

Article

Public Policy and Legal Governance of Electric and Hybrid Vehicle Commercialization in Colombia: Energy Transition Challenges Towards a Competitive and Sustainable Market

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Abstract

The commercialization of electric and hybrid vehicles in Colombia is a strategic component of the national energy-transition agenda and of the country's climate-governance commitments. However, despite relevant regulatory progress, market deployment remains territorially uneven and institutionally fragmented. The article describes how regulation affects the market for electric and hybrid cars, considering regulatory consistency, inter-institutional cooperation, market obstacles, and the rollout of the energy transition. Based on doctrinal legal analysis, comparative public-policy evaluation, and contextual examination of official vehicle-registration information, the study employs a qualitative and comparative research design. The analysis reviews Colombian legal instruments, policy strategies, and governance arrangements related to electric mobility and compares them with selected experiences in Chile and Mexico. The findings show Colombia has developed tariff reductions, tax benefits, circulation privileges, charging-infrastructure obligations, interoperability rules, and strategic planning instruments. Commercialization faces structural barriers: fragmented regulation, uneven territorial implementation, insufficient charging infrastructure, weak public-private coordination, limited consumer awareness, and a lack of long-term governance for battery replacement and industrial adaptation. The results also show that hybrid electric vehicles dominate national registrations, while battery electric and plug-in hybrid vehicles remain comparatively limited. This distinction shows that Colombia's current transition is still more strongly associated with hybridization than with full electrification. The article concludes that Colombia requires a more coherent governance architecture capable of integrating regulatory stability, territorial coordination, infrastructure deployment, market facilitation, and long-term energy-transition planning.

Keywords: public policy; legal governance; energy transition; electric mobility; hybrid vehicles; commercialization; regulatory barriers; Colombia

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1. Introduction

Public policy now prioritizes sustainable transportation schemes and technologies. This shift is a direct response to climate change, urban air pollution, energy security concerns, and the need to reduce dependence on fossil fuels [1]. Within this agenda, electric and hybrid vehicles have gained relevance as instruments for transport decarbonization and as components of broader energy-transition strategies [2]. However, their deployment does not depend solely on technological innovation or consumer preferences [3]. Public policy, legal design, and institutional governance shape the incentives, infrastructure conditions, and market expectations that determine whether these technologies can move from early adoption to sustained commercialization [4,5].

In Latin America, the promotion of electric and hybrid vehicles has followed an uneven path [6]. Several countries have adopted tax incentives, import benefits, technical standards, infrastructure programs, and strategic plans to promote cleaner mobility. Legal coherence, institutional coordination, and practical implementation differ. Sometimes, clearer regulatory frameworks and stable policy signals have sped up deployment. In others, fragmented governance, weak coordination among public authorities, and persistent infrastructure gaps have limited market consolidation [7]. This variation is analytically relevant to Colombia. Although the country has adopted important legal instruments, structural and regulatory barriers continue to constrain commercialization [8].

Colombia has incorporated low- and zero-emission mobility into its climate-mitigation commitments, sustainable-development agenda, and energy-transition policies [9]. Cleaner vehicle technologies support objectives related to affordable and clean energy, sustainable cities, innovation, and climate action [10]. The transport sector requires technological upgrades and legal frameworks to manage environmental goals, energy strategies, industrial changes, infrastructure development, and market expansion [11].

Under Colombian law, zero-emission vehicles are those powered by technologies that do not generate direct greenhouse-gas emissions from the exhaust system, including battery electric vehicles [12]. Low-emission vehicles include technologies that produce lower levels of CO₂-equivalent emissions, such as certain natural-gas vehicles and diesel vehicles complying with the Euro VI standard [13]. This legal distinction is important because different vehicle technologies contribute differently to the energy transition and decarbonization based on ODS goals [10].

From a market and technology perspective, the low- and zero-emission vehicle segment includes several categories with different operational and policy implications [14]:

- Plug-in hybrid electric vehicles (PHEVs) combine an internal-combustion engine with electric motors and rechargeable batteries that can be connected to the electricity grid.
- Extended-range electric vehicles operate primarily with an electric motor and battery, while an internal-combustion engine acts as a generator when additional energy is needed.
- Hybrid electric vehicles (HEVs) are non-plug-in hybrids that rely mainly on an internal-combustion engine supported by a battery charged through regenerative braking. Because they do not depend on external charging infrastructure, their policy implications differ from those of BEVs and PHEVs.
- Mild hybrid electric vehicles integrate an internal-combustion engine with an auxiliary low-voltage electrical system that supports efficiency but cannot propel the vehicle in fully electric mode.

These distinctions are essential for evaluating Colombian electric-mobility policy. People should not interpret growth in HEV registrations as equivalent to full electrification, as HEVs do not require charging infrastructure and continue to depend primarily on combustion technology [15]. BEVs and PHEVs require electricity-system integration,

charging networks, technical standards, and long-term infrastructure planning. A governance analysis must separate hybridization from full electric mobility [16].

This technological divergence fundamentally alters the commercialization dynamics and market expansion pathways within emerging automotive economies. From a market dynamics perspective, the rapid growth of non-plug-in hybrid electric vehicles (HEVs) reflects a transitional consumer preference driven by immediate operational convenience, lower upfront transaction costs, and complete independence from public refueling networks. However, this commercialization pattern presents a distinct market challenge: it risks creating a false sense of transition progress, potentially obscuring stagnation in full-battery electric vehicle (BEV) segments. Competitive market challenges are further exacerbated by the acute asymmetry between urban retail centers and peripheral regions, where charging infrastructure deployment remains nonexistent. Consequently, a comprehensive legal and public policy framework must systematically address these commercialization bottlenecks by establishing clear multi-level regulatory signals that incentivize private infrastructure investments and stabilize long-term market expectations, moving beyond short-term import tariff relief.

Colombia has promoted electric and hybrid vehicle adoption through tariff reductions, differentiated taxes, circulation privileges, charging-infrastructure obligations, and strategic mobility plans [8]. These measures have increased market visibility and created formal incentives for cleaner technologies. However, regulatory progress has not eliminated the major barriers affecting commercialization.

Challenges include insufficient charging infrastructure, uneven implementation, limited support, poor coordination, fragmented policies, low consumer awareness, and no long-term market expansion framework. These barriers show a tension between formal regulatory advances and the practical governance conditions needed to merge electric mobility.

The energy-transition agenda aligns with Colombia's measures, yet implementation has been inconsistent. Market expansion depends not only on vehicle availability but also on charging infrastructure, public information, fiscal stability, public-private coordination, and consumer confidence. More affordable models have entered the market, but they have not fully displaced the functional, economic, and cultural advantages associated with conventional vehicles.

