Federal Fees Law (IFT, 2020a). While tiered payments and the glove offer incentives to telecom operators, as discussed above, the country has one of the highest costs globally.

In addition, the increase in price for the spectrum has not aligned with the evolution of the mobile market. For example, over the past five years, industry revenues have declined, while annual fees have increased, not always in relation to inflation. In turn, Mexico is the only country in Latin America where the amount of allocated spectrum has decreased despite exponential growth in data demand per user (GSMA, 2021).

In this sense, participants argued that the high price translates into higher costs for the end user and a barrier for the adoption of new technologies in the communities that need it the most. It is for this reason that participants recommended changing the way the State conceives the spectrum - from an income generator - into a driver of development and social inclusion. According to different studies, in the last thirty years, every dollar invested by a country in digital technology has helped increase GDP by twenty dollars, while one dollar invested in non-digital technology has increased GDP by only three dollars (World Economic Forum, 2019).



Car growth

connected to a 5G service

Gartner, 2019

According to an industry report by the consulting firm Gartner, by 2023 the automotive industry will represent 53% of the global endpoint market ([12]endpoints of the IoT), a tool whose capacity will be expanded by the 5G network. This new network will promote the connected car market and address key road safety challenges to usher in the next generation of autonomous and intelligent vehicles. The report estimates that the percentage of cars connected to a 5G service will grow from 15% in 2020 to 74% in 2023, and up to 94% in 2028 (Gartner, 2019). On the other hand, a study by ABI Research (2022) estimates that the manufacturing industry globally will have over 49 million 5G connections within its facilities by 2030.

To achieve the adoption of 5G networks in the automotive industry, participants suggested reducing the cost of the spectrum, prioritizing deployment in areas lacking connection and that the State allocate a percentage of the revenue to the telecommunications industry. They also recommended following the practices implemented by the Colombian government, particularly referring to the 2019 tender for the auction of 700 MHz with payment deferred at seventeen years, in exchange for the operator prioritizing deployment and coverage in rural areas in the first five years of the concession (MinTIC, 2019b).

In this regard, the IFT has issued several recommendations: for example, on October 26, 2021, it presented a proposal to reform the Federal Law on Radio Spectrum Fees. One of the recommendations was to include a social expenditure accreditation scheme against the payment of fees for the use of spectrum to bring coverage to locations without internet access; that is, to reduce the cost of spectrum in exchange for incentivizing current concessionaires to invest in mobile internet services frequency bands in locations lacking connection (IFT, 2021). However, it should be noted that, as of the

[12] A physical device that performs a function or task as part of an internet-connected product or service.

writing of this document, these suggestions have not been contemplated in a draft reform nor are they part of the federal budget of the relevant fiscal year.

Last, the participants recommended that part of the concessioned spectrum be used to develop the first 5G industrial corridor in Mexico, and that it starts in the Bajio region. They recommended starting in this region because it hosts a large number of industries-automotive manufacturers and they advised that Queretaro be the state leading this infrastructure is , since it is one of the most relevant data center hubs in Latin America.

To reinforce this proposal, they mentioned similar actions implemented in the region that can serve as a starting point for the creation of public policies. For example, to strengthen manufacturing GDP, which is currently lower than that of Mexico, the Brazilian government has prioritized that part of the 5G spectrum under concession be used by industry, the agricultural and the mining sectors to optimize and make their productive processes more efficient (International Finance, 2022).

RECOMMENDATION 22
Reform the Federal Fees Act so that spectrum can be auctioned at a more competitive price and that, in exchange for this flexibility, operators prioritize the provision of services in rural areas lacking connection. It is also recommended that the State invest a percentage of spectrum revenue in the telecommunications industry. Last, they recommended that part of the concessioned spectrum be allocated to develop the first 5G industrial corridor in Mexico.
RELEVANT ACTORS
The Executive Branch (Presidency); the Ministry of Foreign Affairs; the Ministry of Infrastructure, Communications and Transport (SICT), the Ministry of Finance and Public Credit; the Federal Telecommunications Institute; the National Congress (Finance, Automotive and Telecommunications Commissions)

IV. ELECTRICAL NETWORK

Recommendation 23: Prepare a short- and long-term strategy to strengthen transmission and distribution networks

In the long term, the adoption of electric cars will bring a demand in excess of the currently installed electric capacity. Despite some approximations, industry input will need to contribute to the determination of the expected increase in demand. According to the pledges announced by different countries, global energy demand will increase by 4% in 2030 due to the growth of electromobility, which is equivalent to twice the total energy used in countries such as Brazil (IEA, 2022a).

This is why one of the biggest concerns of the industry is the impact on the electrical grid, from generation, to transmission and distribution. The recommendation of project actors for this obstacle is to develop a comprehensive strategy focused on strengthening the networks, one that takes into account different factors that are explained below.

As a first step, project participants recommended developing a heat map study to determine the expected demand and current installed capacity of the network. In order to have the most accurate information possible, they recommended that the study consider the manufacturing areas and forecasts of electric vehicle sales at the national and regional level, as well as electric fleets, heavy vehicles and public transport. It was highlighted that these studies will initially facilitate the identification of critical demand nodes both at the short and long term.

They pointed out the importance of differentiating the electricity demand that will be required for private vehicles, since those vehicles can use a home charging scheme during the night, minimizing the impact on the network. On the contrary, freight and public transport vehicles will generate a greater demand for energy given their size and operation. Different studies estimate that a vehicle of this nature requires ten times more energy than a private vehicle (Moaz Uddin, 2021). This differentiation will make it possible to identify infrastructure priorities in different urban and metropolitan areas.

As mentioned above, it was recommended that the CFE analyze the possibility of implementing differentiated rates by times of the day to incentivize the nightly charging of vehicles. They consider it was a best practice to have ad hoc meters for the use of recharging infrastructure, and recommended considering giving incentives for their use.

They noted the importance of conveying to users that electric vehicles cannot be compared directly with internal combustion vehicles, since the latter can be recharged in minutes (with fuel), while electromobility requires a different strategy for recharging. That said, it is of utmost relevance

for this recommendation that strategies to minimize the impact on the electrical grid include informing the public of the differences between both types of vehicles.

The participants stressed the need for clean energy generation systems, which shall grow simultaneously with the electricity demand brought by electromobility. They also highlighted the importance of the latter in minimizing the impact on the environment and meeting the international emission reduction objectives to which Mexico has committed.

Last, in post session interviews, the experts explained that the planning and implementation required to strengthen the electricity network generally takes several years, so they recommended the adoption of short-term technologies that allow increasing the demand for electric cars that use the existing network. As an example, they submitted the case of Flywheel Energy Storage Systemtechnology, which allows the installation of fast charging infrastructure without increasing the impact on the electrical grid.

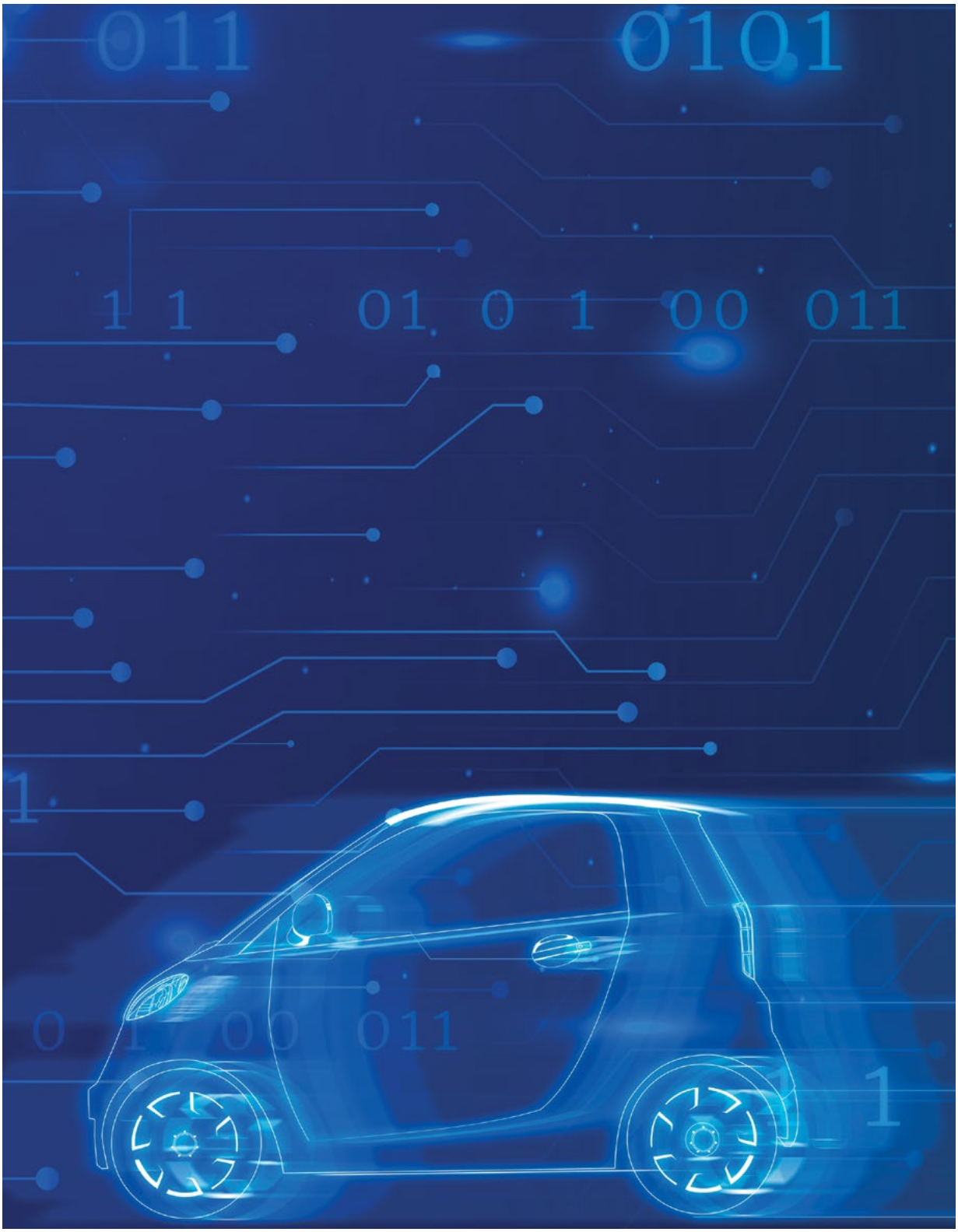
This technology uses a rotational energy storage system using inertia, known as flywheels, which make it possible to use the energy of the network at low consumption times, such as at night, and store it as kinetic energy until it is used for the rapid recharging of electric vehicles. These mechanisms have an intelligent system that allows the optimized use of energy and can be used in microgrid systems that use clean energy, which would further reduce the impact on the national electrical grid (Gabbar and Othman, 2017).

RECOMMENDATION 23

Develop a national strategy to identify electrical grid priority areas, considering the currently installed capacity and future energy demand, with inputs from industry, academia and government. Also, implement technology that accelerates the transition of the automotive sector in the short term and using the current electricity network.

RELEVANT ACTORS

The Ministry of Foreign Affairs; the Federal Electricity Commission; the Ministry of Infrastructure, Communications and Transport: the Ministry of Energy; the automotive industry; the academic sector.


011
0101
1 1
01 0 1 00 011
1
0 1 00 011
1

Gover-nance

Introduction

For the purposes of this chapter, governance is defined as all government processes, institutions, standards, technical regulations, procedures and practices that decide and regulate matters affecting the electromobility sector. This chapter explains the main topics identified in this area by project actors and in subsequent research, so it is not meant to be exhaustive or to cover everything.

As we have seen throughout this paper, the electrification of transport proposes a transition to a new industrial paradigm with new applications and technologies, which will represent a radical transformation in the underlying infrastructure. All this implies fundamental changes in governance and cooperation for all stakeholders. In particular, industrial policy will require a transformation in business models, supply chains, legal framework, consumption patterns, among other factors, which have combined to consolidate the Mexican automotive sector as one of the leaders at the global level.

A large number of countries have undertaken important public policies around the world. In the United States, for example, strategies have been implemented that promote electric vehicle innovation and research. However, most U.S. policies are not federal, but are conducted at the local and state levels (Shields, 2022). Over the past few decades, states like California have led the way with pioneering policies on environmental matters, energy transition, industry-specific and infrastructure programs focused on electromobility.

Part of California's success lies in triple helix collaborations, which enable the development, through intersectoral collaboration, of comprehensive and innovative public policies to increase the demand for electric vehicles in the state. One example was the creation of a 2013 roadmap aimed at having 1.5 million zero-emission vehicles in California by 2025 (California Government, 2013). According to the California Energy Commission, these partnerships caused sales of new ZEVs in 2022 to exceed one million, or 16.32% of all new vehicles sold that year (California Government, 2022).

On the other hand, the collaboration between industry and government led to the development and implementation of the so-called EV corridors which have been strategic, since they allowed the deployment of infrastructure throughout the state and the installation of charging centers to expand electric vehicle connectivity and transport Van der Steen, 2012). This public policy reflects that infrastructure planning involves the cooperation of different stakeholders and working together to advance electromobility at different levels of government (IEA, 2022a).

In the case of Mexico, recharging infrastructure has progressed relatively slowly in recent years. In 2017 there were 1,528 publicly accessible charging centres, including 42 fast-charging ones. According to the directory of electrical stations of the Federal Electricity Commission in 2022 there are 2,100 electric vehicle charging centers in the country (Morales, 2022). Although it is a significant advance compared to 2017, there is still a gap, as well as potential for the development and implementation of charging infrastructure in Mexico, in which public-private initiatives are the best cooperation schemes (Edwards, 2018).

Today, although some Federal Government offices are designing new industrial policies that contemplate the automotive sector, in the country there is still no comprehensive reform project or strategy that focuses on the transition to the manufacture of electric cars. However, Mexico has different mechanisms, under an extensive network of international treaties, that can be used to strengthen this new industry. A report by the Office of the U.S. Trade Representative estimates that - two years after the entry into force of the Mexico-Canada-US trade agreement (USMCA)— the auto and auto parts industry has increased investments to comply with the treaty's

rules of origin. Compliance with these rules involves duty-free warranty, thereby avoiding tariffs of 2 to 5% on light vehicles, and 3 to 4% for lithium-ion batteries, among others (Office of the U.S. Trade Representative, 2022).

