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ELECTROMOBILITY IN MEXICO

Perspectives on Energy and Climate Policy

Content

Introduction

The transition towards electric vehicles (EVs)[1] in Mexico represents a critical intersection of technological innovation, environmental imperatives, and political dynamics. This topic garners interest due to its potential to significantly alter the landscape of transportation, energy consumption, and carbon emissions. The central question this paper explores is how the interplay of socio-technical regimes and political factors shapes Mexico's journey towards electric mobility, a pressing issue in the context of global climate change and the shift towards sustainable practices.

Our analysis reveals that while technological advancements and market dynamics create a conducive environment for EV adoption, political hurdles and entrenched interests present significant challenges. This paper will delve into these complexities, offering a nuanced understanding of the factors influencing Mexico's transition to electric mobility. Section 2 will study the problem, its context and current state at a national level and will introduce the main players. Section 3 will analyze the political landscape, focusing on policy influences and industry dynamics. Section 4 will examine the multi-level perspective on socio-technical regimes, highlighting the systemic barriers to EV adoption. Finally, Section 5 synthesizes these perspectives, demonstrating their complementary nature in providing a comprehensive view of the transition to electric mobility in Mexico. This approach not only enhances our understanding of the current state but also sheds light on the pathways for accelerating this crucial transition.

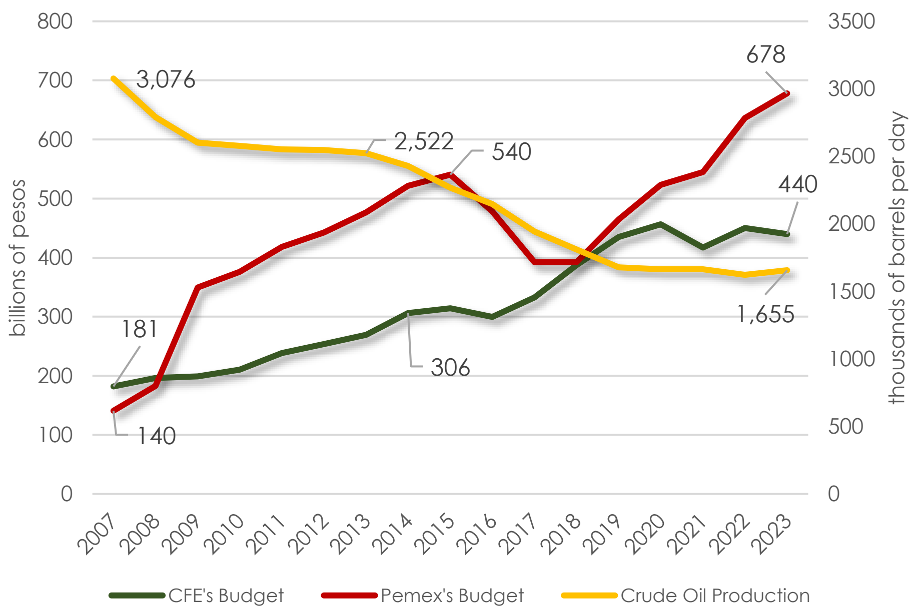
Description of the problem

Mexico's transportation sector, historically reliant on fossil fuels, is deeply entrenched in a system dominated by Internal Combustion Engines (ICE). This scenario is exacerbated by the current administration's focus on "energy sovereignty" and revitalizing PEMEX, the state-owned petroleum company. Substantial investments in fossil fuel infrastructure, like the new refinery in Tabasco, along with significant gasoline subsidies, record-high budget

[1] In this study EV refers to Battery Electric Vehicles (BEV) and Plug-in Hybrid Electric Vehicles (PHEV).

allocated to PEMEX [Figure 1], and increased fuel oil production, underscore a strong commitment to the “carbon lock-in” (Unruh, 2000).

Figure 1. Mexico’s State-Owned Federal Budget Allocation and Declining Oil Production