These limitations reveal the need to move beyond descriptive accounts of electric mobility and toward a systematic analysis of public policy and legal governance. Much of the existing literature focuses on technological performance, environmental benefits, consumer behavior, or infrastructure needs. Although relevant, these approaches often treat regulation as a secondary variable and rarely evaluate legal coherence, institutional responsibilities, implementation capacity, or governance implications in emerging markets.

The research gap addressed by this article lies in the limited understanding of how public-policy design and legal governance condition the commercialization of electric and hybrid vehicles in Colombia. A governance perspective can help us understand why incentives and legal tools do not automatically create lasting market consolidation. It also explains why similar policy goals can lead to varied results in different Latin American countries.

This article examines how public policy and legal governance affect the commercialization of electric and hybrid vehicles in Colombia, with particular attention to the energy-transition agenda. It also identifies comparative governance lessons from Chile and Mexico that may inform policy improvement in Colombia.

The study argues that technological availability or market demand cannot explain the commercialization of electric and hybrid vehicles in Colombia alone. The alignment conditioned it between public-policy objectives, legal-regulatory instruments, institu-

tional coordination, and territorial implementation. Colombia has adopted relevant incentives and incorporated electric mobility into its sustainability agenda, but regulatory fragmentation, implementation asymmetries, and unresolved governance issues continue to limit market consolidation.

The article combines a review of the Colombian legal and regulatory framework with a comparative examination of policy experiences in Chile and Mexico. Official registration data are used to contextualize legal analysis and to distinguish between HEV growth and the adoption of BEVs and PHEVs. This approach connects regulatory analysis with commercialization trends while maintaining a clear focus on governance and public-policy implementation.

The relevance of this discussion extends beyond the Colombian case. As countries commit to decarbonization and sustainable transport, electric mobility increasingly depends on stable, coherent, and implementable governance frameworks. By focusing on regulatory barriers and policy lessons, this article contributes to debates on how law and public policy can enable a cleaner and more competitive transport transition.

The document is organized into five parts. The first examines the relationship between public policy, legal governance, commercialization, and electric mobility. The second analyzes the Colombian legal and policy framework. The third identifies regulatory and market barriers affecting commercialization. The fourth presents comparative policy references from Chile and Mexico. Finally, the discussion and conclusions assess implications for strengthening Colombian electric-mobility governance.

2. Methods

This study adopts a qualitative and comparative research design grounded in legal-governance analysis and public-policy evaluation. The methodology was structured to examine how legal instruments, policy strategies, and institutional arrangements influence the commercialization of electric and hybrid vehicles in Colombia. The research combined three complementary phases: doctrinal legal analysis, comparative policy analysis, and contextual market assessment, as shown in Figure 1.

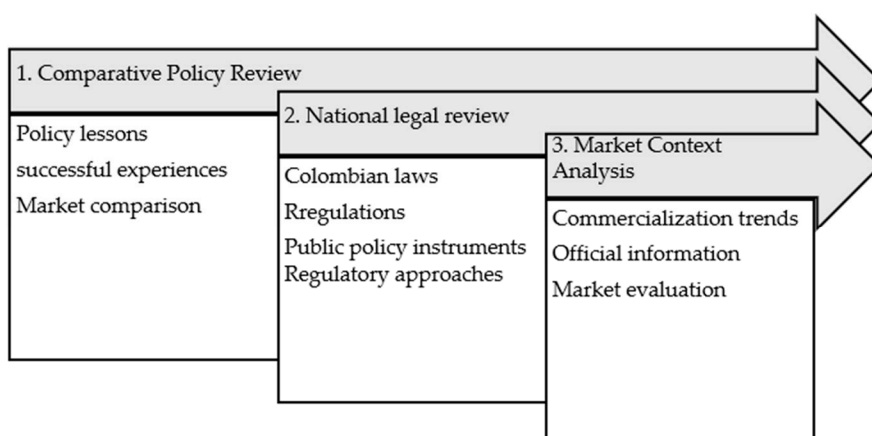


Figure 1. Three-phase methodological design integrating doctrinal legal review, comparative policy review, and market context analysis.

First, the study conducted a comparative policy review to identify regional lessons relevant to electric-mobility governance. The study selected Chile and Mexico as they represent two significant Latin American experiences with different but complementary approaches. The selection of Chile considered its long-term strategy, public-transport electrification, battery end-of-life considerations, technical training, and digital infrastructure support. Mexico was selected for its technical standardization, fiscal incentives, national

strategy alignment, and broader market-oriented deployment. The comparison examined policy objectives, legal instruments, implementation mechanisms, institutional coordination, infrastructure measures, and market facilitation tools.

Second, a doctrinal analysis of the Colombian legal and regulatory framework was conducted. The review included laws, decrees, resolutions, national strategies, and institutional policy documents related to the commercialization of electric and hybrid vehicles between 2010 and 2025. Documents were selected according to four criteria: direct relevance to electric or hybrid vehicle commercialization; relationship with fiscal incentives, charging infrastructure, technical standards, or market regulation; institutional significance for transport or energy-transition governance; and implementation relevance for territorial deployment. The analysis evaluated policy coherence through four dimensions: regulatory continuity, institutional coordination, infrastructure integration, and market-facilitation capacity.

Third, the study incorporated a contextual assessment of official vehicle registration information to relate legal and policy instruments to observable commercialization trends. Data from the National Transit Registry and ANDEMOS were used to identify the evolution of BEVs, PHEVs, and HEVs in Colombia. This component does not function as a causal econometric analysis; the analysis differentiates HEVs from BEVs and PHEVs because HEVs do not require charging infrastructure and do not represent the same decarbonization pathway as fully electric or externally rechargeable vehicles.

The qualitative and comparative research design was specifically optimized to counter common methodological biases in public-policy assessments by isolating formal legal outputs from practical implementation outcomes. The doctrinal legal analysis utilized a rigid evaluation matrix where each regulatory piece (from 2010 to 2025) was codified across four strict dimensions: regulatory continuity, cross-institutional coordination, infrastructure integration capacity, and direct market-facilitation capability. To ensure comparative rigor, Chile and Mexico were selected not merely as regional peers, but because they represent two distinct, mature governance paradigms in Latin America: an ecosystemic, public-transport-driven model (Chile) and a highly standardized, market-driven fiscal model (Mexico). This structural contrast provides a highly reliable analytical benchmark against which the operational bottlenecks, regional asymmetries, and legislative fragments of the Colombian transition can be systemically evaluated and mapped.