In this regard, participants pointed out the need to develop strategies to comply with the treaties Mexico has signed, and thus to take advantage of the opportunities that this new sector offers. For example, as mentioned throughout the document, policies will have to be designed on the subject of batteries, a super component of electric cars that the USMCA prescribes must have a minimum regional content of 3.4% and whose production is today centered in Asia (three out of four lithium-ion batteries in the world are produced in China). In addition, rules of origin require that at least 70% of a vehicle manufacturer's steel and aluminum purchases come from North America. The production of electric vehicles uses more aluminum and plastic, but less steel, so the automotive transition could displace companies that supply this metal in Mexico (Montoya, 2022).

That said, there is a need to accelerate progress in the electrification of transport from a strategic perspective for Mexico, with a view to modernize its automotive industry and guarantee its competitiveness worldwide. Mexico's geographical position and the availability of specialized labor offer international companies a strong incentive to collaborate in the most important transformation of the industry in recent decades. Therefore, it is essential to have mechanisms for governance that allow the sector to accommodate all the interests and leverage the opportunities offered by electromobility, in order to move towards sustainable industrial development.

The following pages explain the governance challenges for this new sector in Mexico. The information was taken from the opinions expressed by automotive experts, government and academia during the first meeting of this thematic axis held on June 22, 2022. In addition, extensive research was carried out with secondary sources to outline the present obstacles.

DIAGNOSIS

1. Regulations, incentives and international outlook

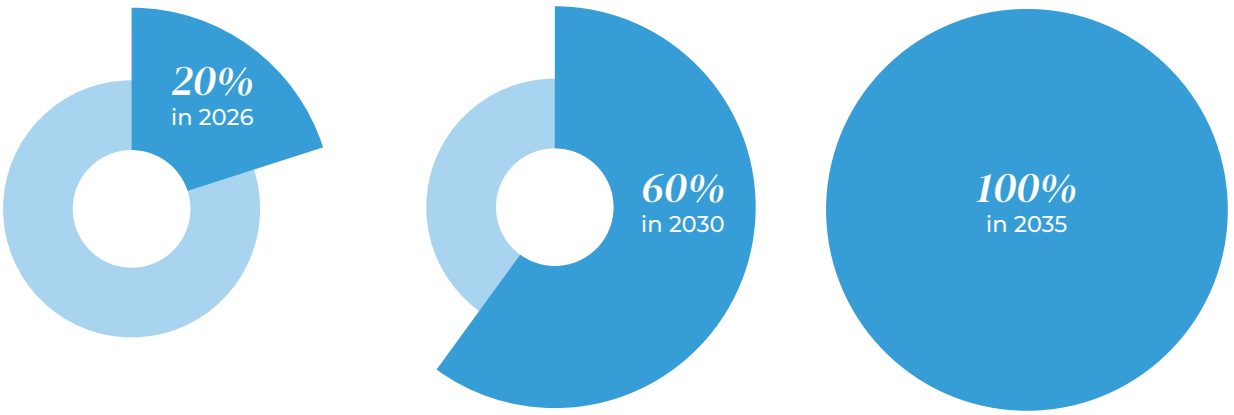
A recurring obstacle experts agreed on was the absence of regulations to facilitate the transition to electric car manufacturing in Mexico. In this regard, they recommended strengthening the legal framework through regulatory changes (laws, regulations, NOM, decrees and agreements), generating fiscal and non-financial incentives, as well as taking advantage of the international treaties to enhance this industry in the country.

In this regard and in the international context, several countries have proposed legislative changes that establish sales targets for electric vehicles in a certain year, or strategies to increase their demand. A clear example is the binding goal to achieve net zero emissions by 2050, set out in the European Climate Law and Canada's Emissions Reduction Plan (ERP), which proposes measures to make a minimum of 20% of new light vehicle sales be zero-emissions vehicles by 2026, 60% by 2030 and 100% by 2035 (Environment and Climate Change Canada, 2022; IEA, 2022a).

In turn, the most advanced nations in this field have implemented tax incentives to increase the demand for electric cars. For example, at the time of writing this report, a draft law was passed in the U.S. Senate to award $7,500 in tax credits on the purchase of new "clean vehicles." The incentive has certain restrictions: auto parts will have to be built with minerals mined in a country with which the United States has a free trade agreement, and the battery has to include a percentage of components manufactured or assembled in North America (Laing and Natter, 2022).

South Korean President Moon Jae-In aims to make his country the number one manufacturer of electric vehicle batteries by 2030. To achieve this ambition, investments in this sector need to total 40 trillion won (USD $34.92 billion) by the end of the decade. To attract the necessary investment, the government will designate batteries, semiconductors and vaccines as national strategic technologies, and it will reinforce tax incentives that allow deductions of up to 50% for research and development in these industries (Greenhalgh, 2021).

However, tax incentives are not the only decisive factor affecting electric vehicle adoption or purchases. Other countries have implemented strategies that are not tax-related at the local and federal levels. For example, Chile's municipal ordinance no. 79 on the loading and unloading of goods in the metropolitan area of Santiago establishes differentiated schedules that favor electric vehicles with a longer product distribution time (Government of Chile, 2022). Likewise, the approval of Law 9518 in Costa Rica in 2017 promoted incentives to increase the demand for electric cars through the elimination of license plate restrictions for this type of transport (United States Department of Commerce, 2021).



Percentage of sales

of new light vehicle sales be zero-emissions vehicles

Environment and Climate Change Canada, 2022; IEA, 2022a

On the other hand, project participants showed concern about the approval of commercial treaties that could negatively impact sectors such as the automotive industry. In particular, they stressed that the absence of a comprehensive evaluation and the involvement of private companies in consultations prior to the negotiations of agreements and treaties could generate important challenges for the new industry. Concrete examples in this regard include the risks perceived by the industry in the approval of a free trade agreement between Mexico and South Korea and the negative impacts on the Mexican automotive industry that this could bring, as well as the benefit it would have for the production of other goods, such as meat for export. In addition, participants emphasized the concern to lift tariffs on goods from countries that carry out anti-competitive practices such as dumping.

In this sense, at the international level, there are cases of countries that are taking advantage of the transition and reconfiguration of global value chains to modernize trade agreements or create new economic strategies that strengthen their automotive industry. In 2021, India signed a memorandum of understanding with Argentina with the aim of strengthening cooperation in lithium exploration and extraction (TPCI, 2021).

Similarly, the Democratic Republic of the Congo and Zambia have signed a cooperation agreement to facilitate the development of the electric battery value chain. The Congo is the largest producer of cobalt in the world, while Zambia is known as a copper producer seeking to enter copper wire production. In short, both African countries are taking advantage of the sector because they have 80% of the minerals needed (cobalt, copper and nickel) for the production of electric car batteries (United Nations, 2022). In this sense, during the intermediate interviews of the project, experts mentioned the need to strengthen regional mechanisms in Latin America to promote cooperation on essential natural resources in this industry.

2. Industrial policy

The need to articulate a comprehensive industrial policy that responds to the challenges of the electrification of transport in Mexico was emphasized during the diagnostic session. Experts said that a policy with clear objectives and goals must be designed in order to consolidate the transformation of the automotive sector. They in turn highlighted that it is strongly related to inter-institutional coordination with the different authorities at all government levels responsible for implementing this type of initiatives. In this sense, more and more national and local governments are demonstrating their intention to completely eliminate combustion engine vehicles. In response, the automotive industry is adapting its business models and moving away from combustion engines to embrace electric power. This comes at a time when combustion vehicles still dominate new car sales in Mexico.

In this context, according to data from INEGI, only 47,121 of the 1,014,735 vehicles sold in 2021 in the country had any electric technology: 1,140 were electric vehicles, 3,495 plug-in hybrids and 42,486 were hybrids (INEGI, 2022a). This represents 4.6% of total light vehicle sales in Mexico. Although it may seem a low figure, it is the highest in the entire Latin American region. Similarly, production of electric vehicles in the North American region is expected to increase by 243% from 2022 to 2023, which will present a turning point for the transition to electromobility (Gonzalez, 2022).

Various governments around the world have joined forces, in collaboration with the automotive industry, to implement industrial phase-out policies in the production and use of internal combustion vehicles to fully transition to the use of zero-carbon vehicles. Currently, seventeen countries have announced specific automotive decarbonization targets for 2050; in 2019, France was the first country to translate this intention into a law, with a 2040 deadline (IEA, 2022). According to the diagnosis of industry experts, the industrial policies applied with regard to electric vehicles depend on the state

of the market or the technology being used. That is, the phase-out both in Mexico and the Latin American region will largely be driven and guided by the dynamics of demand of the largest and most innovative markets in the electrification of transportation: The US, the European Union and China.

Within the framework of a medium and long-term national industrial strategy and policy towards decarbonization, President Andres Manuel Lopez Obrador announced at the Major Economies Forum on Energy and Climate, held on June 17, 2022, that he would join the collective international effort to reach the goal of producing 50% of zero-emission vehicles by 2030 (Government of Mexico, 2022a). This announcement represents a huge step in the transition towards the electrification of transport in the country, as it officially declares Mexico's commitment to be part of this industrial transformation. However, it should be mentioned that this commitment is not binding nor is it in the process of being incorporated into Mexican laws.

During the session the experts mentioned that the current lack of coordination between industry, government and academia, as well as between different levels of government, is one of the main obstacles to the implementation of an industrial policy that responds to the current challenges of the automotive sector. In this sense, based on the experiences of emerging economies such as Mexico, the evidence indicates there is a need to implement both vertical and horizontal industrial development policies[13] that can encompass government actions and market interventions (Stein, 2014), that is, public goods that the government provides to improve the competitiveness of the private sector and stimulate the development of new activities.

In this context, the transition towards the electrification of transport and the evolution of industry represent an enormous opportunity for this type of intervention to be expanded and consolidated in the country, in particular in the automotive clusters and in the industrial corridors. Therefore, having inter-institutional coordination and communication with all levels of government, as well as with the private sector, will be a factor that will largely determine the success of this national effort.

The importance of establishing and defining production and sales targets for electric vehicles that gradually allow a greater penetration of electric vehicles in the national and international market was mentioned during the session of this thematic axis. This means that multinational companies not only should produce in the country, but also seek to encourage demand with affordable electric vehicles. In this regard, they reiterated the need to establish a joint agenda between government and industry in order to consolidate a comprehensive industrial policy that facilitates the transition

[13] Horizontal policies are formulated in collaboration with different actors and decision-making is carried out at the same level. On the contrary, in the formulation of vertical policies, policies are dictated from top (Federal Government) to bottom (state, local governments, etc.).

without leaving anyone behind. This is aimed at promoting mechanisms to encourage domestic demand for this type of vehicle, as well as promoting opportunities for local suppliers.

Finally, one issue that remained unfinished during the diagnostic phase of the project was to define the specific actions to implement phase-out objectives beyond the measures indicated in the official documents or in studies carried out by international organizations. Although some national governments claim that their phase-out targets are an important signal that forces automakers to adopt cleaner vehicles, few have implemented accountability mechanisms to give a binding nature to these targets.

RECOMMENDATIONS

The following section presents a series of general and specific recommendations based on the information provided during the second session of this thematic axis of the project, held on September 9, 2022, with all project participants. This analysis was corroborated with evidence, best practices and subsequent interviews.

I. REGULATIONS

Recommendation 24: Carry out a mapping of existing automotive regulations, as well as expediting the issuance of permits for the deployment and promotion of the sector

As mentioned above in the obstacles section, one of the main challenges identified by project participants in terms of regulations and incentives was the absence of regulations and mechanisms that promote and facilitate the transition towards the manufacture of electric cars in Mexico. In this regard, it was recommended as a first step to carry out a full mapping of federal and state regulations that impact the automotive sector, because they pointed out that in many states current transport regulations prevent the adoption and transition to electromobility.

They also suggested that, once the identification of these standards was completed, a review should be carried out through a participatory process that listens to all voices (academia, industry, government and civil society), in order to propose reforms to laws or other standards that complement the current ones and that respond to the new needs of the sector. In addition, they mentioned that this evaluation will align the standards with

the fulfillment of the Sustainable Development Goals and promote circular economy strategies.

In this regard, it was specifically mentioned that this process can revise standards such as NOM-163-SEMARNAT-ENER-SCFI-2013 relating to carbon dioxide (CO_2) emissions from car exhausts and their equivalence in terms of fuel efficiency (SEMARNAT, 2013), as well as NOM-042-SEMARNAT-2003, which establishes the maximum permissible limits of hydrocarbon emissions (SEMARNAT, 2005).

On the other hand, it was recommended that the regulations cover the legal field, but also the technical regulations associated with disruptive and technological changes in the industry. In this sense, they pointed out that electric cars represent a greater danger to pedestrians and road safety due to their silent engines, so Mexico would have to create rules that regulate those aspects. This coincides with several studies that reveal that pedestrians feel at greater risk of being run over by a hybrid or electric car (Pardo-Ferreira et al., 2020).

In response, several governments have reformed their rules, such as the European Parliament, which in April 2014 published a law on the sound level of vehicles and muffler parts, which requires all new electric cars to emit a sound when driving at less than 20 km/h (European Union, 2014). Similarly, the National Highway Traffic Safety Administration (NHTSA) issued a resolution in 2018 that requires electric cars to emit warning sounds when traveling at speeds below 30 km/h (Shepardson, 2018). However, the literature on this matter also suggests that complementary standards should be adopted and that future studies focus on recommendations that help drivers, pedestrians, cyclists and other public road users to interact with this new type of vehicles (Pardo-Ferreira et al., 2020).

In this regard, they recommended taking advantage of the working groups promoted by the Mexican Council for Standardization and Conformity Assessment (COMENOR), which bring together the country's main quality infrastructure standardizers. In turn, they noted the importance of discussing and drafting this type of standards in the Mexican Electrotechnical Committee of the International Organization for Standardization (ISO). This committee is led by the General Office for Standards of the Ministry of Economy (Government of Mexico, 2015).

Last, they mentioned that there are currently no clear guidelines for the installation and operation of power stations, so they recommended modifying the General Administrative Provisions (DACG) used by the Energy Regulatory Commission to expedite the issuance of permits for new stations.