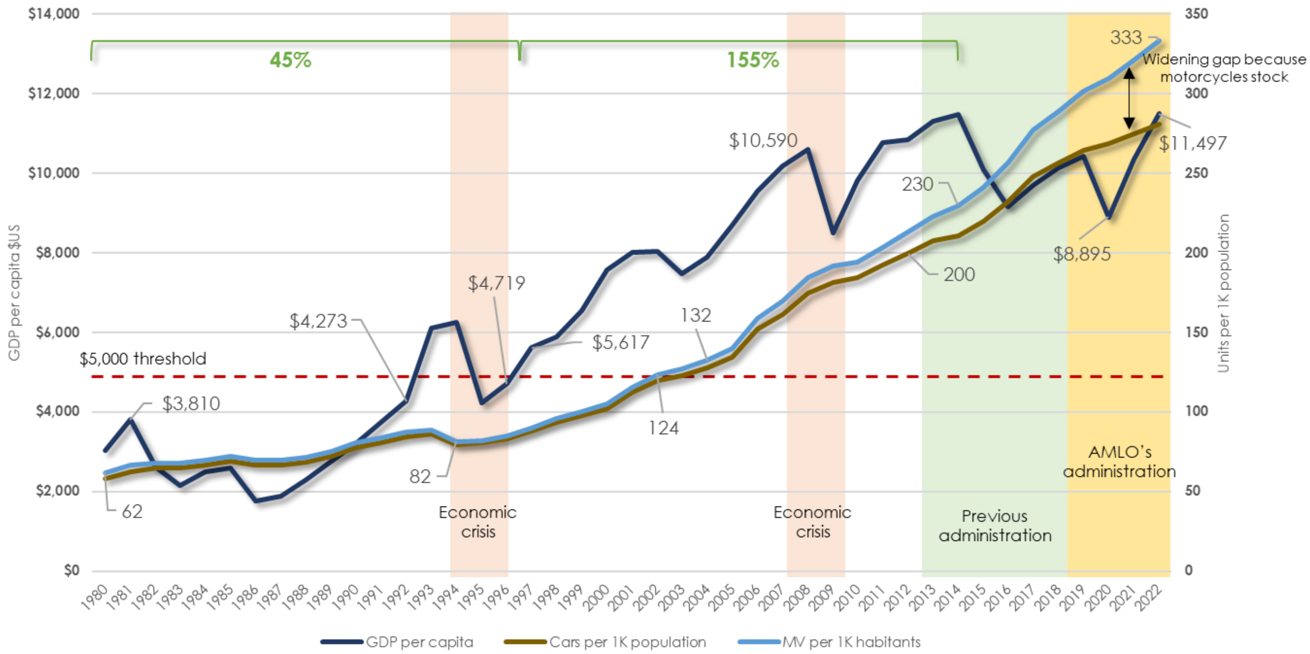
Source: Data sourced from Congress Lower House (2023), and CNH (2023).

In 1980, about 4 million cars navigated Mexico's roads. By 2022, this number had surged to 36.5 million, indicating robust growth in the automotive sector driven predominantly by ICE vehicles (INEGI, 2023a). Recent years have also seen a dramatic rise in motorcycle sales. Corradi et al. (2023, p.3) describe this phenomenon: "The prevailing regime is that of automobility, centered around the ownership and use of ICEVs, sustained by formal and informal institutions." This exponential growth in vehicle numbers signifies a deep-rooted dependence on ICE technologies within the national transportation framework.

Historically, since the 1940s, Mexican presidents have considered the transportation sector a “crucial catalyst for economic take-off” (Briggs et al., 2015, p.64), as noted by the Secretariat of Transport and Communications (SCT, 2019). From 1980 to 1997, vehicle ownership per 1,000 inhabitants rose from 62 to 90. This growth accelerated significantly after Mexico's per capita income crossed the $5,000 US threshold in 1997, with motor vehicle ownership increasing from 90 to 310 per 1,000 inhabitants in the same period.

This trajectory highlights the country's growing dependence on personal vehicles, particularly ICEVs, reinforcing the entrenched automobility regime and posing challenges to sustainable mobility transitions.

Figure 2. Mexico's GDP per capita v. Motor Vehicle (MV)per capita



Source: Data sourced from World Bank (2023), CONAPO (2023), and INEGI (2023).

The introduction of EVs in Mexico marks a shift from its traditional reliance on ICE. Despite a 57% increase in EV sales in 2023, their adoption remains modest, accounting for only 1.19% of total vehicle sales (INEGI, 2023b and 2023c). The EV market, concentrated in urban areas [Figure 3], faces challenges like inadequate charging infrastructure, creating "range anxiety." Additionally, the high upfront costs of EVs and the lack of financial incentives and information hinder broader adoption (Sheldon, 2022; Zhou et al., 2016).

Figure 3. Concentration of EVs stock in Mexico

State	Proportion of EV stock
Mexico City	37.5%
Estado de México	12.8%
Jalisco	9.1%
Nuevo León	8.5%
Rest of states	32.0%

Mexico's role as a significant automotive player globally impacts this transition. The country is the seventh-largest manufacturer and exporter of passenger vehicles. From January to June 2023, it manufactured 47,781 EVs, showcasing the growing relevance of EV production in its industry (INEGI, 2023b). This trend reflects the beginnings of a shift towards electric mobility in Mexico's transportation and manufacturing sectors.

Politics

The political landscape supports the ICE system and limits the progress of EV adoption despite various financial incentives for EVs. The current electromobility scenario in Mexico is marked by insufficient policy support for EVs [Figure 4].