3. Comparative Policy Review in Electric Mobility

This section presents an analysis of positive experiences and barriers identified in previous studies that assess contributions to promoting electric mobility worldwide. The analysis shows practical benefits, policy contributions, and governance conditions that helped integrate electric and hybrid vehicles into national transport systems, going beyond just legal adoption. It also examines existing barriers that require attention, as reported in the literature. The section includes a policy review focused on Mexico and Chile, identifying their contributions to improving electric mobility and the dynamics they are assuming in integrating electric vehicles.

3.1. Barriers and Drivers

The literature on electric mobility shows that public policy as a driver has played a decisive role in accelerating the adoption of electric vehicles across different national contexts. Evidence consistently shows that market expansion links to coordinated policy instruments, including fiscal incentives, regulatory mandates, infrastructure programs, and institutional strategies, aiming to reduce adoption barriers [17]. In this sense, public policy design and legal-institutional support shape the transition toward electric mobility, rather than it being a purely technological or commercial process.

Recent studies also suggest that successful electric mobility experiences emerge where policy frameworks move beyond isolated incentives and instead combine multiple instruments in a coherent and sustained manner [18]. These contributions highlight the importance of policy mixes, stakeholder coordination, infrastructure deployment, and long-term regulatory signals in creating favorable market conditions. These international experiences offer valuable evidence. They show how public intervention influences commercialization, strengthens market confidence, and supports transport decarbonization and energy transition objectives [19].

Table 1 summarizes selected studies that report positive experiences in electric vehicle deployment. It provides a structured basis for identifying recent international lessons and understanding how different drivers have supported electric mobility across diverse regulatory and market environments.

Table 1. Drivers that promote electric vehicles in several countries.

Year	Reference	Country	Drivers Application
2026	[20]	India	The financial incentives and transport electrification policies can reduce adoption barriers and generate environmental and socioeconomic benefits in the electric bus segment.
2026	[21]	China	Subsidies and policy-induced transition programs have supported the deployment of electric heavy-duty trucks and contributed to urban emissions reduction, particularly where charging infrastructure is more developed.
2025	[18]	Indonesia	The combination of policy incentives, public awareness strategies, and green mobility positioning can accelerate electric vehicle adoption in developing-country contexts.
2025	[22]	Italy	The role of European regulatory targets and infrastructure-oriented policies in supporting the territorial deployment of charging stations is essential for sustained electric vehicle market growth.
2024	[23]	China	Policy mixes have been central to consolidating the electric vehicle market in China, showing that coordinated combinations of incentives can significantly strengthen adoption dynamics.
2022	[24]	United Kingdom	Financial incentives positively influence the adoption of electric fleets, and their effectiveness is enhanced when aligned with broader economic conditions.
2018	[25]	Austria	Incentive schemes and favorable regional conditions improve the likelihood of electric vehicle adoption, especially when policy instruments are tailored to user profiles.
2018	[26]	Iceland	Fiscal incentives can accelerate the transition to electric vehicles, reducing fossil fuel dependence and promoting economic and environmental benefits.
2017	[27]	China	A structured public policy incentive can improve consumer acceptance of electric vehicles, sustaining market growth
2016	[17]	United States	A fast effect integrates planning, incentives, public outreach, and multi-level institutional collaboration.
2015	[19]	United States	Technology-forcing regulations, such as California's Zero-emission Vehicle, can stimulate innovation and encourage industrial responses in the electric vehicle sector.
2013	[28]	United States	Federal incentives increased hybrid vehicle sales, demonstrating that policy design and incentive magnitude are critical for influencing vehicle adoption.

However, persistent structural and regulatory barriers can restrict electric mobility deployment. Barriers, as shown in Table 2, encompass insufficient charging infrastructure [29], fragmented regulations [30], poor institution coordination, limited market readiness [31], technological uncertainty [32], and uneven territorial implementation. These prob-

lems go beyond the higher cost of vehicles. In many developing economies, reliance on imported technology, limited fiscal support, consumer reluctance, and the lack of integrated public policies are holding back progress. This is further complicated by the absence of clear roadmaps for infrastructure, incentives, and governance. From a comparative perspective, these studies provide valuable evidence on how barriers in law, policy, and implementation continue to shape commercialization trends and limit the broader expansion of electric mobility.

Table 2. Barriers identified in the literature regarding electric vehicle promotion.

Year	Reference	Country	Barrier Identification
2026	[31]	Zambia	Infrastructure limitations, low institutional readiness, financing constraints, and weak coordination among stakeholders hinder battery-swapping deployment and broader electric vehicle adoption.
2025	[29]	Indonesia	High initial investment costs, limited charging infrastructure, regulatory barriers, and climate-related risks such as flooding and extreme weather constrain EV implementation.
2025	[30]	Italy	Regulatory uncertainty, grid integration challenges, and limited consumer readiness restrict the effective scaling of vehicle-to-grid systems.
2025	[33]	Switzerland and European Union Countries	A fragmented policy design linked with insufficient flexibility measures, and the need for stronger coordination between electrification and power systems are key barriers.
2024	[32]	United States	The absence of standardization, barriers to approval regulations, and market uncertainty slow the introduction of electric mobility.
2020	[34]	Estonia, Latvia, and Lithuania	Weak policy consistency, financing limitations, and governance challenges affect the energy transition integration.
2017	[35]	Germany	The persistence of legal and regulatory barriers affects the successful inclusion and deployment of electrical mobility.
2017	[16]	European Union Countries	Technical and regulatory barriers limit proactive EV integration into distribution grids, particularly in relation to market design, interoperability, and grid management.

3.2. Latin America Policy Comparison: Chile and Mexico

3.2.1. Progress of Electric Mobility in Chile

Chile has shown significant progress in the development of public policies, regulatory instruments, and implementation measures aimed at promoting electric mobility and expanding charging infrastructure. This process falls within broader national commitments to reduce emissions and achieve carbon neutrality. As part of its goals to cut national emissions by 30% by 2030 and reach carbon neutrality by 2050, Chile launched its initial Electromobility Strategy [36].

A major milestone was reached in 2022 with the publication of the New Electromobility Strategy, which established more specific targets for the transport sector. Among its main goals, Chile set that by 2035, one hundred percent of sales of light- and medium-duty vehicles should be zero-emission, one hundred percent of public transport sales, including buses, taxis, and collective transport vehicles, should also be zero-emission, and one hundred percent of sales of high-capacity mobile machinery should move toward zero-emission technologies. These targets reflect a more structured public policy roadmap and provide clearer long-term market signals for the expansion of electric mobility [37].