RECOMMENDATION 24

Carry out a mapping and identification of federal and state standards that apply to the electric automotive industry. Subsequently, organize a forum with the participation of different stakeholders (government, industry, civil society, academia) with the aim of evaluating which standards need to be reformed or, where appropriate, created. to meet the needs of the new sector. In addition, to improve the efficiency of administrative procedures to expedite the issuance of permits and the installation of charging stations.

RELEVANT ACTORS

The Ministry of Foreign Affairs, the Ministry of Economy (General Office for Standards), the Ministry of Energy (Energy Regulatory Commission), industry, academia, civil society.

II. INCENTIVES

Recommendation 25: Reform and extend the decree on tax exemptions for electric cars, and create programs that encourage the supply and demand for this type of vehicles

To begin this section, project actors recommended revising the 2023 budget to align the incentives to the country's budgetary reality. In this context, it is important to note that, at the time of writing this document, the Ministry of Finance and Public Credit announced that it is in the process of designing tax incentives that focus on increasing the profitability of investments under the new industrial policy promoted by the Ministry of Economy, which identifies electromobility as a strategic sector (Saldivar, 2022).

Specifically, they suggested reforming the incentives for the importation of electric vehicles in two areas. The first is to extend the duration of the decree that provides temporary exemptions (effective September 30, 2024) on the tariff on the import of new electric vehicles. This decree specifies that all new electric vehicles, including trucks intended for the transport of cargo, are exempt from taxes, as stipulated in the tariff sections of the tariff General Law on Import and Export Taxes in effect since 2007 (Government of Mexico, 2007). However, this provision does not incorporate tax exemptions on electric vehicle parts, so participants suggested that they should also be considered.

In turn, project participants suggested that incentives be divided or categorized to meet both supply and demand needs. On the production side, they pointed out the importance of encouraging that the electricity supplied to plants in this new sector comes from clean and renewable energies. In addition, they recommended promoting programs and incentives to develop electric components and vehicles in Mexico, as well as supporting companies in the conversion of their production lines (see also the Suppli-

$4 MILLION EUROS

to encourage demand for electric vehicles, under order 2535/2021 in 2021 by the Environment Fund of the Portuguese government

ers chapter). Participants also suggested promoting the import of tariff-free raw materials to strengthen the production processes of the electric automotive industry.

In this regard, some countries have taken various measures to encourage the production and adoption of electric vehicles. For example, the State Council of the Chinese government grants a subsidy of $3,500 per vehicle to companies that manufacture clean cars in the country (S.J. Grand, n.d.). Similarly, in 2021, under order 2535/2021 the Environment Fund of the Portuguese government allocated 4 million euros to encourage demand for electric vehicles. Under this strategy, the government grants tax exemptions to companies that convert their fleets to electric vehicles (EuroFound, 2021).

As mentioned in the obstacles section of this thematic axis, from the perspective of demand in the country, there are user incentives that are not tax related, but they are not well known, so they recommended carrying out communication campaigns to inform users of these benefits. An example of these incentives is the ECOTAG in Mexico City, a prepaid card that grants a 20% discount to electric vehicles transiting in certain urban areas (PASS, 2022). However, project experts noted that these efforts need to be replicated at the federal and state levels, because current policies have not been sufficient.

Last, it was emphasized that a particular strategy to incentivize the consumption of electric cars (while making progress in achieving emission reduction targets) would be discouraging the demand and production of internal combustion cars. By 2026, 35 percent of all new cars sold in the state of California will mandatorily be electric, hybrid or hydrogen vehicles. That proportion will increase to 68% by 2030, before reaching 100% by 2035. Automakers that fail to meet the required percentages by 2035 risk being penalized by the state with a $20,000 fine for each vehicle that does not meet the annual target (De Leon, 2022).

RECOMMENDATION 25

Extend the duration of the decree exempting the import tariff for new electric vehicles and include auto parts in it. Create programs that offer incentives for the production of electric vehicles and their components, for the conversion of production lines, and for the import of raw materials. Last, incentivize users by offering dynamic nightly recharging rates and inform consumers of the existing incentives (such as toll discounts).

RELEVANT ACTORS

The Ministry of Finance and Public Credit, the Ministry of Foreign Affairs, the Ministry of Economy (General Office for Standards), the Ministry of Energy (Energy Regulatory Commission), Litio de Mexico (LitioMx), industry, academia.

III. MULTILATERAL POLICY

Recommendation 26: Coordinate a regional alliance, initiative or multilateral effort in Latin America to regulate and manage the supply and demand of strategic minerals, in particular lithium value chains

As mentioned above in the obstacles section, international commitments and the diversification of foreign relations have been some of the key elements for the success of the first stage of the electrification of transport. In this sense, the transition from internal combustion vehicles to electric vehicles presents important challenges, particularly for strategic mineral extraction and transformation industries, such as lithium. The rapid expansion of the electric vehicle industry will result in increased demand for raw materials used in their production and the manufacture of a primary component: batteries.

Electric vehicles can use different types of batteries, however, the vast majority are lithium-ion (Li-ion) batteries. The strategic minerals needed for their production are lithium, cobalt, nickel, graphite and manganese. The gradual adoption of this type of cars will greatly increase the demand for these minerals. Electric vehicles contain six times more of these minerals compared to conventional internal combustion vehicles (IEA, 2022d). In this sense, the challenge for the strategic minerals industry is to be able to progressively meet demand and balance their prices so that electric vehicles can be reasonably affordable.

As noted in this report, batteries are currently the most expensive component of electric cars, representing on average 30% of the total cost. In turn, the lithium contained in the battery represents approximately 30% of its value (Wentker, 2019). Therefore, lithium demand is expected to increase from 100,000 tons in 2021 to 904,000 tons in 2040 (Van Halm, 2022). That is the reason that it will be essential to guarantee the reduction of its price

and to ensure the sustainability of the chains of this material, so that the industry can move towards electromobility in keeping with the established objectives and goals.

Current strategic mineral supply and processing efforts for component generation fall far short of the demand required for the start of the large-scale automotive electrical industry. The vast majority of these minerals come from a small number of regions. For example, almost all lithium mining - with 98% of joint production in 2020 - is currently carried out in Australia, Latin America and China (Azevedo, 2022). This geographical density has generated enormous global concern regarding the acquisition of these minerals for the transition to electromobility.

Taking into account the comparative advantage of Latin America, project participants recommended the creation of some type of alliance, initiative or regional effort between lithium and other strategic mineral producing countries as a first step that allows diversifying supply chains. At the same time, they recommended that this initiative serve as a platform to attract investments in value chains, to promote technology exchange and innovation, and to create a multilateral cooperation framework for the use of these minerals.

They also emphasized the great benefits of the implementation of a multilateral cooperation mechanism around strategic minerals. On the one hand, they indicated that this will generate an environment of certainty in the regional and national market, since the demand for raw materials for the production of basic components will be guaranteed. This in turn will drive domestic companies to consolidate their position in value chains, which can help them become more competitive internationally. On the other hand, they stressed that the regional administration of these minerals will allow producers to establish reasonable trading prices, which will facilitate a balanced supply and demand that can encourage the automotive industrial development of each country.

In turn, the actors involved pointed out that capacity-building and knowledge transfer can be a particularly fruitful area of cooperation, as experience varies from country to country. Several countries work together at the government level through international organizations, such as the World Bank and the OECD, to strengthen supply chains and consolidate sustainable good practices in mining (Sustainable Global Supply Chains Research Network, 2022).

In addition, specific mineral extraction initiatives have been created , such as the Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development (IFG) and the Energy Resources Governance Initiative (ERGI), designed to promote a robust regulatory framework to strengthen the mining sector and critical mineral supply chains.

In particular, such high-level initiatives can help coordinate work among all authorities of strategic mineral-producing countries and thus ensure the positioning of this industry as part of national security strategies. To make the most of these multilateral initiatives, it is necessary to reinforce and implement synergies between them as soon as possible.

Last, participants mentioned the articulation of a Mexican foreign policy with a regional systemic approach among strategic mineral producing countries in Latin America as an instrument to guarantee the supply of the raw materials that support electromobility. In this regard, they recommended that the proposed multilateral governance mechanism provide the tools to address global challenges in value chains in an energy and industrial security framework that can facilitate the efficient, safe and sustainable transition to electromobility. This leads us to propose a comprehensive strategy that aligns and coordinates the interests of the Mexican government with those of industry, our main economic allies and our Latin American neighbors in order to redesign and restructure our supply chains in order to strengthen, integrate and make them more resilient for the benefit of industry and society.

RECOMMENDATION 26

Arrange an alliance, initiative or regional multilateral effort in Latin America to protect value chains and supply between countries that produce strategic minerals used in the production of electric vehicles. Last, promote a proactive foreign policy that can find synergies and common interests among allied countries in the region in order to develop a governance framework based on the exchange of knowledge, technology and good practices in the mining industry.

RELEVANT ACTORS

The Ministry of Finance and Public Credit, the Ministry of Foreign Affairs, the Ministry of Economy, the Ministry of Energy, the Ministry of the Environment, Litio de Mexico (LitioMx), industry, academia.

IV. INDUSTRIAL POLICY

Recommendation 27: Develop a sustainable industrial policy focused on national developers and electric vehicle manufacturing processes

Industrial policy in Mexico has played a key role in positioning the automotive industry. With the transition to electromobility, being able to introduce a sustainable industrial policy that puts the new needs and opportunities of the sector at the center will also be instrumental for its success.

Project participants pointed out the need to implement a sustainable industrial policy focused on local electric vehicle developers and producers to strengthen supply chains and increase national supply and demand. However, they mentioned that it is also essential to incorporate international companies in the design of national industrial policy because of their capacity for infrastructure, human capital and innovation. Simultaneously, it is important that this is carried out under a scheme of cooperation and exchange of knowledge and technology, particularly with the over thirty-three thousand automotive sector MSMEs in Mexico (Cruz et al., 2020) who will be impacted the most in this transition.[14]

They recommended identifying clear objectives to establish an adequate phase-out of internal combustion vehicles with electric vehicle production goals that promote the adoption of new technologies in the industry. Likewise, they recommended that industrial policy should be comprehensive, covering not only the automotive industry -which is a key sector for Mexico-, but also areas such as telecommunications for the deployment of the 5G network, mining and extraction, construction, among others. This will pave the way for the electrification of transport in the short, medium and long term.

In addition, they mentioned the need for this new industrial policy to take advantage of the opportunity to implement conventional vehicle decarbonization strategies. This way, the adoption of electric vehicles will respond not only to the transition of the industry and consumer demand, but also to the fulfillment of international commitments to reduce CO_2 emissions. In turn, they reiterated that having an industry that can provide substantial product, processes and waste management innovations in a resource-efficient manner will strengthen the development of new business models in Mexico.

[14] The impact on MSMEs is expected to be a major one, because the manufacture of an electric vehicle with approximately 20 moving parts is relatively simpler than the production of an internal combustion vehicle with around 2,000 moving parts. The ecosystem of conventional vehicle suppliers is shrinking as electric vehicles penetrate the market. As a result, it is critical that SMEs invest in building new capabilities, technology and in overhauling their infrastructure.

On the other hand, participants pointed out that industrial policy has to be led by the Federal Government with the help of private initiative and academia to promote the transition of the automotive industry and the development of new activities and technologies in Mexico. With this, they emphasized the priority of producing an official document that serves as a guide and lists in detail the objectives and actions that must be carried out in the field of industrial policy.

RECOMMENDATION 27

Design and implement a sustainable industrial policy led by the Federal Government that integrates the industry and all relevant stakeholders that promote the electrification of transport. Further, promote and facilitate the phase-out of the industry, and contribute to building the capacities of SMEs to strengthen their production and adopt new technologies for the development of electric vehicles in the country.

RELEVANT ACTORS

The Ministry of Economy; the Ministry of Foreign Affairs; the Ministry of Finance and Public Credit; the Ministry of Energy; the Ministry of Environment; the Ministry of Infrastructure, Communications and Transport; Litio de Mexico (LitioMx); the Federal Electricity Commission; local governments; industry; academia.

Recommendation 28: Establish a joint agenda between government, industry, academia and relevant actors for the inter-institutional coordination of actions around the electrification of transport

As electromobility advances in Mexico and around the world, various governments have created participatory mechanisms where relevant actors can communicate and coordinate to make decision-making more efficient. In this regard, they recommended creating a permanent platform that brings together the different levels of government (municipal, state and federal) and their different offices, as well as industry and the academic sector to discuss and update strategies that impact electromobility in the country.

In this sense, they mentioned that it would be of great help to have a guiding instrument to steer electromobility, because the particular needs of each actor can be systematized and identified to avoid confusion in decision-making. Likewise, they emphasized the need to continue consolidating cooperation with academia, particularly in the review and analysis of studies on the complex issues around electro-mobility. In addition, they stated the need for academia to be more involved in decision making with its knowledge and expertise in each interdisciplinary field, to support the industry and the government.

On the other hand, they highlighted the need to deepen the link with industrial clusters to enhance the strategy of electrification of transport. In

this regard, participants highlighted that the triple-helix collaboration present at the clusters has been key to the growth of the automotive industry and the economic development of Mexico. These industrial ecosystems are the spearhead for the production and deployment of electric vehicles in strategic areas. However, it was mentioned that there are still opportunities to modernize and further intensify this type of coordination in spaces where best practices are shared, to then replicate them in other regions of the country, particularly in the southeast.

Finally, it was pointed out that having a participation mechanism that is open to everyone will facilitate decision-making and the implementation of policies at all levels of government. The goal is to move forward in a coordinated, safe and sustainable way so that Mexico can continue to be a world leader in this and other industries.

RECOMMENDATION 28

Establish a joint participatory platform or mechanism for government, industry, academia and other relevant actors to maintain an ongoing dialogue about the different electromobility strategies in the country. It is also necessary to strengthen the different types of collaboration, at local and regional level, with industrial clusters and to promote cooperation with academia for an ongoing execution of interdisciplinary studies.

RELEVANT ACTORS

The Ministry of Economy; the Ministry of Foreign Affairs; the Ministry of Finance and Public Credit; the Ministry of Energy; the Ministry of Environment; Ministry of Infrastructure, Communications and Transport; Litio de Mexico (LitioMx); the Federal Electricity Commission; local governments; industry; academia.

As electromobility advances in Me
various governments have created
where relevant actors can commu
to make decision-making more effi

xico and around the world,
l participatory mechanisms
nicate and coordinate
icient.