Figure 4. Current EVs Incentives

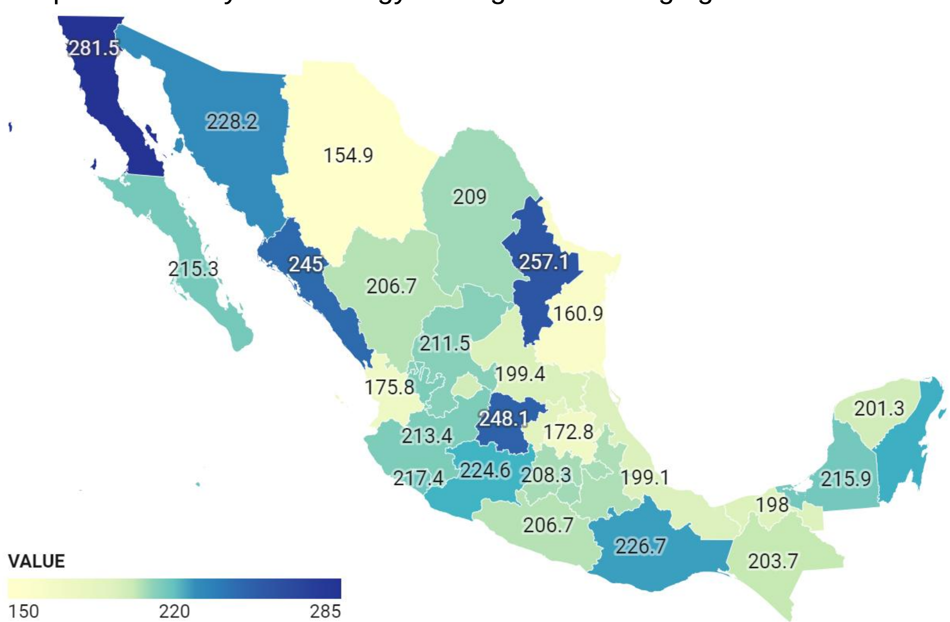
Incentive/Policy	Disadvantages
New Vehicle Tax (ISAN) exemption	While EV owners benefit from this exemption, ICE vehicles below a certain price are also exempted, diluting the incentive's impact.
Income Tax Deductions	The Income Tax Law permits higher deductions for EVs, yet the difference from ICE vehicles is marginal.
Leasing Deductions	Slightly higher deductions for EVs do not significantly offset the cost disparity with ICE vehicles.
Tax Credit for Public Chargers	Not targeted for consumers.
Residential Electric Meter for EVs by Comisión Federal de Electricidad (CFE) -Mexico's electricity public utility-	This policy aids in operational cost reduction but doesn't address the high initial investment in EVs [see Figure 5].
State-Specific Incentives	Varied across states.

Source: ISAN Law, Income Tax Law and CFE (2023).

This gap perpetuates consumer misconceptions about the Total Cost of Ownership (TCO) for EVs. Many consumers overlook the long-term savings EVs offer in energy costs due to initial higher prices, a phenomenon known as consumer myopia (Corradi et al., 2023; Rapson & Muehlegger, 2021).

The CFE's initiative to install separate electric meters for EVs in residences is a key strategy to prevent higher tariffs for EV owners. This policy could be a major incentive -if combined with incentives addressing upfront costs of installing the charger stations-, offering significant energy cost savings and underscoring the economic benefits of EVs over the long term [Figure 5].

Figure 5. Comparative Analysis of Energy Savings - EV Charging at Home vs. Gasoline Prices



Source: The data employed in this analysis is sourced from three authoritative entities: CRE (2023a), CRE (2023b), and Banxico (2023a). The synthesis and visualization of this data have been executed using Datawrapper. See appendix.

Mexico's automotive landscape, traditionally centered around ICE vehicles, is currently at a crossroads, heavily influenced by political factors. This impacts the integration of emerging technologies like EVs. As Breetz et al. (2018) note, public policy plays a crucial role in the rate of technology adoption, even if it does not reshape the technology curve itself (p. 497). The Mexican automotive sector demonstrates a strong path dependency, hindered by historical, economic, and socio-political factors, creating a 'lock-in' effect that slows the shift towards a sustainable, EV-dominated future (Unruh, 2000).

The nuances of this lock-in phenomenon are multifaceted, encompassing economic constraints, social-cognitive biases, and power dynamics, all of which collectively impede the transition towards a more sustainable, EV-focused future. The following table encapsulates the key aspects of this lock-in situation, offering a structured insight into the complex interplay of forces at play:

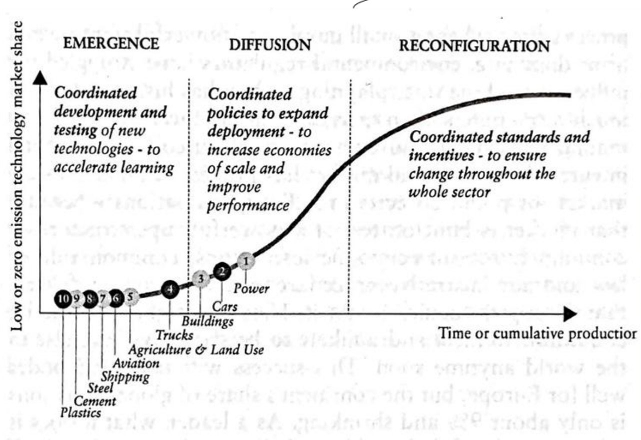
Figure 6. Lock-in situations in Mexico

Lock-in aspect	Description
Economic	- Substantial investments historically channeled into ICE vehicle infrastructure. - A pronounced price disparity between ICE vehicles and EVs, with the former being more affordable due to extensive subsidies, well-established supply chains, and absence of comparable incentives for EVs. - Limited financial incentives targeting EV consumers and the nascent EV manufacturing industry, overshadowed by the long-established and deeply ingrained ICE vehicle industry.
Social-Cognitive	- A deeply rooted societal reliance upon and familiarity with ICE vehicles, ingrained in the national psyche. - A dominant perception upholding ICE vehicles as the primary and most dependable mode of transportation, firmly embedded in the cultural narrative. - Persistent skepticism and a notable deficit in awareness regarding the tangible benefits and practical feasibility of EVs, underscored by concerns such as range anxiety and a lack of comprehensive understanding of the Total Cost of Ownership (TCO) benefits.
Power	- Concentration of power in the fossil fuel industry, particularly PEMEX. - Influence of energy lobbyists and the incumbent automotive industry coalition on policymaking. - Political resistance to significant shifts in energy policy, favoring the status quo and hindering the adoption of EVs. - Low political prioritization of EVs and sustainable transportation alternatives.

Globally, the rise of EVs marks a pivotal shift in the automotive industry, with EVs now progressing through the diffusion phase of market share (Cullenward et al., 2020). In this context, Mexico faces a crucial decision point in aligning with this global movement towards decarbonizing its road transport sector.

Breetz et al. (2018) emphasize the crucial role of politics in guiding the adoption rate of emerging technologies, including EVs. They identify three stages of technological maturity, with EVs currently in the 'middle of the curve,' a critical stage demanding targeted fiscal incentives, comprehensive regulatory frameworks, and robust infrastructure development. Despite global momentum towards EV adoption, Mexico's political support for this transition seems lacking [Figure 7]. This gap is evident in the limited fiscal support, disjointed regulatory measures, and lagging infrastructure development crucial for EV adoption.

Figure 7. Middle of the curve support strategies



Source: Redrawn with permission from David G. Victor, Frank W. Geels, and Simon Sharpe, "Accelerating the Low Carbon Transition: The Case for Stronger, More Targeted and Coordinated International Action," Energy Transitions Commission and Brookings Institution (2019), based on assessments of technological development that rely heavily on the work of the Energy Transitions Commission (*http://www.energy-transitions.org/*).

Fiscal incentives	Regulations	Infrastructure development
Lack of fiscal incentives for EV buyers.	No Zero Emission Vehicle (ZEV) mandates	Lack of incentives for infrastructure at home.
Fiscal incentives for ICE vehicles in place.	Fuel economy standards in place.	Range anxiety.
No level playing field between ICE and EV.	Emissions standards in place.	No coherent National Strategy.
Gasoline subsidies.		CFE preferential electricity tariff when charger installed at home.

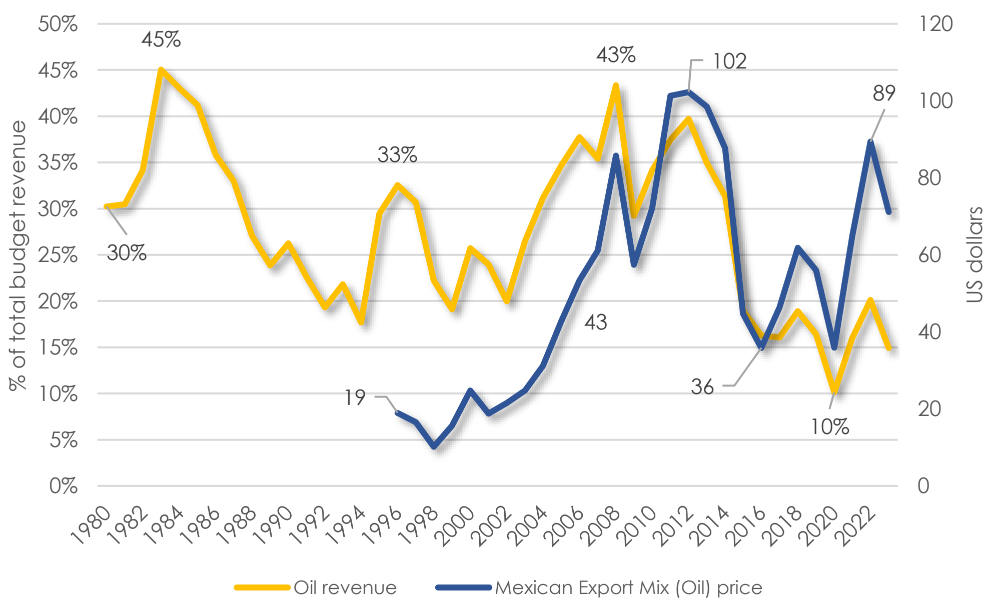
Source: Table of my own making based on Breetz et al. (2018); graph from Cullenward et al., (2020).