Chile is prioritizing public transport to meet its goals. Electrification here is more impactful socially and economically because of extensive fleet usage. In 2021, the country

launched the Mi Taxi Eléctrico program, which provides direct support for taxi owners to replace conventional vehicles with electric ones [38]. Also, online monitoring of an electric taxi becomes economically viable, even without subsidy support, when annual mileage exceeds approximately 35,000 km [39]. Chile has also promoted the Electrologistic initiative, a public–private program designed to encourage the use of electric vans and trucks in urban logistics. These actions show Chile has prioritized strategic transport segments in which public policy can speed up adoption and show concrete operational benefits.

Another important feature of the Chilean case is the incorporation of environmental and end-of-life considerations into electric mobility policy. Chile has adopted an extended producer responsibility framework that regulates the final disposal of batteries and seeks to avoid negative environmental effects once their vehicular life cycle ends. According to the document, batteries typically last eight to ten years in vehicles. Subsequently, people can use them in stationary roles for an additional ten to fifteen years before recycling begins. This reflects a broader policy vision. It links electric mobility not just to vehicle commercialization, but also to sustainability, waste management, and long-term environmental governance.

Chile has also recognized that the expansion of electric mobility requires technological and labor adaptation. Since 2021, the country has worked on higher technical education profiles related to the maintenance and installation of charging infrastructure for electric vehicles. In parallel, universities have supported this transition by incorporating electric mobility topics into academic programs and research activities related to electric mobility, power electronics, renewable generation, and electric systems control. This educational dimension strengthens the human capital required for long-term implementation and policy sustainability [40].

Charging infrastructure has also become a central pillar of Chilean progress. By August 2021, Chile had 818 installed chargers totaling 45.7 MW [41], and added 10.6 MW for public uses in 2024 [42], which involves a dynamic promotion of national policy to the successful deployment of the technology. This figure encompasses public and private chargers, electro-terminals, and charging centers for public transport. Chile also created the EcoCarga app. It shows users where public charging stations are, along with details like charging time, power, connector type, availability, and cost. The document further notes that Chile currently has 878 charging points registered on its electromobility platform. These measures illustrate a more advanced market facilitation framework in which digital information tools and user accessibility complement infrastructure deployment.

Overall, the Chilean experience shows that electric mobility progress depends on the articulation of long-term goals, public transport incentives, environmental regulations, charging infrastructure deployment, technical training, and digital support mechanisms [43]. Rather than relying on isolated incentives, Chile has advanced through a more integrated public policy approach that combines regulatory direction, institutional coordination, and practical implementation tools.

3.2.2. Progress of Electric Mobility in Mexico

Mexico advances electric mobility by defining strategic goals, technical rules, and financial incentives for electric and hybrid vehicles. These efforts align with its Paris Agreement commitments, including emission reductions of 35% in greenhouse gases and 51% in black carbon. Mexico seeks 50% zero-emission vehicle sales by 2030 and full electric and plug-in hybrid sales in light and heavy passenger vehicles by 2040 [44].

To further ground these Latin American targets in the contemporary global landscape, the recent literature emphasizes that transport decarbonization transitions are highly non-linear and heavily contingent upon temporal policy continuity and integrated multi-level governance [21]. While early adoption in developing markets typically relies

on localized fiscal relief or basic tariff exemptions, institutional scaling requires moving away from fragmented regulatory silos and toward cohesive, infrastructure-backed policy mixes [33]. Emerging empirical evidence from transitional economies underlines that without standardized technical parameters and binding public–private execution structures, formal statutory goals fail to translate into sustained regional commercialization [20]. Therefore, the contextualization of the Colombian framework requires assessing not just formal legislative decrees, but the precise structural and execution friction points that differentiate nominal hybridization from deep infrastructure-integrated electrification [31].

The Mexican case highlights a more structured technical and regulatory framework for electric mobility [45]. Its regulation promotes standards through a normalization committee focused on electric and hybrid road vehicles. These standards cover vehicles powered fully or partially by electricity from autonomous energy sources, including charging infrastructure. This technical-regulatory approach strengthens interoperability, charging systems, safety requirements, and equipment specifications, supporting more formal market development [46].

Mexico has also adopted broad fiscal incentives to support electric mobility, including tax exemptions, income tax deductions for green-vehicle investments, and benefits for renewable-energy equipment [46]. These measures also cover charging-station investments, electric bicycles, and electric motorcycles. Some states grant a five-year exemption from annual vehicle ownership taxes, followed by a 50% discount. The Federal Electric Commission also installs home charging meters for free. In some metropolitan areas, electric and hybrid vehicles receive exemptions from vehicle-verification requirements and circulation restrictions, including the program named Hoy No Circula. These incentives show Mexico has incorporated electric mobility into a broader fiscal and administrative support structure.

In 2023, Mexico established the National Electric Mobility Strategy, an important institutional milestone. The document outlines a strategy to build the foundational elements for electric mobility (environmental, technical, financial, legal, and institutional). This will position it nationally as a viable, sustainable choice to lower greenhouse gas emissions and local air pollutants. Also, broader national initiatives align with the strategy, including multisectoral policies for mobility, energy, industrial development, infrastructure adaptation, and supply-chain strengthening. This policy integration reinforces the idea that the Mexican approach seeks to connect electric mobility not only with environmental goals but also with industrial and territorial development.

The market results reported in the document also suggest an important level of progress. Since 2016, Mexico has sold 273,153 zero- and low-emission vehicles, distributed among battery electric vehicles, plug-in hybrid electric vehicles, and hybrid vehicles [47]. Of this total, hybrid vehicles account for the largest share, followed by electric and plug-in hybrid vehicles. These show a positive market response to policies and incentives. Still, the prevalence of conventional hybrid vehicles suggests a gradual transition to fully electric mobility.

To charge infrastructure, Mexico had reached 1274 charging stations by October 2023, mainly concentrated in Mexico City, Jalisco, and Nuevo León. A new 1 MW charging station has opened in San Lorenzo Almecatla, Puebla, a joint venture by QiOn and XC Power, representing a major technological stride [48]. This infrastructure allows output capacities ranging from 240 kW to 1000 kW and charging times between 7 and 25 min, depending on the battery type. This development is important as it addresses a key concern for EV buyers: charging time. It shows how infrastructure policy and technological advances can boost market confidence and usability.

Overall, strategic planning, technical regulations, fiscal incentives, and infrastructure deployment have supported the progress of electric mobility in Mexico. Unlike approaches based solely on environmental discourse, Mexico has integrated electric mobility into a broader framework that includes standardization, industrial readiness, charging expansion, and financial support mechanisms.

3.2.3. Comparative Market

From a comparative public-policy perspective, Chile and Mexico follow complementary pathways in promoting electric-mobility markets as shown in **Table 3**. Chile prioritizes long-term governance, public-transport electrification, charging infrastructure, battery end-of-life management, and human-capital development. Mexico emphasizes technical standardization, fiscal incentives, national strategy alignment, and large-scale infrastructure deployment. These experiences show that successful electric-mobility deployment depends on coherent policy ecosystems rather than isolated incentives. They also provide lessons for Colombia regarding policy stability, public-private coordination, financing mechanisms for infrastructure, digital information tools, and the need to align market incentives with energy-transition objectives.