Conclusions

The results of the analyses and diagnoses included in this document have verified several of the reasons why the Mexican automotive industry has the solid leadership position worldwide that has characterized it in recent decades. However, in the transition to electromobility, conditions are changing and this is precisely what this effort documents. But most importantly, this document goes beyond a descriptive or diagnostic approach to a proactive one by making numerous recommendations. The analyses and recommendations - sometimes of a general nature, in some cases specific - came from the academia, industry and government participants themselves and will serve as a guide for decision-makers and relevant actors as to the first steps that will model this transition.

Likewise, it is important to conclude this document by summarizing the most relevant findings and teachings in each of the thematic axes analyzed. In the innovation axis, this industry-specific exercise showed the importance of research and development (R&D) not only in this sector, but more generally at the country level. This way, the solutions it arrived to involve general recommendations to promote a broad dialogue at the national level - under parliamentary forums - where the appropriate mechanisms to promote innovation in Mexico can be discussed.

More specifically, it also proposes the development of sectoral technology centers that in turn can trigger the creation of industrial hubs, for which a variety of comparative experience models were identified. Having approached the process of transition to electromobility from an innovation perspective also made it possible to identify problems that must be anticipated and addressed creatively and in an innovative way. This is the case of the waste that will be generated by this industry, because the solution will come through regulatory innovation and the promotion of innovative business models based on circular economies. Last but not least, this document highlights the need to have well-developed STEMS capacities, the human resource that will be the engine of innovation in Mexico.

Regarding human capital, the opportunity was identified to strengthen the relationship between educational authorities in Mexico and companies in the automotive industry for the training and updating of staff skills. This way, educational and job training programs and initiatives can be replicated and adapted to the requirements in this transition to electromobility.

Likewise, it became evident how important it is to revalue working in this industry in this technological juncture, considering that people are the most valuable resource of companies and economies. Therefore, addressing the obstacles faced by the workers who bring the sector to life must be a priority in the agenda for government and industry, promoting increasingly competitive wages, greater inclusion and better working conditions.

On the other hand, during three decades Mexico consolidated supply chains that positioned it among the leading countries in car manufacturing and export. However, technology changes and the transition from internal combustion vehicles to electric vehicles also brings substantial changes in the type of components, parts and even raw materials used, not to mention that all this happens within a juncture of significant geopolitical tensions. This makes it necessary to rethink the current supply chains, and to encourage existing suppliers to reinvent themselves to remain relevant. Given this situation, a broad consensus was found among the project participants on the need and opportunities that bringing the supply side of this industry to Mexico involves. In this regard, a first step proposed was to carry out a collaborative mapping of existing suppliers and then, as a second step, to prepare a directory to overcome any information gaps. This in turn would help to identify conversion opportunities for existing suppliers as well as the supply gaps to propose mechanisms to attract targeted investment.

On the other hand, it was emphasized that digital supplies (hardware and software) are increasingly relevant for vehicles (and for most industries), which warrants the creation of a roadmap to guide and facilitate their development in Mexico. Finally, this section identified the need to align existing policies, as well as the different offices in charge, to reduce administrative and fiscal costs that hinder the development of industry in the country.

Another topic discussed in virtually all thematic areas - and mainly in terms of suppliers - was manufacturing batteries in Mexico in support of this new sector and to increase the country's value added, as well as to comply with the regional content rules established by the USMCA. This is why the diagnosis in this area proposed that the competent legal bodies in lithium matters organize round tables to listen to all the relevant actors in this industry and its derivatives, thereby ensuring that this resource generates the greatest benefits for Mexico.

In terms of infrastructure, both the working sessions and the complementary research revealed the complexity, implications, and the challenges that Mexico - and the rest of the world - will face in the transition to electromo-

bility. The importance of adapting the capacity of the electricity network and of accelerating the overhauling of recharging infrastructure in vertical housing to guarantee recharges in residential areas was noted.

The interaction there will be between the automotive sector and the telecommunications sector, as well as the role of the 5G network in optimizing factory processes and improving user experience became evident. For Mexico it is essential to increase the adoption of electric vehicles in the country, with actions such as the standardization of charger types and voltages, the location of charging stations and the ease of access to that infrastructure.

Finally, the governance thematic axis identified the enormous importance of the entire network of decision-making processes, as well as the shared responsibility between electromobility stakeholders. On the one hand, during the session and in the research carried out for this document, it was detected that government has a leading role in implementing incentives and actions to update the legal framework to lay the foundation for the gradual adoption of electric vehicles. Similarly, the implementation of an industrial policy oriented towards decarbonization proved to be a determining factor for vehicle production companies, where the need to have the right tools to move towards the electrification of transport was highlighted. In turn, this showed that a guiding agenda must be formulated to improve intersectoral coordination with the different levels of government, industry and academia.

The different work sessions and the support of project actors throughout the year gave us the rewarding opportunity to witness the will and capacity that exists in the sector to join forces to overcome the major challenges

imposed on us by the current context, an era defined by the urgency to implement transformations - in particular technology changes -, to achieve greater productivity and address the global climate change crisis.

Addressing these challenges is certainly not an easy task. However, we are firmly convinced that we will once again overcome them through our joint efforts. The first step to achieve this transition was to open the path to a plural and inclusive dialogue that broadened the scope of the diagnosis, achieving a more integral vision of the opportunities and challenges of the industry. In turn, listening to the recommendations and aligning interests to overcome these obstacles - from each front. with creativity and commitment - gave us evidence of the capacity that exists to reach agreements for the benefit of Mexico.

In a second stage of this initiative and as the next steps, we will publish the results of this work to explore the possibility of having the relevant decision-making bodies implement them. This will seek to promote the consideration of the findings identified as a step forward in the dialogue promoted by the Ministry on the transition of the automotive sector and its contribution to the development of the industry.

It is also expected that this initial collaboration between the stakeholders of the different working groups will act as a catalyst to continue the intersectoral work for the benefit of the automotive transition in Mexico and in the region. Finally, it is important to mention that this initiative seeks to continue promoting the welfare of the communities that host this industry, to revalue the work of people in the sector and that to make the opportunities offered by electromobility accessible for and beneficial to Mexican society as a whole.

Project creation and methodological process

The following pages explain the development of the creation process, the identification of project stakeholders and goals, as well as the design of the deliverable presented in this document.

On August 5, 2021, U.S. President Joseph Biden issued the executive order that establishes the guideline for the automotive industry that at least 50% of new cars sold in that country must be electric by 2030 (White House, 2021b). This decree, in view of the transition this industry is undergoing in other parts of the world, and of Mexico's leadership in this industry, prompted the idea to create the US-Mexico Task Force for the Electrification of Transport under a bi-national perspective, in collaboration with the Mexico Alliance of the University of California. The state of California is not only the fifth largest economy in the world but is also a leader in the electric automotive sector.

In order to materialize the objectives of the project, based on past industrial policies implemented in Mexico and consulting with the sector, it was decided that the task force be divided into five thematic axes, which are the basis for the structure of this document. However, the SRE is aware that there are other automotive industry and electromobility topics and areas that were not addressed in this document, and therefore it recommends that the different sectors involved in the project (industry, government and academia) complement this research in subsequent work.

After defining the thematic axes of the initiative and deciding that, given the complexity of the transition, this should be a triple helix alliance, the next step was to identify the actors of each sector. For this purpose, we enrolled the active participation of the University of California, who assisted in the identification of the most relevant actors of the government, industry and the academic sector of the United States.

Given that the project would be coordinated by Mexico, that the format would be hybrid with in-person meetings at the premises of the SRE, it was decided that most of the meetings would be conducted in Spanish.

It should be noted that this was not a restriction for the participation of US actors. It also was decided that the project would have two separate deliverables. The first is a roadmap written by University of California academics, which contains a global and regional analysis of the automotive sector and builds on the best practices outlined in the sessions of the task force. Advances in the progress of this roadmap were presented by the Deputy Ministry for Multilateral Affairs and Human Rights of the SRE in the 2022 edition of COP 27. The second deliverable is this document, which contains a diagnosis and recommendations for the automotive industry, the academic sector and the government in Mexico. The diagnosis and recommendations are based on the aforementioned sessions and on the research of the Ministry of Foreign Affairs through the General Office for Global Investment, an office that was created in collaboration with the United Nations Development Program (UNDP) and is responsible for the attraction of investment and the economic promotion of Mexico abroad.

With the project objectives approved, the launch ceremony of the US-Mexico Task Force for the Electrification of Transport was held on February 8, 2022. The event was attended by leaders from the three sectors involved in the project and was chaired by Chancellor Marcelo Ebrard.

METHODOLOGY

This section of the document explains the methodological process and the stages of development of this report, which was initially supported by primary or empirical sources. Over 160 experts, leaders and decision-makers from industry, academia and government participated in the project, which allowed the task force to incorporate different perspectives, opinions and expertise to generate a document that takes into account the actors that currently play fundamental roles in the transition towards the electrification of transport in Mexico.

The participation of this wide-ranging group provided a solid information base through more than fifty hours of meetings that productively enriched the debate around the electrification of the automotive sector in Mexico, and the processes that have to be carried out in this industrial transition using a holistic and comprehensive approach. The research was carried out in two stages; first a diagnosis stage, and then a recommendations stage. All the primary information collected during the sessions was later supported and supplemented with secondary research.

The primary or empirical sources consisted of discussion forums held between February and November 2022 and focused on the five predefined thematic axes (or focus groups) in hybrid format (online and in person) with participants from industry, government and academia.

The five thematic axes around which the project was structured were:

1. **Innovation:** Adaptation and application of new technologies, processes and practices to meet the needs of the transition towards the electrification of transport.
2. **Human capital:** Development of new skills and abilities of the automotive industry workforce.
3. **Suppliers:** Diversification and strengthening of electric vehicle supply chains.
4. **Infrastructure:** Infrastructure development to carry out the transition of the automotive industry in a sustainable and safe way.
5. **Governance:** Regulation and steering of the regulations required for the electrification of transport, and for stakeholder coordination and communication.

The objective of creating focus groups in the first stage of the project was to identify specific challenges in the transition to electromobility, but also to understand the participants' position, ideas and expertise. This technique was particularly useful to explore the knowledge and experiences of the actors in a context of interaction that made it possible analyze the root causes of their opinions and positions.

Subsequently, a set of "intermediate interviews" was carried out between July and August 2022 with the information collected in these groups. Through structured or semi-structured interviews, this process sought to outline the obstacles identified and the statements made by participants in the diagnostic focus groups.

Questionnaires with a minimum of five questions were designed for the intermediate interviews, seeking to detect the opportunities and challenges related to the status of the electrification of the industry under each thematic axis. During this period, key actors of the task force sessions were selected to participated in the interviews, based on their participation and contributions to the general discussion.

The duration of each of these meetings was approximately one hour, depending on the depth of the responses. Once the interviews were concluded, a space was made to submit additional notes and comments for the consideration of the participants, to be included in future sessions. It should be noted that, in the process of identifying the most relevant obstacles, an investigation was carried out to contrast the information obtained by project experts with evidence.

Based on the obstacles or challenges identified in the first part of the project, a similar process was used in the second phase, in the sense of listening to the participants in a focus group, with the difference that the structure of the sessions was focused on the identification of solutions. In addition, intermediate follow-up interviews were conducted with key actors during the second phase, in order to gain a detailed understanding of the proposals and/or to obtain more information about them.

All empirical research was contrasted and supplemented with secondary sources, such as public policy reports, industry publications, academic articles, specialized books, legal sources, as well as other documentary and hemerographic sources. Regarding the bibliography used, it should be noted that this report is not exhaustive, since it does not intend to carry out a literary review, but rather to find examples and support the information provided by the participants and mainly support and outline the recommendations.

Last, it should be noted that this work was in itself a novel exercise for this office, which made it possible to explore and test different work and research methodologies -for example, different interview formats-, to develop and strengthen internal and research capacities for future research projects that the Ministry of Foreign Affairs may carry out.


50
DC
3

Areas of Opportunity

Any research, diagnosis and recommendations have limitations of their own, and so the objective of this section is to present them in a transparent way, so that future projects can complement or update the information provided.

The first limitation of the project was its scope, since five thematic axes are not sufficient to expose the needs and complexity of the automotive sector. As mentioned above, the decided was made to structure the sessions that way because of Mexico's industrial policies and the degree of interconnectivity between these five areas. However, there are other areas that would be worth analyzing in more detail, such as the case of strategic natural resources (lithium, nickel, graphite, graphene, cobalt) and clustering (companies and local government organizations). The impact of these subareas is explained in the five thematic axes of the document; however, further studies are required on each area.

One of the successes of the project is the enormous response and interest it aroused: over 160 actors, 20 companies, officials from different government levels and the main universities in the country had an active participation in this project. However, the SRE is aware that it is necessary to engage a greater number of small and medium companies, as well as different government officials at the municipal level and secure a larger representation of civil society in this type of proposals. That is why there will be new stages of the project to hear the voices of local and national stakeholders and from other regions of the world.

One limitation was the time frame for the creation, execution and completion of the project. The pressing urgency of having a diagnosis detailing the obstacles, as well as the imminent need for a joint effort by different sectors to identify the first steps toward the electric transition, resulted in the initiative being carried out in just one year. That is why one of the clear objectives of this publication is to serve as a first step in the development of public policies; as an active, reviewable and editable document.

On the other hand, it should be clear that this document is not a roadmap with specific steps for the implementation of the recommendations, since the creation and implementation of such actions is not part of the respon-

sibilities of this office. This document seeks to serve as a tool and to demonstrate the concerns, interests and possible solutions of the industry and stakeholders to facilitate the development and implementation of an industrial policy by the different offices in charge.

It is important to note that the present research should be complemented with an in-depth theoretical framework, since this document is not a final report, and its bibliography does not constitute an exhaustive literature review. It is recommended that any subsequent work delves into the academic literature and available case studies.

This document adopted the term human capital in contrast to human resources as differentiated concepts. This is because the former is considered a factor of production given the industrial dimension of the analysis, as opposed to human resources, a concept that is more linked to staff management literature.

Regarding the increase in wages and benefits for people working in the automotive sector, it is important to note that several studies in recent years have commented on low labor wages, instability in recruitment modalities, along with the deterioration of union organization and the dependence of people in this industry on these sources of employment due to the lack of alternatives where they live. All this has been related to a deterioration in the quality of life of workers in recent decades, which is not only manifest in salary levels, but also in the absence of residential areas close to the workplace and the absence or insufficiency of services such as nurseries or transport (Garcia-Jimenez, 2021; Sancak, 2022).