Mexico's commitment to climate action, as demonstrated by signing the Glasgow Climate Pact in 2022, emphasized promoting EVs across various sectors (SEMARNAT, 2023). However, there's a disconnect between this commitment and practical implementation.

The National Electric Mobility Strategy (NEMS), while collaborative, offers general recommendations without specific reform actions or implementation strategies. It lacks a clear Technological Route Map and new incentives for EV buyers.

The current administration's policies further complicate this scenario. Their commitment to maintaining low electricity and gasoline prices, increasing oil production, investing in refineries, and reliance on oil revenues (Banxico, 2023b) indicates a deep-rooted dependency on hydrocarbon revenues. This reliance, as Bonilla et al. (2022) note, creates resistance to electrifying the transport system.

Figure 8. Mexico's Government Reliance on Oil Revenues



Source: Data sourced from Banxico (2023b and 2023c).

The narrative of "rescuing PEMEX," central to the President's 2018 campaign, intertwines the oil industry with national sentiment, sending mixed signals to potential electromobility sector investors. This approach not only perpetuates the ICE-dominated regime but also entrenches the existing lock-in system, posing significant challenges for transitioning to an electrified transportation future. Rosenbloom et al. (2019) highlight that early policy decisions can create self-reinforcing cycles, making departures from established systems increasingly difficult. Thus, Mexico's current policy landscape presents substantial barriers to shifting away from the ICE system towards a sustainable, electrified transportation future.

Socio-technical regimes

Due to a series of early choices in the beginning of the XIXth century, the petroleum car ecosystem was locked in, even when alternatives such as EVs presented better efficiencies. This path-dependence trajectory of inferior technologies has been studied extensively (Rosenbloom et al., 2019; Unruh, 2000; Pahud et al. 2023; Geels, 2005). These systems become entrenched and self-reinforcing as different existing regimes co-evolve and develop a "meta-coordination through socio-technical regimes" (Geels, 2004, p. 905).

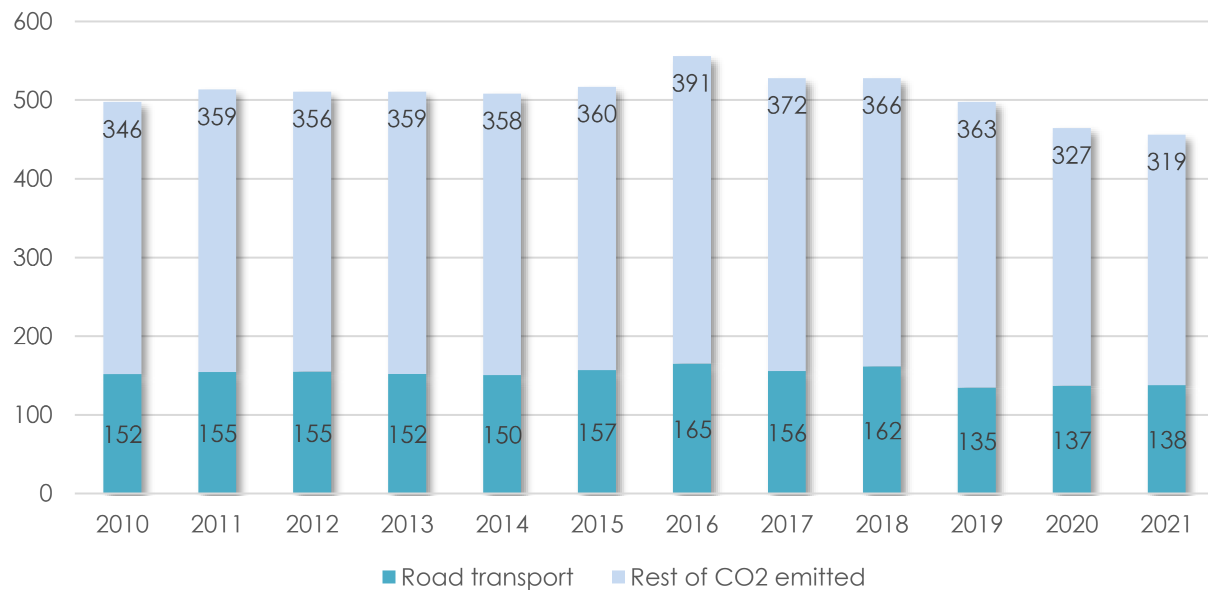
This section analyses the multi-level perspective developed by Geels, (2004), identifies the main regimes and the transformative outcomes from Ghosh et al. (2021) that the niche technology of EVs can push to accelerate adoption.