Table 3. Comparison of electric vehicle markets in Chile and Mexico.

Comparative Policy Topic	Chile	Mexico
Climate and transition targets	Linked electric mobility to the goal of reducing national emissions by 30% by 2030 and achieving carbon neutrality by 2050 [41].	Linked electric mobility to the Paris Agreement commitments, including a 35% reduction in greenhouse gas emissions and a 51% reduction in black carbon emissions [49].
National strategy	In 2022, the country adopted its first Electromobility Strategy and later a New Electromobility Strategy [41].	Established the National Electric Mobility Strategy (ENME) in 2023 through SEMARNAT [50].
Market goals	Policies seek to reach by 2035 that 100% sales of light- and medium-duty vehicles, public transport vehicles, and large mobile machinery should be zero-emission [41].	By 2030, 50% of light- and heavy-duty vehicle sales should be zero-emission, and by 2040, 100% of passenger light- and heavy-duty vehicle sales should be electric or plug-in hybrid [50].
Main market focus	Strong emphasis on public transport electrification, particularly taxis, buses, and urban logistics [41].	Broader market development combining private vehicles, fiscal incentives, technical regulation, and national deployment [45,51].
Flagship public policy programs	Includes Mi Taxi Eléctrico and Electrologística, aimed at taxis and electric logistics fleets [52].	Includes fiscal support schemes, national strategy alignment, and technical-regulatory instruments under ANCE and CONANCE [50].
Regulatory approach	Combines market targets, transport electrification, battery end-of-life regulation, labor adaptation, and infrastructure expansion [41].	Stronger emphasis on technical standardization, vehicle and charger regulation, and multisectoral policy alignment [53].
Battery end-of-life policy	Chile has an extended producer responsibility law regulating final battery disposal and promoting second-life and recycling pathways [54].	The country has made partial advances in charge infrastructure and policies towards the circular economy to dispose of batteries [55].

Human capital and training	Higher education institutions actively support electromobility through technical training, academic programs, and thesis development [56].	The institutional and strategic alignment works on strategies to promote training and outcomes development [45,57].
Charging infrastructure	Chile reached 818 chargers and 45.7 MW installed by August 2021 and later reported 878 charging points and 1918 EV charging stations [58].	Reached 1274 charging stations by October 2023, mainly concentrated in Mexico City, Jalisco, and Nuevo León [55].
Digital user support	Developed the EcoCarga app, which provides charger location, connector type, charging power, compatibility, availability, distance, and price [58].	There is no clear emphasis on infrastructure expansion and fast-changing technology. However, learning from the experiences of other countries, Mexico has the potential to increase the growth of EV infrastructure [55].
Fast-charging development	The document emphasizes infrastructure coverage and public access information more than ultra-fast charging milestones [59].	Reported a 1 MW charging station in several regions, with charging times between 7 and 25 min depending on battery type [55].
Market scale	The document emphasizes strategic progress, infrastructure, and policy depth, but does not provide an aggregate vehicle sales figure [60].	By the end of 2025, Mexico had sold 146,724 hybrid and electric vehicles during the year, including 112,117 HEVs, 20,923 BEVs, and 13,684 PHEVs. Cumulatively, sales of hybrid and electric vehicles reached 530,231 units between 2016 and 2025 [47,61].
Dominant market pattern	Public policy is oriented toward building an integrated ecosystem for long-term zero-emission mobility [40,62].	Market growth has been substantial, but hybrid vehicles still dominate the sales mix, suggesting a gradual transition toward full electrification [47,61].

4. The Case of Colombia: Support for an Equitable Energy Transition

Colombia has promoted electric vehicles through legal, fiscal, and regulatory actions as part of its energy-transition and sustainable-transport objectives. Over time, the national framework moved from tariff-based import quotas toward a more structured policy architecture that includes tax incentives, circulation benefits, infrastructure provisions, interoperability rules, and strategic planning tools. These measures reflect growing institutional recognition that cleaner transport technologies contribute not only to the reduction in emissions but also to urban air quality, energy diversification, market modernization, and international climate commitments.

Colombian policy developed in two broad stages. The first, from 2010 to 2018 (Table 4), relied primarily on import quotas, tariff reductions, and selective tax benefits. During this period, several decrees sought to simplify the importation of electric and hybrid vehicles and charging systems by reducing or eliminating import duties. Law 1819 of 2016 reinforced these measures by establishing a differentiated VAT rate for electric, hybrid, and plug-in hybrid vehicles. However, this stage did not produce the expected market results because of limited policy continuity, administrative constraints, and underuse of import quotas.

Table 4. Advances in Colombian regulations between 2010 and 2018.

Year	Regulatory	Main Objective
2010	Decree 2439	Approved an import quota of 100 electric or hybrid vehicles with a 0% import tariff until December 31, 2010, for passenger, family, and goods transport vehicles [63].
2011	Decree 2658	Authorized an import quota of 161 electric and hybrid vehicles, including unused units from 2010, also with a 0% import tariff [64].
2011	Decree 4931	Extended the import quota of 161 electric and hybrid vehicles with a 0% tariff until December 31, 2012 [65].
2013	Decree 2909	Established, for three calendar years, an annual import quota with 0% tariff for 750 electric vehicles, 5% tariff for 750 plug-in hybrid vehicles, and 0% tariff for fast-charging stations and home-charging systems [66].
2016	Law 1819	Introduction of a differential VAT rate of 5% for electric, hybrid, and plug-in hybrid vehicles in various transport categories [67].
2017	Decree 1116	Reduced the import tariff to 0% for electric vehicles and 5% for hybrid vehicles until 2027, with annual import quotas and 0% tariff for charging systems [68].
2017	Law 1844	Approved the Paris Agreement, under which Colombia committed to reducing greenhouse gas emissions by 51% by 2030 [69].
2017	Resolution 1988	Established an energy-saving target of 5.49% by 2022 in the transport sector, promoting electricity use in public fleets, taxis, motorcycles, passenger vehicles, and public transport [70].

The second stage began in 2019 with a more comprehensive effort to incorporate electric mobility into national energy-transition governance (Table 5). Law 1964 of 2019 introduced major incentives for electric vehicles, including caps on vehicle tax, discounts on mandatory insurance, exemptions from circulation restrictions, preferential parking provisions, municipal charging-infrastructure obligations, and targets for public-sector and mass-transit fleets. The National Electric Mobility Strategy established a target of 600,000 electric vehicles by 2030 and promoted regulatory, technical, market, and infrastructure mechanisms to accelerate deployment. Subsequent measures addressed charging-service regulation, connector standards, technical-inspection discounts, public-charging interoperability, and energy-efficiency objectives through PROURE and the National Sustainable Transport Strategy.