Notwithstanding the above, the participants of the meetings on the human capital axis did not produce concrete recommendations to resolve these obstacles using strategies that contemplate decent and well-paid work, and that in turn comply with the Sustainable Development Goals and the 2030 Agenda. In addition, during these discussions, there were no proposals for Mexico to comply with the commitments established under the USMCA, which imposes a labor content value (LCV) of having at least 40% (initially 30% for light vehicles and a fixed 45% for heavy units) of the value of the car manufactured at plants where workers are paid at least $16 per hour.

Acknowledgments

Last, the SRE thanks the members of the industry, academia and civil society of Mexico and the United States, as well as the public officials of different government agencies of both countries for their active participation in this project. Thank you for demonstrating once again that triple helix alliances are possible and necessary to propose solutions to the most complex changes in our society.

The persons who participated in the launch, working sessions and interviews that supported the creation of this document are listed below:

Adrian Hernandez – Director of Promotion, Ministry of Economy and Innovation of Baja California

Adriana Santibañez – Government Affairs Analyst, Nissan Mexico

Agustin Filippo – Lead Economist, Inter-American Development Bank (IDB)

Agustin Llamas – Consultant, EV Ready

Alberto Bustamante Gonzalez – General Manager, National Auto Parts Industry

Alberto Delgado – Product Manager, Circutor

Alex Covarrubias – Researcher, Colegio de Sonora

Alexander Mirabal – Zacua

Alfredo Arzola Lopez – Director, Automotive Cluster of Guanajuato

Almudena Diaz Niebla – Software Industry Business Development Executive, SIEMENS

Ana Lilia Moreno – Regulatory and Competition Coordinator, Mexico Evalua

Andrea Burgos – Sales Director, Volvo

Andrea Colin Albarran – Director General of Business Development and Investment Attraction, Ministry of Economic Development of Jalisco

Andres Fernandez de Alba – Sales Director, EV Ready

Angel Ordoñana – Government Affairs Specialist, Ford Mexico

Angelo Vaghi Martinez – Director General of Industrial Development, Ministry of Economic Development of Aguascalientes

Araceli Vazquez – Associate Director of External Liaison, Alianza Mx

Arnulfo Arteaga – Researcher, Universidad Autonoma de Mexico (UAM)

Arturo Flores – Scholar, Universidad Anahuac, Mexico

Arturo Guerrero Gomez – Head of Department. Business Development, Ministry of Economy of Queretaro

Bruno Cattori – CEO, Stellantis Mexico

Carlos Guaipatin – Senior Science and Technology Specialist, Inter-American Development Bank (IDB)

Carlos Jimenez – Research Consultant, International Council on Clean Transportation (ICCT)

Carlos Lerma – Director General, Altan Redes

Carlos Meneses – Automotive Coordinator, United States -Mexico Foundation for Science (FUMEC)

Carlos Santillan – Commissioner, World Road Association (PIARC)

Carlos Vazquez Castañeda – Scholar, Universidad Anahuac Mexico

Carmen Hernandez – Director, Automotive Cluster of Jalisco

Carolina Coraza – Border Transport, Ministry of Infrastructure Communications and Transportation

Cecilia Romo Bernal – Director, Automotive Cluster of Aguascalientes

Cristina Fernandez-Baca – American Association for the Advancement of Science (AAAS) Science & Technology Policy Fellow of the United States Department of State

Daniel Hernandez Camacho – Director, Automotive Cluster of Queretaro

Daniel Rios – Vice President, AT&T

Daniel Rocha – Economic specialist focused on energy and climate change affairs, U.S. Embassy in Mexico

Daniela Flores – Institute of Mobility and Urban Territorial Development of Yucatan, Government of Yucatan

Daniela Rios – Economic and Legislative Studies Manager, AT&T

David M. Turk – Deputy Secretary, U.S. Department of Energy

Diego Ramirez Vincent – Director of Government Affairs, Nissan Mexico

Donaciano Dominguez – Deputy Director General, Ministry of Labour and Social Security

Edgar Bañuelos – Innovation and Institutional Relations Manager, National Chamber of Electrical Manufactures (CANAME)

Eduardo Alvarado – Director, Voltway

Eduardo Gajon Gomez – Director, Automotive Cluster of La Laguna

Eduardo Shelley - Automotive Development Manager, SIEMENS

Eleni Kounalakis – Lieutenant Governor of California

Elias Araujo Arcos – Secretary of Infrastructure Communications and Transport

Elisa Crespo Ferrer – Executive President, Automotive Cluster of the State of Mexico

Enrique Mitz Hernandez – Director of Investment Planning, and Promotion; State Energy Agency of the State of Puebla

Erik Gascon Muñiz – Jr. Manager Government Affairs, Nissan Mexico

Erika Ortiz Sanchez – Energy Program Manager, Climate Initiative of Mexico

Erika Ruiz Sotelo – Government Liaison Coordinator, Mexican Association of Automotive Distributors (AMDA)

Ermilo Barrera Novel – Director General, State Energy Agency of the State of Puebla

Eugenio Grandio – LATAM Policy and Business Development, Tesla

Eugenio Salinas – Chairman of the Committee on Foreign Trade and International Affairs, Confederation of Industrial Chambers of the United Mexican States (CONCAMIN)

Fabiola Aguilar Martinez – Director, Automotive Cluster of Coahuila

Fausto Cuevas – Director General, Mexican Association of the Automotive Industry

Felipe Gallego – Co-founder, Megaflux Electric Drivetrains

Fernando Yitzaek Pavon – Labor Market Specialist, Inter-American Development Bank

Francisco Cabeza – EV Lead, Element Corp

Francisco Cervantes – President, Business Coordinating Council

Francisco Fabian Montiel – Researcher, Instituto Politecnico Nacional

Francisco Gonzalez – President, National Auto Parts Industry (INA)

Francisco Manuel Aguilar Flores – Director of Investment Attraction, Ministry of Sustainable Economic Development of Guanajuato

German Carmona Paredes – Researcher, Universidad Nacional Autonoma de Mexico (UNAM)

Gonzalo Garcia – Research Consultant, International Council on Clean Transportation (ICCT)

Guadalupe Contreras – International Relations Specialist, Office of International Transportation and Trade, U.S. Department of State

Guillermo Solomon – Executive Director of Digital Transformation for Latam, Huawei Mexico

Gunther J. Barajas – Chief Commercial Officer, SIEMENS

Gustavo Crespi – Director of the Competitiveness, Technology and Innovation Division, IDB

Hector Rene Garcia Flores – Coordinator of Investment Attraction Projects, Ministry of Sustainable Economic Development of the State of Guanajuato

Ilse Avalos Vargas – Research Associate in the Energy Program, Climate Initiative of Mexico

Isabel Studer – Director, Alianza Mx

Isidoro Massri – Director General, JAC Mexico

Israel Hurtado – President, Mexican Hydrogen Association

Itzel Caballero – Political Strategy Group Associate, Mexican Association of Motorcycle Manufacturers and Importers (AMFIM)

Ivette Camacho – Chairman of the PR Committee, AMFIM

J. Mares – Director of Technical Services; Ministry for Infrastructure, Communications and Transport

Javier Garduño – Head of the Planning and Institutional Development Unit; Ministry of Agricultural, Territorial and Urban Development (SEDATU)

Joaquin Alava – Director of Government Affairs, Stellantis

Jorge Fernando Negrete – President, Digital Policy and Law Group

Jorge Luis Estrada – Director of Federal Motor Transport Verification and Sanctions; Ministry of Infrastructure, Communications and Transport

Jorge Martinez – Executive Chairman of Zacua

Jorge Pardi – Latam Controller, Aptiv

Jose Francisco Garza Rodriguez – President and CEO, General Motors Mexico

Jose Ignacio Huertas – Professor-researcher, Tecnologico de Monterrey

Jose San Vicente Saenz – CEO, Nomad Group

Jose Zozaya – President, Mexican Association of the Automotive Industry (AMIA)

Juan Diaz Mazadiego – Director General, Mexican Council for Standardization and Conformity Assessment

Juan Pablo Vega Ocegueda – Coordinator of Investment Projects, Ministry of Sustainable Economic Development of Guanajuato

Judith Trujillo – Deputy Director of the Transport Sector, Ministry of Environment and Natural Resources (SEMARNAT)

Julio Sanchez – Link EV, Citizen Resources

Karen Thomas Paz – Director, Automotive Cluster of Chihuahua

Kenya Botello Figueroa – Standardization Assistant, Suzuki Motor de Mexico

Laura Sima – Attache of the Department of Energy, U.S. Embassy in Mexico

Ledenika Mendez – Executive Director of Digital Inclusion; Ministry of Infrastructure, Communications and Transport (SICT)

Leonardo Alvarez Larrauri – Deputy Director of Network Companies, Federal Electricity Commission (CFE)

Leonardo Fernandez – Director of Future Supply, Schneider Electric

Leticia Elena Trujillo Mutio – Secretary of the Director, Instituto Politecnico Nacional

Leticia Pineda – Acting Director, Mexico and Researcher for the Latin American Region, International Council on Clean Transportation (ICCT)

Liane Randolph – Chair of the Air Resources Board, California Governor's Office

Liliana Aguilar Martinez – Redcam Coordinator, National Network of Clusters

Lorena Lopez – Director of Government Affairs Americas, Aptiv

Lorenzo Ortego – Director General, Voltway Mexico

Lori Michaelson – Energy and Environment Officer, Office of Mexican Affairs, U.S. Department of State

Luis Alberto Bautista Gutierrez – Mexico & Latam Commercial Segment Leader, Prolec G&E

Luis Alberto Gonzalez Olvera – Director, Automotive Cluster of San Luis Potosi

Luis Angel Paniagua Marquez – Technical Secretary, Ministry of Economic Development of Morelos

Luis Godoy – Director General of the Global Economic Intelligence Unit, Ministry of Economy

Luis Pineda – Advanced Manufacturing Coordinator, FUMEC

Luisa Sierra Brozon – Director of the Energy Program, Climate Initiative of Mexico

Luz Elena del Castillo – President and CEO, Ford Mexico

Manuel Montoya – General Manager, Automotive Cluster of Nuevo Leon

Maria Valencia – Advisor, Resuena Mexico

Mariana Alva Cal y Mayor – Institutional Relations Manager, Xignux

Mariana Hernandez Calderon – Legal Assistant, Federal Electricity Commission (CFE)

Martha de la Rosa – Ministry of Infrastructure, Communications and Transport

Mary Vargas – Trade and Investment Officer, U.S. Embassy in Mexico

Mauricio Alvarado – Scholar, Escuela Superior de Ingenieria Mecanica y Electrica, Zacatenco Unit

Mauricio Cardenas Palacios – Director of Business Development, Ministry of Economy of Queretaro

Mauricio Jaramillo Reyes – CRZA Abogados

Mauricio Kuri – Director of Government Affairs, Volkswagen Mexico

Melissa Escalante Gongora – Government Affairs Analyst, Nissan Mexico

Merlin Cochran – Director General, Mexican Association of Hydrocarbon Companies

Miguel Aguilar – Government Relations, Honda de Mexico

Miguel Bravo – Coordinator of Supplier Development and Foreign Trade, National Network of Clusters

Miguel Elizalde – President; National Association of Bus, Truck and Tractor Truck Producers (ANPACT)

Miguel Medina – Director of Government Affairs, BMW

Miguel Ogazon – Technical and Engineering Director, ANPACT

Monica Doger Ramirez – Director, Automotive Cluster of the Central Region

Monica Duhem – Head of the Economic and Global Intelligence Unit, Ministry of Energy

Nazareth Black – CEO, Zacua

Nicolas San Vicente Bortoni – Nomad Group

Olivia Salomon Vivaldo – Ministry of Economy of the State of Puebla

Omar Martinez Gonzalez – Original Equipment Manager, National Auto Parts Industry

Ordacir Barquera – Director of Strategy, Business Coordinating Council

Osvaldo Belmont – Mexican Association of the Automotive Industry

Pablo Gutierrez Sanchez – Government Relations and Compliance Manager, Suzuki Motor de Mexico

Paola Galvez Hernandez – Communication and Human Capital Manager, CANAME

Pato Bichara – CEO, Collective Academy

Patty Monahan – Commissioner on the California Energy Commission, California Energy Commission

Pedro Campos – Federal Electricity Commission (CFE)

Rafael Leyva – Researcher, Instituto Politecnico Nacional (IPN)

Rafael Selim Medina – Director of Promotion and Investment, Ministry of Economy of Coahuila

Raul del Campo – Director of Government Affairs, Ford Mexico

Ricardo Apaez – Director of Innovation, Automotive Cluster of Nuevo Leon

Ricardo del Rio – Executive Director, Altan Redes

Ricardo Uribe – Coordinator of Innovation and Industry 4.0, Automotive Industry Cluster of Coahuila

Roberto Bernal – Director General of Promotion and Strategic Projects, Ministry of Economic Development of Coahuila

Rodolfo Andrade – Ministry of Economy and Innovation of Baja California

Rodrigo Grimaldo – Energy Agency of the State of Puebla

Rodrigo Hurtado – Government Affairs, Honda de Mexico

Rogelio Arzate – Director of Government Relations and Institutional Affairs, GM de Mexico

Rolando Lopez Saldaña – Director General of Labor Training Centers, Ministry of Public Education

Sahie Gazal – Head of Government Affairs, Audi

Salvador Monroy – Director of International Motor Transport Services, SICT

Sharon Yepiz Aboytes – Ministry of Infrastructure, Communications and Transport

Sofia Lopez Casarrubias – Consultant, Climate Initiative of Mexico

Susana Galvan – Global Economic Intelligence Unit, Ministry of Economy

Sylvia B. Ortega Salazar – Advisor, Colegio Nacional de Educacion Profesional Tecnica (CONALEP)

Teresa Arenas – the Political Strategy Group Associate, AMFIM

Ulises Figueroa – Professor-researcher, ITESM

Victor Perez – Ford Mexico

Virginia Olalde – Director of Foreign Trade and Economic Studies, ANPACT

Viviana Patiño – Researcher of the Competition and Regulation Program, Mexico Evalua