Socio-technical landscape

Climate Change

Mexico, as a participant in global climate agreements like the Paris Agreement, faces international pressure to reduce its carbon footprint. This global commitment translates into national strategies to embrace cleaner technologies, including the promotion of EVs. Mexico's policies may increasingly focus on reducing emissions from the transportation sector, which is the second contributor to the country's overall greenhouse gas emissions with 30% (INECC, 2022).

Figure 9. Road transport CO2 emissions in Mexico (Mt)



Source: Data sourced from INECC, 2022.

Impact of international oil prices

Mexico, as an oil-exporting nation, has a complex relationship with international oil prices. While higher prices can benefit the national economy and the state-owned company PEMEX, they also increase the cost of fuel for consumers and strain financial budgets when gasoline subsidies are applied (Inchauste et al., 2017), which in turn could make EVs more appealing to actors within the regime, like the government.

Socio-technical regime

Decision-makers often confront significant risks associated with making irreversible investments (Unruh, 2000). This hesitation is often seen in the backdrop of a 'carbon lock-in' system, a term that describes the entrenched nature of fossil fuel-based technologies in our society. And, as Urry (2007, p. 31) points out, what led to the ICE vehicle to be "irreversibly locked-in". Corradi et al. (2023, p. 2) further emphasize the dynamic nature of the process of unlocking the system when it's the same incumbent actors within the regime that reframe their behaviour. We draw from the work of the latter to analyse the current regime and its resistance and distabilising factors:

Figure 10. Factors of resistance and instability within the regime

Regime	***Factors of resistance***	***Factors of instability within the regime***	***Examples of instability***
Users and market	- High upfront costs of EVs. - Range anxiety. - Limited range of vehicles. - Lack of effective incentives and infrastructure. - Cheap gasoline - Consumer myopia towards operating costs.	- Changing consumer preferences. - Eventual cost competitiveness of EVs. - Shift towards environmental consciousness. - Influence of social factors (e.g., shared mobility, urban lifestyles). - Younger generations' preference for eco-friendly vehicles. - Business and government fleet adoption.	- Uptake of EVs sales (INEGI, 203). - State pilot initiatives of adoption of EVs for taxis, business and government (SEMARNAT, 2023).
Industry	- Unclear government policy directions. - Nested investments in ICE product lines. - High cost of transitioning to EV production. - Dependence on ICE component revenues. - Uncertainty in consumer demand and infrastructure development.	- Legal commitments to sustainability (ESG indicators). - Mexico's role in automotive manufacturing. - Nearshoring effects and bandwagon effects in the industry. - Market disruption and regime change potential.	- Production of EVs like JAC and Mustang Mach-E in Mexico. - Announcements by Tesla, BMW, and Audi. - Companies recording and revealing ESG indicators. - Green Taxonomy published by Finance Secretariat (SHCP, 2023).
Policy	- Lock-in to traditional oil-based industries. - Reluctance to embrace electric mobility. - Historical reliance on oil economy.	- Potential for decarbonization of transport. - Influence of international climate change policies. - Development of regulatory frameworks for EVs.	- Financial incentives and EV infrastructure. - Emissions standards and carbon pricing policies (IEA, 2023).

Source: Own making.

Niche

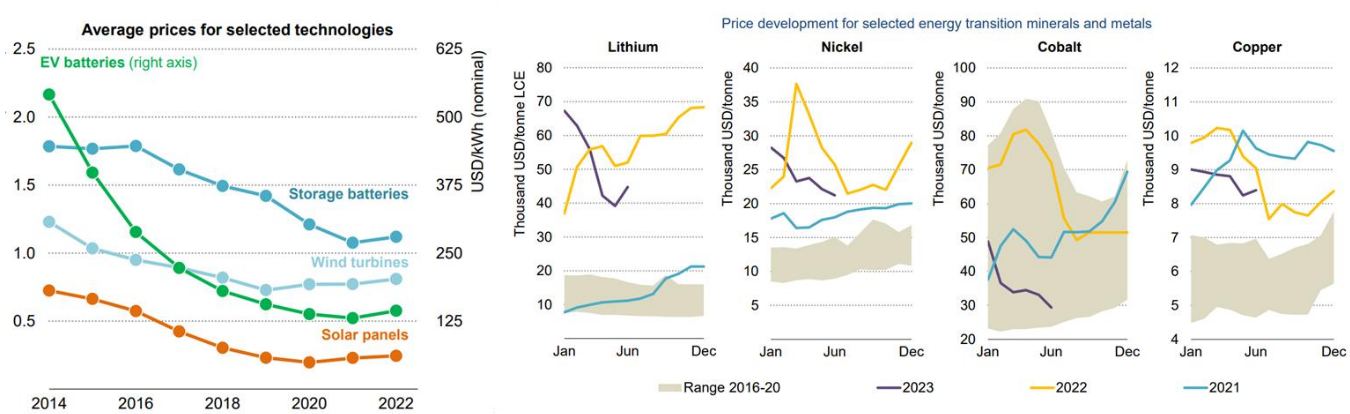
Drawing from the work of Geels (2004) and Ghosh et al. (2021), we outline four ‘transformative outcomes’ that could benefit the electric mobility transition:

Shielding

Early automobile adoption was influenced by policy decisions such as road infrastructure development and traffic regulations. These policies facilitated the use of automobiles and gradually marginalized horse-drawn transport (Geels, 2006). Current transitions to electric mobility are significantly influenced by government policies and regulatory frameworks. Incentives such as tax rebates, subsidies for EV buyers, investments in charging infrastructure, and regulations like emissions standards are shaping the market (Breetz et al., 2018; IEA, 2023). Policies that discourage fossil fuel use, such as carbon pricing and restrictions on ICE vehicles in urban areas, also play a crucial role.

Upscaling

The rise of gasoline-powered vehicles was catalyzed by innovations like the ICE and the development of gasoline as a cheap fuel source. These technological advancements were supported by an ecosystem that included early tinkerers, inventors, and eventually large-scale manufacturers like Ford (Geels, 2006). In electric mobility, advancements in battery technology, electric motor efficiency, and renewable energy sources are key drivers. The development of lithium-ion batteries, for instance, has significantly improved the range and reduced the cost of EVs (IEA, 2023).



Source: IEA, 2023.

The innovation ecosystem now includes not just traditional automotive manufacturers but also technology companies, startups, and a diverse range of stakeholders in the renewable energy sector. The automobile's adoption was partly driven by cultural factors such as the perception of cars as symbols of modernity and status. This cultural shift was supported by a growing middle class and urbanization trends. Today, EVs are increasingly seen as symbols of environmental consciousness and technological advancement.

De-aligning and destabilizing

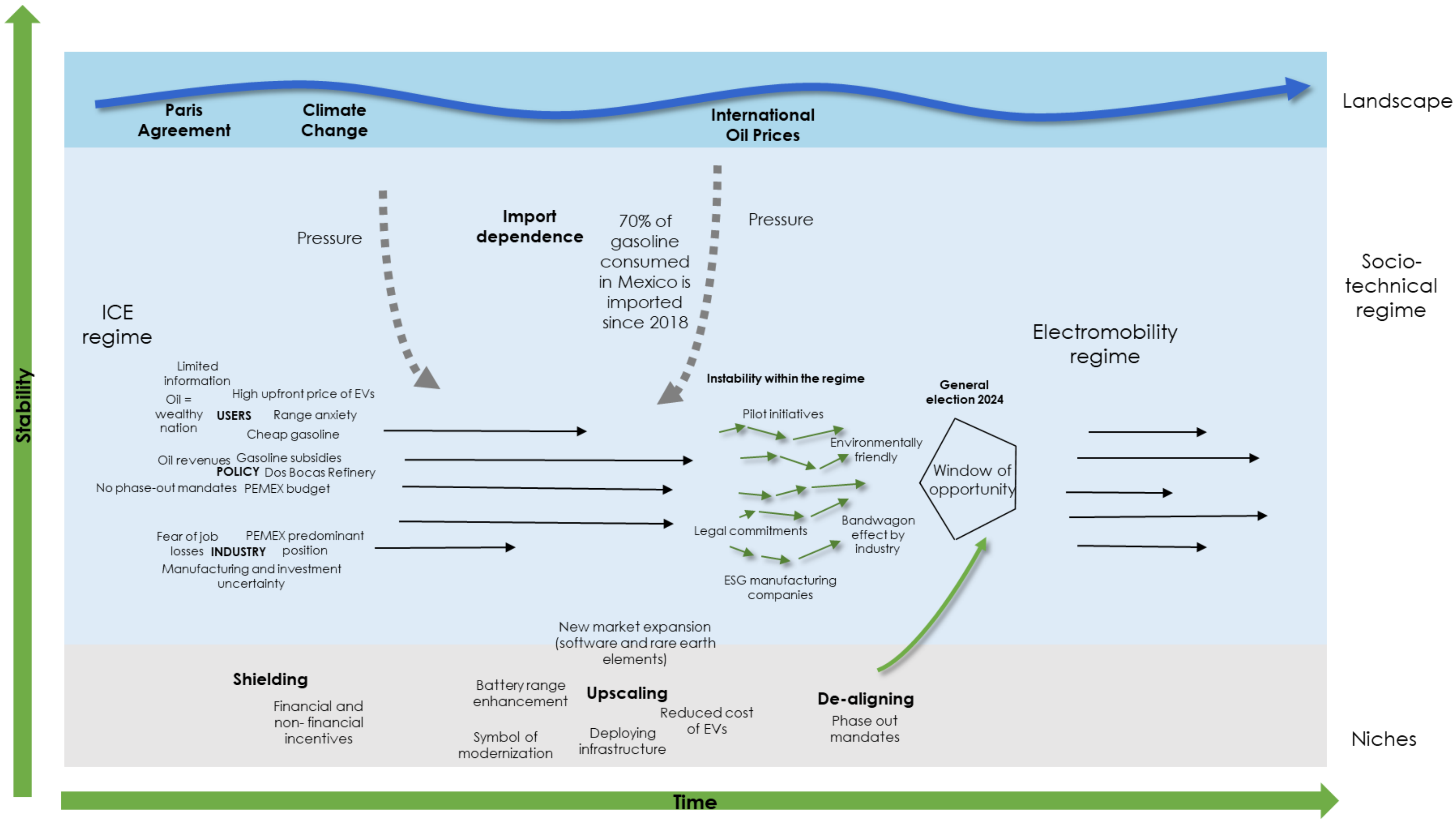
Just as road infrastructure development and regulatory changes facilitated the transition from horse carriages to ICE vehicles, similar strategies can be employed for EVs. Governments could implement policies phasing out ICE vehicles, similar to how coal-burning plants are being phased out in some regions (Ghosh et al., 2018). This could include setting deadlines for ending the sale of new ICE vehicles, as some countries have already proposed.