Table 5. Advances in Colombian regulations between 2019 and 2025.

Year	Regulatory Measure	Main Objective
2019	Decree 2051	It eliminated import quotas for electric vehicles and established a permanent 0% import tariff [71].

2019	Law 1964	The law promotes the use of electric vehicles. It established key incentives for electric vehicles, including a vehicle tax cap, a 10% discount on mandatory insurance, exemption from circulation restrictions, preferential parking requirements, and obligations for municipalities to promote charging infrastructure and public fleet electrification [12]. Otherwise, in [72] is analyzed the law points out that, despite regulatory advances, challenges related to coordination, pricing, and charging infrastructure persist.
2019	National Electric Mobility Strategy	Defined actions to accelerate the transition to electric mobility, with a target of 600,000 electric vehicles by 2030, while promoting regulatory development, market mechanisms, technical guidelines, and charging infrastructure expansion [73].
2019	Resolution 5304	Established the vehicle modernization program for public and private freight vehicles over 10.5 tons, providing additional incentives when replacement vehicles are electric, hybrid, or natural gas-powered [74].
2020	Resolution 40405	Authorized service stations to provide electric charging services for electric and hybrid vehicles through the installation of charging points [75].
2021	Resolution 40223	Regulated minimum technical standards for charging service providers, including connector requirements, charging levels, and the free setting of charging service prices [76].
2021	Decree 1078	Removed the import quota for hybrid electric vehicles until December 31, 2021, maintaining a 5% tariff and preserving future quotas under previous regulations [77].
2021	Resolution 20213040039485	Established a 30% discount on technical and emissions inspection fees for electric vehicles [78].
2021	Decree 191	Introduced official identification through logos and color marking for preferential parking spaces for electric vehicles [79].
2022	Resolution 40156 (PROURE 2022–2030)	Set energy-efficiency and emissions-reduction targets for the transport sector, promoting electric-vehicle adoption, hybrid and plug-in hybrid fleet renewal, efficient driving devices, and electric rail transport [80].
2022	National Sustainable Transport Strategy	The regulation established policy guidelines to reduce greenhouse gas emissions, improve energy efficiency, modernize transport systems, and create enabling social and economic conditions for energy transition in transport [81].
2024	Resolution 40123	Established interoperability conditions for public charging stations for electric and plug-in hybrid vehicles and introduced platforms to provide technical and commercial information on charging points across the country [82].

5. National Electric Vehicle Context

5.1. Current Status of Electric Mobility in the Colombian Market

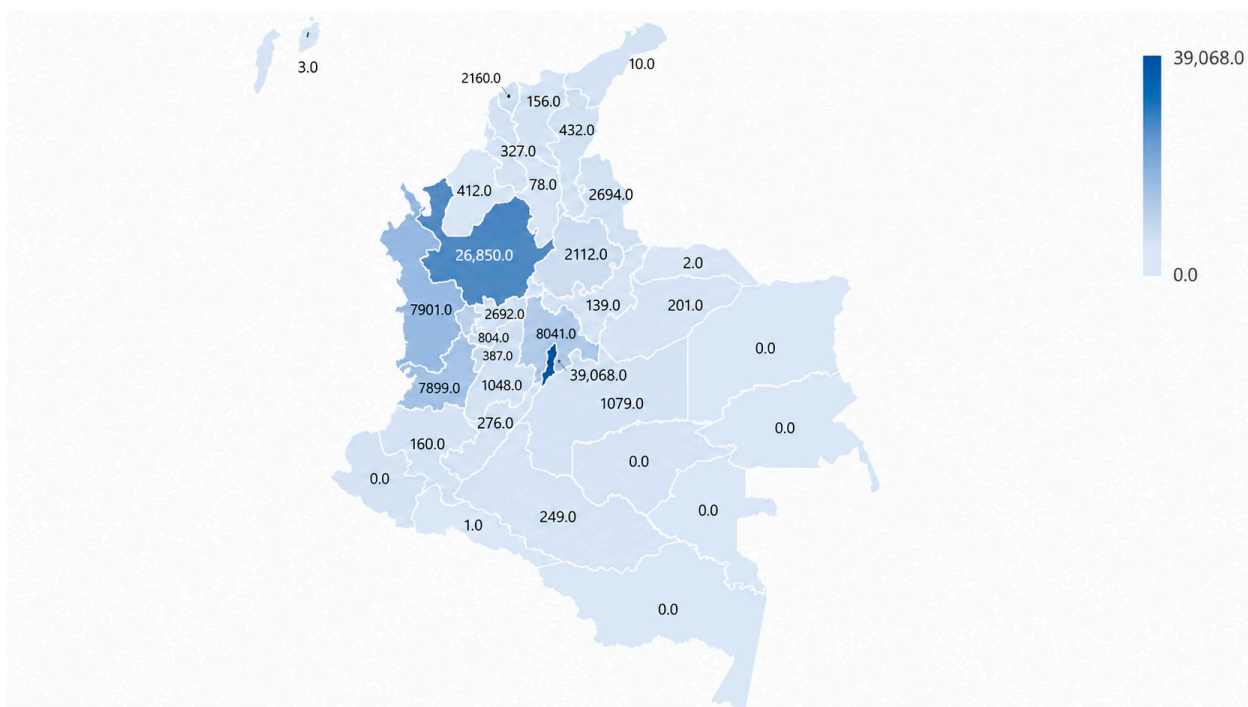
The evolution of the electric and hybrid vehicle market in Colombia from 2019 to 2025 is presented in Table 6. The data were obtained from the National Association for Sustainable Mobility (ANDEMOS), which compiles information reported by the National Transit Registry and provides records of vehicle registrations by technology type [83].

Table 6. Electric and hybrid vehicles registered in the national transit registry between 2019 and 2025.

Type of Vehicle	2019	2020	2021	2022	2023	2024	2025	Total
battery electric vehicle: BEV	923	1313	1332	3274	3703	9193	19,910	39,648
plug-in hybrid vehicles: PHEV	467	422	1276	1478	1795	2067	4867	12,372
hybrid electric vehicle: HEV	1744	4275	15,093	23,093	25,652	40,631	62,900	173,388
Total	3134	6010	17,701	27,845	31,150	51,891	87,677	225,408

Source: [83].