William Ayala – Commercial Section, U.S. Embassy in Mexico

Xochitl Toledo – Ministry of Tourism and Economy, Baja California Sur

Yliana Silva – Government Affairs Manager, Toyota

Zyanya Castro Morales – Technical Coordination, General Office for Global Investment

Bibliography

ABI Research. (2022). *In 2030, Manufacturing and Industrial Facilities Will Have Over 49 Million 5G Connections, Generating US$2.4 Billion in Connections Revenue for Suppliers*. https://www.abiresearch.com/press/in-2030-manufacturing-and-industrial-facilities-will-have-over-49-million-5g-connections-generating-us24-billion-in-connections-revenue-for-suppliers/

Aboagye, A., Burkacky, O., Mahindroo, A. and Wiseman, B. (2022). *When the chips are down: How the semiconductor industry is dealing with a worldwide shortage*. World Economic Forum. https://www.weforum.org/agenda/2022/02/semiconductor-chip-shortage-supply-chain/

Advanced Propulsion Center UK (APCUK). (2019). *Automotive Batteries A £4.8bn a year supply chain opportunity by 2030 for UK chemical and material companies*. https://apcuk.co.uk/app/uploads/2021/09/Automotive-Batteries-Report-Summary-April-2019.pdf

Agencia Nacional de Investigacion y Desarrollo [Chile]. (n.d.). *Centros de Excelencia Internacional*. https://www.anid.cl/centros-e-investigacion-asociativa/centros-de-excelencia-internacional/

Aghion, P., Bergeaud, A., & Van Reenen, J. (2021). *The impact of regulation on innovation. Centre for Economic Performance, LSE*. https://cep.lse.ac.uk/pubs/download/dp1744.pdf

Alta Ley (2022). *Hoja de Ruta del Litio: El nuevo desafio que emprende Corporacion Alta Ley.* https://corporacionaltaley.cl/hoja-de-ruta-del-litio-el-nuevo-desafio-que-emprende-corporacion-alta-ley/

Azevedo, Marcelo, M. B. (2022). *Lithium mining: How new production technologies could fuel the global EV revolution.* McKinsey & Company. https://www.mckinsey.com/industries/metals-and-mining/our-insights/lithium-mining-how-new-production-technologies-could-fuel-the-global-ev-revolution

Bauer, G., Hsu. C, Nicholas, M. & Lutsey, N. (2021). *Charging Up America: Assessing the Growing Need for U.S. Charging Infrastructure through 2030. International Council on Clean Transportation, White Paper* 1- 45. https://theicct.org/wp-content/uploads/2021/12/charging-up-america-jul2021.pdf

Berkeley EECS. (2022). *Master of Engineering (M.Eng.)*. https://eecs.berkeley.edu/academics/graduate/industry-programs/meng

Bloom, N, Van Reenen, J., Williams, H. (2019). A Toolkit of Policies to Promote Innovation. *Journal of Economic Perspectives, Vol. 33 Issue 3 Pages 163-184. https://pubs.aeaweb.org/doi/pdfplus/10.1257/jep.33.3.163*

BMV. Mexican Stock Exchange (2021). *El financiamiento en las FIBRAS. https://blog.bmv.com.mx/2021/04/el-financiamiento-en-las-fibras/*

BNamericas. (2021). *Spotlight: Spectrum prices in Latin America.* https://www.bnamericas.com/en/features/spotlight-spectrum-prices-in-latin-america

Calderón-Villarreal, C., Ochoa-Adame, G. L. and Huescas-Reynoso, L. (2017). *Mercado Laboral y Cambio Tecnológico en el sector manufacturero de las regiones de México (2005-2014). Economía, Sociedad y Territorio, 17(54)*

Carrillo, J., De los Santos Gomez, J. S., & Briones, J. (2020). *Hacia una electromovilidad publica en Mexico.* https://repositorio.cepal.org/bitstream/handle/11362/46060/S2000368_es.pdf?sequence=1&isAllowed=y

CENACE. (2021). Programa de Ampliacion y Modernizacion de la Red Nacional de Transmision y Redes Generalesde Distribucion del Mercado Electrico Mayorista (PAMRNT). https://www.cenace.gob.mx/Docs/10_PLANEACION/ProgramasAyM/Programa%20de%20Ampliaci%C3%B3n%20y%20Modernizaci%C3%B3n%20de%20la%20RNT%20y%20RGD%202021%20-%202035.pdf

CEPAL. (2019). *ODS 7: Garantizar el acceso a una energia asequible, fiable, sostenible y moderna para todos en America Latina y el Caribe.* https://www.cepal.org/sites/default/files/static/files/ods7_c1900694_press_0.pdf

Chacon, D., Sierra, L., Blazquez, A., Correa, C., Rativa, D., Peñaloza, J.D., Cruz, R.R. (2021). Manual para la Planeacion de la Transicion Energetica a Nivel Subnacional. Climate Initiative of Mexico. https://www.iniciativaclimatica.org/wp-content/uploads/2022/04/ManualTrEM_digital-VF.pdf

Chavez C., Eduardo, Guerrero S.J., Carlos Alberto, Garcia J., Omar. (2020). *MSMEs in the automotive sector in Mexico, based on global value chains under the T-MEC. Revista Universitaria Digital de Ciencias Sociales, UNAM, Vol. 11, No. 21, p. 15.*

Industrial Cluster. (2022). *Coahuila: primer lugar nacional en inversion automotriz acumulada durante 2021.* https://www.clusterindustrial.com.mx/noticia/4472/coahuila-primer-lugar-nacional-en-inversion-automotriz-acumulada-durante-2021

Industrial Cluster. (2022). *Guanajuato ha producido el 21.63% de todos los autos hechos en Mexico durante el 2022.* https://www.clusterindustrial.com.mx/noticia/5096/guanajuato-ha-producido-el-21-63-de-todos-los-autos-hechos-en-mexico-durante-el-2022

European Commission. (2021). *European Green Deal: Commission proposes transformation of EU economy and society to meet climate ambitions.* https://ec.europa.eu/commission/presscorner/detail/cen/IP_21_3541

National Council for Standardization and Certification of Labour Skills. (2022). *Certifica Conocer a 2.9 millones de personas en competencias laborales en mas de dos decadas.* https://conocer.gob.mx/blog/certifica-conocer-a-2-9-millones-de-personas-en-competencias-laborales-en-mas-de-dos-decadas/

Crespi, G. (n.d.). *Sectoral Technology Centres: Evidencia de ALC*. Inter-American Development Bank [Powerpoint Presentation].

De Leon, A. (2022). *California's coming gas car ban: What it means. Los Angeles Times*. https://www.latimes.com/business/story/2022-08-25/californias-coming-gas-car-ban-what-it-means

Deloitte. (2022a). *Industria automotriz: ¿como 'acelerar' y superar los desafios de 2022?* https://www2.deloitte.com/mx/es/pages/dnoticias/articles/desafios-para-la-industria-automotriz-2022.html

Deloitte. (2022b). *Mujeres abriendo el camino en el sector automotriz*. https://www2.deloitte.com/mx/es/pages/dnoticias/articles/mujeres-abriendo-camino-en-el-sector-automotriz.html

Deloitte. (2022c). 2022 *Semiconductor Industry Outlook*. https://www2.deloitte.com/us/en/pages/technology-media-and-telecommunications/articles/semiconductor-industry-outlook.html

Department of Commerce (2021a, June 9). *Costa Rica Electric Vehicles*. International Trade Administration. https://www.trade.gov/market-intelligence/costa-rica-electric-vehicles

Department of Commerce (2021b, September 2). *Mexico - Country Commercial Guide, Automotive Industry*. International Trade Administration. https://www.trade.gov/country-commercial-guides/mexico-automotive-industry

Department of Energy. (2014). *The History of the Electric Car*. https://www.energy.gov/articles/history-electric-car

Diario Oficial de la Federacion (DOF). (2022, April 2). *Mining Law*. https://www.diputados.gob.mx/LeyesBiblio/pdf/LMin.pdf

Diario Oficial de la Federacion (DOF). (2022, August 23). *Decreto por el que se crea el organismo público descentralizado denominado Litio para México*. https://www.dof.gob.mx/nota_detalle.php?codigo=5662345&fecha=23/08/2022&print=true

Diario Oficial de la Federacion (DOF). (2009, November 30). *Decreto Para el Apoyo de la Competitividad de la industria automotriz terminal y el impulso al desarrollo del mercado interno de automoviles*. https://dof.gob.mx/nota_detalle.php?codigo=5121961&fecha=30/11/2009#gsc.tab=0

General Office for Labor Training Centers (2022). *Beneficios de los servicios y acuerdos con el sector empresarial*.

DSV. (n.d.). *Class 9A. Lithium Batteries. Dangerous Goods*. https://www.dsv.com/en-gb/support/faq/transporting-dangerous-goods/9-classes-of-dangerous-goods/class-9a-lithium-batteries)

EAFO. (2021). Pricing Of Electric Vehicle Recharging in Europe. European Alternative Fuels Observatory. https://www.avere.org/wp-content/uploads/2021/07/EAFO-Report-Pricing-of-Electric-Vehicle-Recharging-in-Europe.pdf

Edwards, L. V. (2018). *Charging Ahead: The Growth of Electric Car and Bus Markets in Latin American Cities*. Washington, D.C. The Dialogue: Leadership for the Americas.

Empresa Brasileira de Pesquisa e Inovação Industrial (EMBRAPII). (2020). *EMBRAPII Operations Manual*. https://embrapii.org.br/en/institutional/embrapii-operations-manual/

Environment and Climate Change Canada. (2022). *2030 Emissions Reduction PlanCanada's Next Steps for Clean Air and a Strong Economy. 1-271*. https://www.canada.ca/content/dam/eccc/documents/pdf/climate-change/erp/Canada-2030-Emissions-Reduction-Plan-eng.pdf

EuroFound. (2021). *Portugal: Company incentives to deploy electric vehicles*. https://www.eurofound.europa.eu/observatories/emcc/erm/legislation/portugal-company-incentives-to-deploy-electric-vehicles#:~:text=Companies%20that%20invest%20in%20green,reduced%20autonomous%20corporate%20income%-20tax.

European Environment Agency. (2021). *Electric vehicles and the energy sector - impacts on Europe's future emissions. Briefing*. https://www.eea.europa.eu/publications/electric-vehicles-and-the-energy

European Interactive Battery Community. http://www.e-magic.eu/

European Software Skills Alliance, (n.d). *About. ESSA supports the Software sector in meeting the skills needs of today and tomorrow*. https://www.softwareskills.eu/about/).

Fedepalma, (n.d.). *¿Que es el Fondo de Fomento Palmero?* https://web.fedepalma.org/que-es-el-fondo-de-fomento-palmero

Job Fairs. (n.d.). *¿Que son las ferias presenciales?* https://ferias.empleo.gob.mx/content/common/Ferias_Presenciales.jsf;jsessionid=RJXcjPFGf6B0kFFjLRtp8Wd98BzNL2pRpYLZqm7V47yWsg0slvhg!1541591795

Foran, C. and Berret T., (2022, July 29). *Senate passes bipartisan bill investing $52 billion in US semiconductor production.* CNN. https://edition.cnn.com/2022/07/27/politics/senate-vote-chips-bill-semiconductor-manufacturing/index.html

Freeman. C., (1992). *The economics of hope: essays on technical change, economic growth, and the environment*. Pinter Publishers.

Garcia-Jimenez, H., (2021). *Salarios en tiempos de libre comercio ¿Ofrece la industria automotriz salarios dignos en Mexico?* El Colegio de la Frontera Norte.

Gartner. (2019). *Gartner Predicts Outdoor Surveillance Cameras Will Be Largest Market for 5G Internet of Things Solutions Over Next Three Years. Press Releases.* https://www.gartner.com/en/newsroom/press-releases/2019-10-17-gartner-predicts-outdoor-surveillance-cameras-will-be

Gartner, J. (2021). *Demystifying Charging with Data Will Expand the EV Market. Center for Sustainable Energy.* https://energycenter.org/thought-leadership/blog/demystifying-charging-data-will-expand-ev-market

General Motors (n.d.). *Milford*. https://www.gm.com/company/facilities/milford-proving-ground

California Government. (2013). *Zero-Emission Vehicles in California: Community Readiness Guidebook*, 1-180. https://opr.ca.gov/docs/ZEV_Guidebook.pdf

California Government. (2022). *As Statewide ZEV Sales Exceed 16 Percent of All New Vehicles, California ZEV Program Surpasses 250,000 Point-of-Sale Incentives.* https://www.gov.ca.gov/2022/05/10/as-statewide-zev-sales-exceed-16-percent-of-all-new-vehicles-california-zev-program-surpasses-250000-point-of-sale-incentives/#:~:text=According%20to%20the%20California%20Energy,and%207.78%20percent%20in%202020.