Window of opportunity

The nation is experiencing a shift in consumer preference towards environmentally friendly technologies, driven by a growing awareness of climate change. This change in consumer behavior is paralleled by international pressures and commitments to combat climate change, pushing Mexico to align its policies with global environmental goals. The diminishing returns from oil production can serve as a catalyst for embracing alternative energy sources, including EVs. The automotive manufacturing sector in Mexico is witnessing a bandwagon effect, with increased investments in EV production, which also offers potential economic growth and job creation within the country.

Mexico currently stands at a critical juncture. The upcoming federal election in 2024 presents a unique 'window of opportunity' to capitalize on these converging factors [see Figure 12]. Claudia Sheinbaum, a probable candidate for the presidency and successor to the current administration, is a scientist, has a background in energy, and is the former governor of Mexico City. This gives her both the scientific knowledge and the political experience to steer Mexico's transition towards sustainable mobility, if not led by political impulses. Sheinbaum's presidency could mark a pivotal moment for Mexico, utilizing this window of opportunity to transition towards electric mobility, aligning with international climate commitments, and fostering economic growth in the process.

Figure 12. Multi-level Perspective from ICE regime to an Electromobility regime



Source: Adapted from Geels (2004).

Discussion and Conclusion

The exploration of Mexico's transition to EVs through both political and multi-level perspectives uncovers distinct strengths and weaknesses. The political analysis shines in dissecting barriers to reform and potential solutions, illustrating the intricate dynamics of policymaking influenced by entrenched industries. Yet, it somewhat neglects the urgency of reforming policies like fossil fuel subsidies, crucial for environmental progress.

Conversely, the multi-level perspective excels at revealing the detrimental effects of deeply rooted systems, offering a broader view of technological shifts. However, it can sometimes overlook the nuanced roles and strategies of political actors in influencing these changes.

Integrating these perspectives results in a more nuanced and comprehensive understanding of Mexico's journey towards EV adoption. It emphasizes the importance of aligning policy decisions with technological and market evolutions to ensure an effective transition to EVs.

This combined approach not only offers systemic insights but also highlights the importance of political will and strategy in driving change. Despite facing challenges like consumer misconceptions, policy gaps, and resistance from traditional industry players, there are emerging opportunities for transformative change driven by global sustainability trends, evolving consumer preferences, and technological innovations.

In conclusion, Mexico's transition to electric mobility is at a pivotal moment where political, technological, and market forces must converge going forward to the general elections in 2024 and be catapulted through the next decade. Addressing systemic barriers through integrated policies, enhancing public awareness, and encouraging industry innovation are critical. This paper's dual perspective approach reveals that understanding the interplay between political dynamics and socio-technical regimes is key to navigating towards a sustainable, electrified transportation future in Mexico, particularly as the country approaches the 2024 federal election. This election could represent a strategic window of opportunity, particularly with potential leadership changes, to accelerate the transition and align Mexico's automotive sector with global electrification trends.

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Appendix:

Note on Figure 5: This figure presents a compelling comparison of the energy savings achieved by operating a 2023 JAC EJ7 electric vehicle (EV), with a 50.1 kWh battery operating at 85% efficiency, as opposed to a 2023 Nissan Versa, a conventional Internal Combustion Engine (ICE) vehicle. The analysis is grounded on the assumption that both vehicles cover a distance of 7,500 kilometers, aligning with the average distance traveled as reported by CFE (2023). The fuel efficiency of the Nissan Versa is gauged at 17.3 kilometers per liter, in accordance with the standards set by CONUEE (2023). The calculation of tariffs for this comparison is meticulously based on the basic supply rate calculation memories as delineated by CRE. Concurrently, the assessment of gasoline prices draws on the monthly averages published by CRE (2023b), ensuring an accurate and current reflection of the cost dynamics.