Table 6 shows that HEVs account for most registrations, followed by BEVs and, at a considerably lower level, PHEVs. This pattern reveals an important distinction for policy evaluation. The strongest market growth corresponds to non-plug-in hybridization rather than full electrification. HEVs may reduce fuel consumption and emissions relative to conventional vehicles, but they do not require charging infrastructure and do not generate the same electricity-system or infrastructure demands as BEVs and PHEVs. Therefore, Colombia's registration growth should be interpreted cautiously: it indicates progress in cleaner-vehicle adoption, but not necessarily equivalent progress toward a fully electric mobility system. The territorial distribution shown in Figure 2 also indicates concentration in Bogotá, Antioquia, Cundinamarca, and Valle del Cauca, confirming that deployment remains geographically uneven.

**Figure 2.** Distribution of registered vehicles in Colombia.

Regarding charging infrastructure, Article 9 of Law 1964 of 2019 established that, beginning in 2022, special-category municipalities, including Medellín, Cartagena de Indias, Bucaramanga, Barranquilla, and Cali, must guarantee at least five operational fast-charging stations. Bogotá, D.C., must guarantee at least twenty such stations.

The same law defined a fast-charging station as one with output power greater than 50 kW. Resolution 40223 of 2021 complemented this definition by specifying that Level 3, or fast charging, includes alternating-current connections above 22 kW or direct-current connections above 50 kW.

Colombia has strengthened the formal basis for charging infrastructure through legal obligations, technical standards, and digital information platforms. Resolution 40123 of 2024 introduced interoperability conditions for public charging stations and created the Cárgame platform as an official tool for identifying technical and commercial characteristics of charging points. However, infrastructure deployment remains uneven and insufficient for national-scale market confidence, especially outside major urban centers and for interurban travel.

5.2. Challenges Facing Electric Mobility in Colombia

Electric mobility is a key policy instrument for reducing greenhouse gas emissions, improving air quality, and decreasing dependence on fossil fuels. Despite more than thirteen years of regulatory initiatives, Colombia's electric-mobility market remains below the level required to achieve long-term energy-transition goals. By 2025, approximately 225,408 electric and hybrid vehicles had been registered, representing 37.5% of the 2030 national target. However, because most registrations correspond to HEVs, this figure overstates progress toward full electrification if BEVs and PHEVs are not examined separately.

The Colombian market continues to face structural barriers that hinder consolidation. One of the most consequential is limited public information and consumer awareness. Many potential users do not clearly understand the incentives available, the operating conditions of electric vehicles, charging options, or long-term maintenance requirements. This information gap affects purchase decisions, particularly in the private-vehicle segment, where consumers often continue to prefer conventional technologies because they perceive them as more reliable, familiar, and easier to service.

Other barriers are equally significant. The upfront purchase cost of electric and plug-in vehicles remains higher than that of conventional internal-combustion vehicles, largely because of battery costs. Public fast-charging infrastructure remains limited, especially for long-distance and interurban travel. These limitations reduce consumer confidence and constrain the commercial viability of BEVs and PHEVs [84].

Consumer confidence is also weakened by the shortage of specialized after-sales services, maintenance centers, trained personnel, spare parts, and standardized technical support. In addition, the absence of stronger policies to support domestic production and industrial adaptation limits the capacity of manufacturers, importers, and fleet operators to plan for a broader transition. These constraints are particularly relevant for public transport and freight, where technology standardization and infrastructure planning are essential.

5.3. Drivers Towards Electric Mobility in Colombia

Despite these barriers, several factors support the development of electric mobility in Colombia. Environmental policy and growing social awareness regarding greenhouse gas emissions have increased interest in cleaner transportation technologies. Public-sector commitments, urban air-quality concerns, and international climate obligations also provide legitimacy for expanding electric mobility.

Fuel-price dynamics have also encouraged users to consider electric alternatives, including electric motorcycles and urban vehicles. Charging an electric vehicle can reduce operating costs per kilometer compared with gasoline-powered vehicles, and electric drivetrains usually require less maintenance. These economic advantages may become

more important as fuel prices increase and as users become more familiar with the total cost of ownership rather than only the purchase price [85].

Public transport policy represents another relevant driver. Electrification of buses, taxis, and public fleets can generate high utilization rates, visible environmental benefits, and economies of scale for charging infrastructure. Fiscal benefits, such as reduced mandatory insurance costs, lower vehicle taxes, preferential parking, and circulation privileges, also improve the relative attractiveness of electric vehicles. Nevertheless, these drivers require stronger governance coordination to produce sustained market consolidation.

6. Discussion

Electric-mobility policies operate through several interrelated channels. They reduce structural adoption barriers through tax incentives, import benefits, preferential circulation rules, and charging infrastructure measures. They also support broader energy-transition objectives by reducing fossil-fuel dependence, improving air quality, and aligning transport policy with climate commitments. However, their effectiveness depends on the coherence of the legal framework and on the institutional capacity to implement policy instruments across territories.

A central contribution of electric-mobility governance is the creation of predictable market conditions. Stable legal incentives and consistent policy signals reduce uncertainty for consumers, investors, distributors, fleet operators, charging providers, and electricity-sector actors. In emerging markets such as Colombia, regulatory predictability is especially important because adoption depends not only on vehicle prices but also on confidence in infrastructure availability, technical support, and long-term public commitment.

The territorial dimension is equally important. Charging networks, technical services, and operational support remain concentrated in large urban areas, while many regions continue to lack the infrastructure required for reliable electric mobility. This uneven deployment shows that national legislation must be complemented by territorial implementation mechanisms, municipal capacity, and coordination between transport, energy, environmental, and planning authorities.

Comparative analysis shows that electric-mobility policy cannot be reduced to purchase incentives. Chile and Mexico demonstrate that successful deployment requires broader governance ecosystems. Chile combines long-term targets, public-transport electrification, charging infrastructure, battery end-of-life regulation, technical training, and digital information tools. Mexico emphasizes technical standardization, fiscal incentives, national strategy alignment, and large-scale infrastructure deployment. These experiences highlight policy design principles that are relevant for Colombia: long-term regulatory stability, institutional coordination, public-private collaboration, infrastructure financing mechanisms, technical standardization, and consumer-oriented information systems.

Within Latin America, Chile and Mexico offer useful reference points because they illustrate different but complementary policy pathways. Chile's model is more strongly oriented toward ecosystem development and public-transport transformation, whereas Mexico's model is more market-oriented and supported by technical regulation and fiscal incentives. For Colombia, these cases suggest that the next phase of policy should move from isolated incentives toward an integrated governance architecture.