Government of Chile (2021). *National Electromobility Strategy. Ministry of Energy*, 1-66. https://energia.gob.cl/sites/default/files/estrategia-nacional-electromovilidad_ministerio-de-energia.pdf

Government of Chile (2022). *Electromobility Platform*. https://energia.gob.cl/electromovilidad/reglamentacion/normativa-vehiculos-electricos

Government of Mexico (2007). *Decreto por el que se modifica la Tarifa de la Ley de los Impuestos Generales de Importacion y de Exportacion*. https://www.dof.gob.mx/nota_detalle.php?codigo=5599614&fecha=03/09/2020#gsc.tab=0

Government of Mexico (2022). *Speech by President Andres Manuel Lopez Obrador at the Forum of Major Economies on Energy and Climate Action*. https://www.gob.mx/sre/documentos/discurso-del-presidente-andres-manuel-lopez-obrador-en-el-foro-de-las-principales-economias-sobre-energia-y-accion-climatica?idiom=es

Gonzalez Diaz, Francisco N. (2022). *Presente y Futuro de la Industria Automotriz en Mexico* [Webinar]. Mexico Industry. https://mexicoindustry.com/webinars/presente-y-futuro-de-de-la-industria-automotriz-en-mexico/

Greenhalgh, K. (2021). *Moon eyes EV battery top spot, promises South Korean "ecosystem of solidarity". IHS Markit, S&P Global*. https://cleanenergynews.ihsmarkit.com/research-analysis/moon-eyes-ev-battery-top-spot-promises-south-korean-ecosystem-.html

Greenpeace (2019). *Crashing the Climate How care Industry is Driving the Climate Crisis. Greenpeace East Asia and Greenpeace Germany,* 1-44. https://www.greenpeace.de/publikationen/crashing-climate

GSMA Latin America. (2020). *Mexico: Los precios altos de espectro son un obstaculo para la inclusion digital y el desarrollo de nuevas tecnologias*. https://www.gsma.com/latinamerica/es/mexico-los-precios-altos-de-espectro-son-un-obstaculo-para-la-inclusion-digital-y-el-desarrollo-de-nuevas-tecnologias/

GSMA. (2021). *El impacto de los precios del espectro en Mexico*. 1-3. https://www.gsma.com/latinamerica/wp-content/uploads/2022/08/GSMA_El-impacto-de-los-precios-del-espectro-en-Mexico_Agosto-2022-1.pdf

Hall, D. & Lutsey, N. (2020). *Electric vehicle charging guide for cities*. International Council on Clean Transportation. https://theicct.org/sites/default/files/publications/EV_charging_guide_03162020.pdf

Hyundai. (2021, October 20). *Hyundai invierte en baterias de hidrogeno*. http://www.hyundai.com.mx/noticias/hyundai-invierte-baterias-hidrogeno/

IHS Markit (2021). *EV Charging Infrastructure Report and Forecast*. https://autotechinsight.ihsmarkit.com/shop/product/5002789/ev-charging-infrastructure-forecast-and-report

INA. (2022, March 4). *AMDA-AMIA-INA Conference Sale, Production and Export of New Vehicles and Auto Parts* [Conference]. Industria Nacional de Autopartes, A.C. https://ina.com.mx/?p=10638

International Energy Agency (IEA). (2022a). *Global EV Outlook 2022*. International Energy Agency. https://www.iea.org/reports/global-ev-outlook-2022

International Energy Agency (IEA). (2022b). *Global Supply Chains of EV Batteries*. International Energy Agency. https://www.iea.org/reports/global-supply-chains-of-ev-batteries

International Energy Agency (IEA). (2022c). *Policy Brief on Public Charging Infrastructure Promoting successful roll-out strategies and business models*. International Energy Agency. https://www.iea.org/reports/policy-brief-on-public-charging-infrastructure

International Energy Agency (IEA). (2022d). *The Role of Critical Minerals in Clean Energy Transitions*. International Energy Agency. https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions

International Finance. (2022). 5G Could Become the Next Big Economic Driver in Brazil. https://internationalfinance.com/5g-become-next-big-economic-driver-brazil/

National Institute of Statistics and Geography (INEGI). (2016). *Estadisticas a proposito de la Industria Automotriz 2016*. https://www.inegi.org.mx/contenidos/productos/prod_serv/contenidos/espanol/bvinegi/productos/nueva_estruc/702825079963.pdf

National Institute of Statistics and Geography (INEGI). (2022). *Registro administrativo de la industria automotriz de vehiculos ligero*s. https://www.inegi.org.mx/datosprimarios/iavl/#Tabulados

Federal Telecommunications Institute (IFT). (2020a). *Efectos y Alternativas de la Iniciativa de Reforma a la Ley Federal de Derechos para 2021 en materia de Espectro Radioelectrico*. 1-34. https://www.ift.org.mx/sites/default/files/contenidogeneral/espectro-radioelectrico/efectosyalternativasdelainiciativadereformaalaleyfederaldederechospara2021enmateriadeespectroradioel_0.pdf

Federal Telecommunications Institute (IFT). (2020b). *Primera Encuesta 2020, Usuarios de Servicios de Telecomunicaciones*. https://www.ift.org.mx/usuarios-y-audiencias/primera-encuesta-2020-usuarios-de-servicios-de-telecomunicaciones

Federal Telecommunications Institute (IFT). (2020c). *Vision y prospectiva de la conectividad 5G*. 1-17. https://www.ift.org.mx/sites/default/files/comunicacion-y-medios/otros-documentos/visionyprospectivadelaconectividad5g.pdf

Federal Telecommunications Institute (2021). *Propuesta de reforma de la Ley Federal de Derechos en materia de espectro radioelectrico*. 1-39. https://www.ift.org.mx/sites/default/files/contenidogeneral/espectro-radioelectrico/propuestadereformalfd.pdf

National Institute of Statistics and Geography (INEGI). (2018). Colección de estudios sectoriales y regionales Conociendo la Industria automotriz. Coleccion de estudios sectoriales y regionales. http://internet.contenidos.inegi.org.mx/contenidos/Productos/prod_serv/contenidos/espanol/bvinegi/productos/nueva_estruc/702825106829.pdf

National Institute of Statistics and Geography (INEGI). (2019). *Censo Economico Los hombres y las mujeres en las actividades economicas*. https://www.inegi.org.mx/contenidos/productos/prod_serv/contenidos/espanol/bvinegi/productos/nueva_estruc/702825198664.pdf

National Institute of Statistics and Geography (INEGI). (2021). Encuesta Nacional sobre Disponibilidad y Uso de Tecnologias de la Informacion en los Hogares. *In collaboration with the Federal Telecommunications Institute (IFT)*, 1-19. https://www.inegi.org.mx/contenidos/saladeprensa/boletines/2022/OtrTemEcon/ENDUTIH_21.pdf

National Institute of Statistics and Geography (INEGI). Registro administrativo de la industria automotriz de vehiculos ligeros. https://www.inegi.org.mx/datosprimarios/iavl/

National Institute of Statistics and Geography (INEGI). *National Statistical Directory of Economic Units*. https://www.inegi.org.mx/app/mapa/denue/default.aspx

International Energy Agency *Global EV Outlook 2022 Securing supplies for an electric future*. OECD Publishing, Paris, 1-221. https://doi.org/10.1787/c83f815c-en.

International Organization of Motor Vehicle Manufacturers (OICA). (2021). World Motor Vehicle Production 2021. https://www.oica.net/category/production-statistics/2021-statistics/

International Renewable Energy Agency (2019). Innovation Outlook, Smart Charging for Electric Vehicles. *In collaboration with the German Ministry of Environment, Nature Protection and Nuclear Safety,* 1-138. https://www.irena.org/publications/2019/May/Innovation-Outlook-Smart-Charging

International Telecommunications Union (ITU). (2018). Setting the Scene for 5G: Opportunities & Challenges. 1-56. https://www.itu.int/en/ITU-D/Documents/ITU_5G_REPORT-2018.pdf

International Telecommunications Union (ITU). (2021). *Implementing 5G for Good Do electromagnetic fields matter?* 1-49. https://www.itu.int/dms_pub/itu-d/opb/pref/D-PREF-BB.5G_02-2021-PDF-E.pdf

Kim, S., Seo, D., Ma, X., Ceder, G., & Kang, K. (2012). Electrode Materials for Rechargeable Sodium-Ion Batteries: Potential Alternatives to Current Lithium-Ion Batteries. *Advanced Energy Materials, 2(7), 710-721*.

Kumar, R. R., Chakraborty, A., & Mandal, P. (2021). Promoting electric vehicle adoption: Who should invest in charging infrastructure? *Transportation Research Part E: Logistics and Transportation Review, 149, 102295*. https://doi.org/10.1016/j.tre.2021.102295

Laing, K. & Natter, A. (2022). *Senate Deal Includes EV Tax Credits Sought by Tesla, Toyota*. Bloomberg. https://www.bloomberg.com/news/articles/2022-07-27/senate-deal-includes-ev-tax-credits-sought-by-tesla-toyota

Larios, A., Davila, C., & Brena, C. (2022). *Green Skills for Prosperity. Study of the future skills and competencies in the electromobility value chain.* British Embassy in Mexico City, DAI Global in collaboration with Bremass Energy Advisors.

Federal Telecommunications and Broadcasting Law (2021). Last Reform Published in the Official Journal of the Federation on May 20, 2021. https://www.gob.mx/cms/uploads/attachment/file/346846/LEY_FEDERAL_DE_TELECOMUNICACIONES_Y_RADIODIFUSION.pdf

Martijn Van der Steen, P.V. (2012). Governing and Innovation: The Transition to E-Mobility - A Dutch Perspective. *World Electric Vehicle Journal*. Vol 5. p. 58-71.

Mendoza, E. (2021). 'Ally-shoring', la oportunidad de reemplazar a China como proveedores de EU. Forbes Mexico. https://www.forbes.com.mx/ally-shoring-oportunidad-reemplazar-china-proveedores-eu/

Millbrook. (n.d.). https://www.millbrook.co.uk

Ministry of Energy, Chile (2021). *Electromobility Platform.* https://energia.gob.cl/electromobility/sistemas-de-carga

Ministry of Information and Communications Technologies of Colombia (MinTIC) (2019a). *Plan 5G Colombia, el Futuro Digital es de Todos*.

Ministry of Information and Communications Technologies of Colombia (MinTIC) (2019b). *MinTIC expidio las resoluciones que asignan los permisos de uso de los bloques de espectro.* https://www.mintic.gov.co/micrositios/asignacion_espectro-imt/742/w3-propertyvalue-217982.html

Miranda, A. (2007). La industria automotriz en Mexico: Antecedentes, situacion actual y perspectivas. pp.209-246. http://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S0186-10422007000100010&lng=es&nrm=iso>. ISSN 0186-1042

Moaz Uddin, M. (2021). Charging Medium- and Heavy-Duty Electric Vehicles: Plugging into the Future Part II. *Transportation & Fuels.* Great Plains Institute. https://betterenergy.org/blog/charging-medium-and-heavy-duty-electric-vehicles-plugging-into-the-future-part-ii/

Modesto, R. (2020). *Sector Automotriz: Los caminos frente al T-MEC*. [Interview]. Deloitte. https://www2.deloitte.com/mx/es/pages/dnoticias/articles/sector-automotriz-frente-T-MEC.html

Montoya, M. (2022). Oportunidades para la industria automotriz en Mexico: TMEC y vehiculos electricos. https://mexicoindustry.com/noticia/oportunidades-para-la-industria-automotriz-en-mexico-tmec-y-vehiculos-electricos

Morales, L. (2022, July 7). *Charging stations for electric cars in Mexico.* CFE Tramites. Retrieved July 27, 2022. https://tarifasdeluz.mx/cfe-tramites/contrato-electrolineras#tipos-de-electrolineras

Morales, R. (2022, April 20). *Mexico se enfocara en 5 de las 6 etapas de produccion de semiconductores.* El Economista. https://www.eleconomista.com.mx/empresas/Mexico-se-enfocara-en-5-de-6-etapas-de-produccion-de-semiconductores-20220420-0065.html

Muttaqi, M., Islam, M. & Sutanto, D. (2019). Future Power Distribution Grids: Integration of Renewable Energy, Energy Storage, Electric Vehicles, Superconductor, and Magnetic Bus. *IEEE Transactions on Applied Superconductivity, 29(2*), 1-5. doi: 10.1109/TASC.2019.2895528.

Ocampo, O. (2022). Apostar Por La Transmision Electrica Es Fortalecer a La CFE. Centro de Investigacion de Politica Publica. https://imco.org.mx/apostar-por-la-transmision-electrica-es-fortalecer-a-la-cfe/

Office of the United States Trade Representative. (2022). Report to Congress on the Operation of the United-States-Mexico-Canada Agreement with respect to Trade in Automotive Goods, 1-20. https://ustr.gov/sites/default/files/2022%20USMCA%20Autos%20Report%20to%20Congress.pdf

United Nations Organization (UN). (2019). *Recommendations on the Transport of Dangerous Goods. Model Regulation. Volume I and II*. 21st revised edition. https://unece.org/rev-21-2019

United Nations Organization (UN). (2011). *Recommendations on the Transport of Dangerous Goods. Manual of Tests and Criteria. Part II Classification*. 17th Revised Edition. https://unece.org/rev-17-2011

Pardo-Ferreira, Torrecilla-Garcia, J., de las Heras Rosas, C., & Rubio-Romero, J. (2020). New Risk Situations Related to Low Noise from Electric Vehicles: Perception of Workers as Pedestrians and Other Vehicle Drivers. *International Journal of Environmental Research and Public Health*. 17. 6701. 10.3390/ijerph17186701.

PASE. (2022). ECOTAG PASE 2022. https://www.pase.com.mx/promociones/ecotag-pase-2022/ (Consultado el 23 de septiembre de 2022).

Placek, M. (2022). *Global light vehicle production in 2019 with a forecast for 2020 through 2025*. Statista Transportation & Logistics. https://www.statista.com/statistics/266813/growth-of-the-global-vehicle-production-since-2009/

United Kingdom. (2015). *Waste Batteries and Accumulators (Amendment) Regulations 2015*. https://www.legislation.gov.uk/uksi/2015/1935

Renub Research. (2021). *Global Automotive Market, Growth & Forecast, Impact of Coronavirus, Industry Trends, By Region, Opportunity Company Analysis*. 1-250

Sustainable Global Supply Chains Research Network. (2022). *Sustainable Global Supply Chains Annual Report 2022*. German Development Institute.

Robbins, A. and Sullivan, P. (2021). *It's Time to Power-Up the Electric Vehicle (EV) Supply Chain*. Accenture. https://www.accenture.com/_acnmedia/PDF-160/Accenture-Its-Time-To-Power-Up-The-Electric-Vehicle-Supply-Chain.pdf#zoom=50

Rodríguez Abreu, Mauricio / Landy Sánchez Peña (2017). El futuro del trabajo automotriz en Mexico en Apuntes para la Equidad, No. March 1, 2017. El Colegio de Mexico.

Saldivar, B. (2022). Incentivos para nueva politica industrial aun se discuten: SHCP El Economista. https://www.eleconomista.com.mx/empresas/Incentivos-para-nueva-politica-industrial-aun-se-discuten-SHCP-20220921-0016.html

Sambuli, N. and Whitt, J.P. (2017) *Technology innovation hubs and policy engagement*, Making All Voices Count Research Report. The Institute for Development Studies. https://opendocs.ids.ac.uk/opendocs/handle/20.500.12413/12860

Sancak, M. (2022). The skilling practices of the Mexican firms, in *Global Production, National Institutions, and Skill Formation: The Political Economy of Training and Employment in Auto Parts Suppliers from Mexico and Turkey*, OUP Oxford.