For Colombia, the comparative review reveals both strengths and limitations. Colombia has adopted relevant incentives, legal mandates, and infrastructure standards. However, its implementation remains fragmented, and its market growth is strongly concentrated in HEVs. Therefore, policy evaluation should distinguish between hybridization and full electrification. Without this distinction, the apparent growth of the market may obscure the slower development of BEVs, PHEVs, and charging infrastructure.

Based on the experiences of Chile and Mexico, Colombia should strengthen its electric-mobility policy through measures that connect commercialization with energy-transition governance. These measures include a clearer national infrastructure roadmap, stable financing mechanisms, stronger public–private coordination, technical training programs, and digital platforms that provide reliable information about charging availability, costs, and compatibility.

First, public transport should receive greater policy priority. Buses, taxis, and high-utilization fleets generate stronger environmental and social benefits because their operating intensity is higher than that of private vehicles. Public-transport electrification can also create anchor demand for charging infrastructure and reduce uncertainty for investors.

Second, market readiness requires better technical and institutional support. Training programs for mechanics, emergency responders, charging-station operators, and public officials are necessary to reduce operational risks and improve user confidence. Public information campaigns should explain incentives, charging procedures, maintenance requirements, and the total cost of ownership.

Third, long-term market consolidation requires regulatory and institutional adjustments beyond short-term incentives. Priority areas include standardization of charging connectors and payment systems, interoperability rules, clear responsibilities among institutions, and mechanisms to coordinate national objectives with municipal implementation.

A vehicle energy-efficiency labeling policy, similar to those adopted in more mature regulatory environments, would also help consumers compare technologies based on energy use, emissions, and operating costs. Such information could reduce uncertainty and strengthen the commercial positioning of BEVs and PHEVs.

Colombia should also begin formulating a battery end-of-life governance policy for electric and hybrid vehicles. This policy should include second-life uses, recycling pathways, producer responsibility, traceability systems, and environmental safeguards. Without such a framework, the expansion of electric mobility may generate future environmental and regulatory risks.

The comparison presented in Table 7 shows that Colombia, Chile, and Mexico differ not only in the number of incentives adopted but also in the maturity of their governance arrangements. The Colombian framework contains important instruments, but it requires stronger integration between infrastructure deployment, territorial implementation, technical standardization, market information, and energy-transition planning.

Table 7. Comparison of Incentives and Policies.

Category	Policy and incentives	Country		
		Colombia	Chile	Mexico
Purchase incentives	Import duty	0% for electric vehicles; 6% for electric and 5% for hybrid vehicles	hybrid vehicles	0% for electric and hybrid vehicles by September 2024
	Value-added tax (VAT)	5%	19%	16%
	Income tax	No	No	Deduction of up to the COP equivalent of USD 10,258 for electric vehicles and USD 14,655 for hybrid vehicles

Use and circulation incentives	Vehicle tax	Cannot exceed 1% of the commercial value for electric vehicles	100% discount during years 1 and 2 after purchase, 75% in years 3 and 4, 50% in years 5 and 6, and 25% in years 7 and 8	Exemption during the first 5 years and a 50% discount during the following 5 years
	Toll exemption	No	20% toll discount for electric vehicles	Discounts on toll roads
	Mandatory vehicle insurance	10% discount for electric vehicles	No	No
	Preferential parking spaces	2% of total parking spaces are reserved for electric vehicles	No	No
	Technical inspection	30% discount on electric vehicles	No	Hybrid and electric vehicles are exempt from vehicle verification
Other promotion instruments	Vehicle circulation restrictions	Exemption from pico y placa and car-free day restrictions	Exemption from pico y placa and car-free day restrictions	Exemption from the Hoy No Circula program
	Differentiated electricity tariffs	No	No	Free installation of residential charging meters
	National electric mobility strategy	Yes	Yes	Yes
	Public transport policies	By 2025, at least 10% of vehicles acquired for public transport systems must be zero-emission	Mi Taxi Eléctrico co-financing program, up to USD 8768 for vehicle purchase	Taxi renewal bonus: USD 5862 for hybrid vehicles and USD 10,258 for electric vehicles
	Freight transport policies	Incentive program for the modernization of vehicles over 10.5 tons, including BEVs, HEVs, and natural gas vehicles	Electrologist program	Renewal bonus of up to USD 29,310 for electric vehicles
	Battery end-of-life policy	No	Extended Producer Responsibility Law	No
	Incentives for charging station investment	No	No	Tax credit equivalent to 30% of the investment
	Energy efficiency labeling	No	Yes	No

From a comparative standpoint, Chile appears to have developed a more integrated policy model, while Mexico has advanced through a broader market-facilitation and technical-standardization approach. Colombia can draw lessons from both. Chile, it can learn the value of public-transport prioritization, battery governance, human-capital development, and digital charging information. Mexico, it can learn the importance of technical standards, fiscal incentives, and infrastructure scalability.

For Colombia, the discussion derived from Table 7 is particularly relevant because it identifies a gap between formal regulatory progress and effective implementation. The country has policy instruments, but their practical impact depends on the capacity to co-

ordinate institutions, finance infrastructure, inform consumers, and align market incentives with long-term decarbonization goals.

Therefore, the comparative analysis indicates that long-term market development depends on institutional and regulatory measures that go beyond immediate purchase incentives. Electric mobility should be treated as a governance challenge involving transport policy, energy planning, environmental regulation, industrial policy, territorial planning, and private-sector participation.

7. Conclusions

This article examined how public policy and legal governance shape the commercialization of electric and hybrid vehicles in Colombia within the broader energy-transition agenda. The analysis shows that Colombia has made significant regulatory progress through tariff reductions, tax benefits, circulation privileges, infrastructure obligations, technical standards, and national mobility strategies. Nevertheless, these instruments have not been sufficient to consolidate a fully electric-mobility market.

One of the main findings is that Colombian market growth is dominated by HEVs, while BEVs and PHEVs remain comparatively limited. This distinction is essential because HEVs do not require charging infrastructure and do not represent the same decarbonization pathway as fully electric or plug-in technologies. Consequently, Colombia's progress should be interpreted as a process of cleaner-vehicle adoption and partial hybridization rather than full electrification.

The study also finds that regulatory progress is constrained by fragmented governance, uneven territorial implementation, insufficient charging infrastructure, limited consumer information, weak public-private coordination, and the absence of long-term frameworks for battery replacement and industrial adaptation. These barriers affect commercialization by reducing market confidence and limiting the practical conditions required for BEV and PHEV adoption.

Comparative evidence from Chile and Mexico confirms that successful electric-mobility deployment depends on coherent long-term strategies, institutional coordination, technical standardization, infrastructure planning, public-private collaboration, and user-oriented information systems. Colombia can use these lessons to strengthen its governance architecture and move beyond isolated incentives toward a more integrated policy framework.

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