Ministry of Economy. (2015, September 3). *Competitividad y Normatividad / Normalizacion / Normalizacion Internacional / Comite Electrotecnico Mexicano (CEM)*. https://www.gob.mx/se/documentos/competitividad-y-normatividad-normalizacion-normalizacion-internacional-comite-electrotecnico-mexicano-cem

Ministry of Economy. (2022, 20 April). *La Secretaria de Economia e Intel apuestan por el fortalecimiento de la cadena de suministro de semiconductores en Mexico*. https://www.gob.mx/se/es/articulos/la-secretaria-de-economia-e-intel-apuestan-por-el-fortalecimiento-de-la-cadena-de-suministro-de-semiconductores-en-mexico-299721?idiom=es

Ministry of Infrastructure, Communications and Transport (SICT). (2021). *Estadistica Basica del Autotransporte Federal*. http://www.sct.gob.mx/TRANSPORTE-Y-MEDICINA-PREVENTIVA/AUTOTRANSPORTE-FEDERAL/ESTADISTICA/

Ministry of Environment and Natural Resources (SEMARNAT). (2005, 7 September). *Norma Oficial Mexicana NOM-042-SEMARNAT-2003*. https://dof.gob.mx/nota_detalle.php?codigo=2091196&fecha=07/09/2005#gsc.tab=0

Ministry of Environment and Natural Resources (SEMARNAT). (2013, June 21). *Norma Oficial Mexicana NOM-163-SEMARNAT-ENER-SCFI-2013*. https://dof.gob.mx/nota_detalle.php?codigo=5303391&fecha=21/06/2013#gsc.tab=0

Ministry of Environment and Natural Resources (SEMARNAT). *Prevencion y gestion integral de los residuos Programa orientado a los estados y municipios*. https://www.gob.mx/semarnat/acciones-y-programas/prevencion-y-gestion-integral-de-los-residuos

Ministry of Labour and Social Security (STPS) (2021). *Programa de Capacitacion a Distancia para Trabajadores*. https://www.gob.mx/empleo/articulos/cursos-de-capacitacion-en-linea

Semiconductor Industry Association (SIA). (2020). *2020 State of the U.S. Semiconductor Industry*. https://www.semiconductors.org/wp-content/uploads/2020/06/2020-SIA-State-of-the-Industry-Report.pdf

Mexican Geology Service. (2021). *Anuario Estadistico de la Mineria Mexicana, 2020*. Ministry of Economy.

National Employment Service. (n.d.). *About the SNE*. https://www.empleo.gob.mx/accerca-sne

Shariff, SM.,Alam, MS., Hameed, S., Khalid, M., Ahmad, A., Essam A., Al-Ammar, A., Alsaidan,I. & Alrajhi, H. (2022). A state-of-the-art review on the impact of fast EV charging on the utility sector. *Energy Storage 4*(4), 1-21. doi:10.1002/est2.300

Shepardson, D. (2018). U.S. finalizes long-delayed 'quiet cars' rule, extending deadline. *Reuters*. https://www.reuters.com/article/us-autos-regulations-sounds/u-s-finalizes-long-delayed-quiet-cars-rule-extending-deadline-idUSKCN1GA2GV

S.J. Grand. (n.d.). The Electric Car Industry in China Gets Tax Relief and Incentives. https://www.sjgrand.cn/electric-car-industry-china-tax-relief-incentives/

Skillman. (n.d). https://skillman.eu/

SNC Lavalin. (2018). Renew Atlanta North Avenue Smart Corridor https://www.snclavalin.com/en/projects/renew-atlanta-north-avenue-smart-corridor

Sopha, B., Purnamasari, D., & Ma'mun, S. (2022). Barriers and Enablers of Circular Economy Implementation for Electric-Vehicle Batteries: From Systematic Literature Review to Conceptual Framework. *Sustainability (Basel, Switzerland), 14*(10), 6359

Stanford University Human Centered Artificial Intelligence (SUHCAI), (2021). *Artificial Intelligence Report 2021*. Stanford University. https://aiindex.stanford.edu/wp-content/uploads/2021/11/2021-AI-Index-Report_Master.pdf

Statista Research Department. (2022). La industria automovilistica en Mexico – Datos estadisticos. https://es.statista.com/temas/6404/la-industria-automotriz-en-mexico/#dossierKeyfigures

Statista. (2022). Numero de estaciones de carga para vehiculos electricos en Mexico de 2015 a 2019. https://es.statista.com/estadisticas/1186114/estaciones-de-carga-vehiculos-electricos-mexico/

Stein, E. (2014). A Conceptual Framework for Productive Development Policies. En E. F-A- Gustavo Crespi, *Rethinking Productive Development Sound Policies and Institutions for Economic Transformation* (pags. 33-35). Inter-American Development Bank, Palgrave Macmillan.

Deputy Ministry of Secondary and Higher Education (2020). *Coordinacion Sectorial de Fortalecimiento Academico (COSFAC)*. http://sems.gob.mx/cosfac

Shields, K. H. (2022, April 26). *State Policies Promoting Hybrid and Electric Vehicles*. Retrieved from National Conference of State Legislatures: https://www.ncsl.org/research/energy/state-electric-vehicle-incentives-state-chart.aspx

The European Association of Electrical Contractors, Alyssa Pek, Giorgia Concas, Janne Skokberg, Lucien Mathieu, Oddvin Breiteig (2019) "Powering a new value chain in the automotive sector. The job potential of transport electrification".

Thomson Reuters Mexico. (2021). Nearshoring: La solucion actual para el comercio exterior. https://www.thomsonreutersmexico.com/es-mx/soluciones-de-comercio-exterior/blog-comercio-exterior/nearshoring-la-solucion-actual-para-el-comercio-exteior

Toivonen, T. and Friederici, N. (2015, 7 abril). *Time to define what a 'Hub' really is*. Stanford Social Innovation Review. https://ssir.org/articles/entry/time_to_define_what_a_hub_really_is

Trade Promotion Council India (TPCI). (2021). MoU with Argentina for securing minerals. https://www.tpci.in/indiabusinesstrade/news_buzz/mou-with-argentina-for-securing-minerals/

UK Government. (2022). COP26 declaration on accelerating the transition to 100% zero emission cars and vans. Policy paper. *Department for Business, Energy & Industrial Strategy.* https://www.gov.uk/government/publications/cop26-declaration-zero-emission-cars-and-vans/cop26-declaration-on-accelerating-the-transition-to-100-zero-emission-cars-and-vans

European Union. (2014). Regulation (EU) No 540/2014 of the European Parliament and of the Council. 1-65. https://eur-lex.europa.eu/eli/reg/2014/540/oj

Universidad Nacional Autonoma de Mexico. (2017). Estudio Origen-Destino de la ZMVM 2017. http://giitral.iingen.unam.mx/Estudios/EOD-Hogares-01.html#estudio

Universidad Nacional Autonoma de Mexico. (2019) *Cuenta la UNAM con 14 sedes en nueve paises*. https://www.gaceta.unam.mx/cuenta-la-unam-con-14-sedes-en-nueve-paises/

University of California. (2021). *University of California Sistemwide Program*. https://alianzamx.universityofcalifornia.edu/history/#ucini

United Nations. (2022). Trade ties: Zambia and DRC sign cooperation Agreement to manufacture electric batteries, create jobs. https://www.un.org/africarenewal/magazine/may-2022/trade-ties-zambia-and-drc-sign-cooperation-agreement-manufacture-electric

Van Halm, Isabeu. (2022). *Concerns for mineral supply chain amid booming EV sales*. Mining Technology. https://www.mining-technology.com/analysis/concerns-for-mineral-supply-chain-amid-booming-ev-sales/

Wall, M. (2019). Automotive Industry Outlook: Managing Volatility and Leveraging Opportunities in a Dynamic Market Environment. I*HS Markit*, 1-18.

Wentker, M., M. G. (2019). *A Bottom-Up Approach to Lithium-Ion Battery Cost Modeling with a Focus on Cathode Active Minerals.* Energies, Vol. 12, No. 502, 5.

White House. (2021a, June 8). *FACT SHEET: Biden-Harris Administration Announces Supply Chain Disruptions Task Force to Address Short-Term Supply Chain Discontinuities. https://www.whitehouse.gov/briefing-room/statements-releases/2021/06/08/fact-sheet-biden-harris-administration-announces-supply-chain-disruptions-task-force-to-address-short-term-supply-chain-discontinuities/*

White House. (2021b, August 5). *Executive Order on Strengthening American Leadership in Clean Cars and Trucks*. https://www.whitehouse.gov/briefing-room/presidential-actions/2021/08/05/executive-order-on-strengthening-american-leadership-in-clean-cars-and-trucks/

World Economic Forum. (2019). How is the Fourth Industrial Revolution changing our economy? https://www.weforum.org/agenda/2019/11/the-fourth-industrial-revolution-is-redefining-the-economy-as-we-know-it/

WRI Mexico. (2021). 4 medidas para fortalecer la red electrica en Mexico. https://wrimexico.org/bloga/4-medidas-para-fortalecer-la-red-el%C3%A9ctrica-en-m%C3%A9xico

Zhen Li & Yuyu Li. (2022). *All-solid-state batteries, in Storing Energy* (Second Edition), Editor(s): Trevor M. Letcher, Elsevier, 343-361.


RELACIONES EXTERIORES
UNIVERSITY OF CALIFORNIA
ALIANZAMX

Team in charge of the Task Force on the Electrification of Transport

Iker Jimenez Martinez, Director General for Global Investment

He has over 13 years of experience as a high-level executive in public relations and business development, creating and implementing strategies in the private sector (B2B and B2C) and in government entities in Mexico. He specializes in trade facilitation, and public communication, productivity and competitiveness, negotiations, research and analysis projects, and customer service. He has worked for State Ministries in charge of foreign policy and industrial policy. He graduated with honors as a Bachelor of International Trade at Universidad del Valle de Mexico and Walden University. He holds a Master's Degree in International Management from the Instituto Tecnologico Autonomo de Mexico (ITAM).

Margarita Alcantara Alcala, Head of the Undersecretary for Multilateral Affairs and Human Rights

She has over 10 years of professional experience in the public sector. She is a Master in public policy from King's College London and a bachelor in political science from Instituto Tecnologico de Monterrey. Currently, she serves as the Head of Undersecretary for Multilateral Affairs and Human Rights of the Ministry of Foreign Affairs, where she has participated in high-profile strategic projects Mexico in the field of Feminist Foreign Policy, the response to the COVID-19 pandemic, United Nations, among others.

Jorge Jimenez Solomon, Coordinator of the Task Force on the Electrification of Transport (GTE)

He has over 8 years of professional experience in the field of public policy, working in the OECD and the UN, as well as in project coordination and external relations, implementing strategies (B2C and G2B) between the private and public sector. He graduated with honors in International Studies, majoring in sustainable development and economics at Simon Fraser University in Vancouver, Canada. He was a recipient of the *Chevening* fellowship of the United Kingdom to do the Master's studies in public administration with a specialty in climate change and energy.

Aurora Tenorio Dena, Supervisor of Infrastructure and Supplier Development, AWG

Engineer in Innovation and Design, graduated with honors from Universidad Panamericana, majoring in international logistics. Master's Degree in Environment and Sustainable Development from University College London, graduated with honors. She has over 9 years of experience in the design of solutions and implementation of logistics projects for transport at transnational companies, startups and non-profit organizations.

Alberto Chavez Mejia, Institutional Liaison, Innovation Supervisor

Degree in International Relations from Universidad Anahuac. He has completed multiple degrees in diplomacy, security and international disarmament. He has 8 years of experience on political and electoral matters in the public and private sector, designing and implementing logistics solutions.

Bethlehem Elizabeth Licona Romero, Coordinator of the Territorial-Industrial Prospective Atlas, Human Capital Supervisor, GTE

She has 8 years of experience on economic, urban, legal consulting, migration and international law in the public and private sector. PhD in International Security from Universidad Anahuac. Master in International Relations and International Law from the University of Aberdeen. Bachelor of Law and Bachelor of International Trade from Universidad Vizcaya de las Americas.

Leonardo Castañeda Lopez, Consultant of the Task Force on the Electrification of Transport

With a career of over 15 years in the public sector and international organizations in both Mexico and Australia, he specializes in issues of international development, economic promotion and business liaison. Graduated with honors as a Master of Development Practice from Monash University in Australia, and as a bachelor of international trade and business administration from Universidad del Valle de Mexico (Mexico) and Walden University (United States).

Santiago Bolaños Signoret, Consultant of the Task Force on the Electrification of Transport

He has over 10 years of experience in public law and public policy. He is a Bachelor of Law from Instituto Tecnologico Autonomo de Mexico (ITAM), a Master of Rule of Law for Development from Loyola University Chicago, and a Master of Regional and Urban Planning from the London School of Economics.

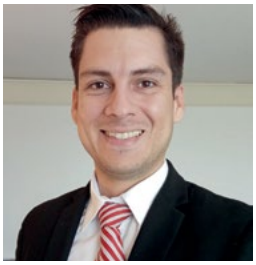
Franco Fernandez Rodriguez, Consultant of the Task Force on the Electrification of Transport

Economist with a major in economics-politics from Instituto Tecnologico Autonomo de Mexico (ITAM). His areas of expertise include political analysis and strategic planning. He has worked for over 5 years as a public servant in the Energy Regulatory Commission and in the Ministry of Foreign Affairs, promoting Mexico abroad and attracting investment.

Sebastian Ponce Landañu, Consultant of the Task Force on the Electrification of Transport

He has over 4 years of professional experience in the design and creation of foreign policy strategies in the public sector, as well as in public policies with local governments. He graduated with honors in International Relations from UNAM and followed postgraduate studies in foreign policy at the University of São Paulo. He was awarded the Orange Tulip and Holland Scholarship by the Dutch government to carry out the Master's Degree in International Security at the University of Groningen.

Luis Gabriel Lopez Nuñez, Consultant of the Task Force on the Electrification of Transport



Public policy expert, a Bachelor of Public Policy from Universidad Autonoma de Sinaloa, with master's and doctoral studies at UNAM, specializing in new approaches to administration and public policies. He has over four years of work experience in different institutions of the federal government (SAT, SEP) promoting strategic projects for innovation and designing public policy for the Mexican government.

Image index

US-Mexico Task Force for the Electrification of Transport:
Diagnosis and Recommendations for the Transition
of Mexico's Automotive Industry

It was held in Mexico City.
November 2022

RELACIONES EXTERIORES

SECRETARÍA DE RELACIONES EXTERIORES

UNIVERSITY OF CALIFORNIA

ALIANZAMX

CANAME