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Article

Trade and Supply Chain Constraints in North American Electric Vehicle Manufacturing

Samuel C. Rankin

Abstract: This article examines the transformation of electric vehicle production in North America, arguing that it is shaped as much by trade rules, industrial policy, and material constraints as by technological innovation. Rather than treating electric vehicle production as a purely technological shift, the article shows how outcomes are structured by USMCA trade commitments, incentive-based industrial policies, limitations in battery supply chains, and the strategic decisions of multinational firms. By analyzing tariff-free trade, rules of origin, conditional subsidies, and dependencies on critical minerals, the article demonstrates how policy frameworks guide investment decisions, sourcing strategies, and the geographic organization of production. Ultimately, the transition to electric vehicle manufacturing is not abrupt or disruptive, but incremental, unfolding within established cross-border production networks that continue to constrain and shape the direction of industrial change.

Keywords: electric vehicle production; trade policy; industrial policy; battery supply chains; multinational firms

1. Introduction

Electric vehicle production is often discussed as a matter of technological progress *or* environmental urgency. While both perspectives highlight important aspects of the transition, they risk overlooking a more basic point. Electric vehicles are produced through complex industrial systems spread across multiple locations. The organization of these systems is shaped not only by engineering capacity but also by trade rules, access to markets, and policy incentives. Decisions about where vehicles, batteries, and components are manufactured are influenced by tariffs, rules of origin, subsidy eligibility, and the structure of cross-border supply chains. For this reason, the shift to electric mobility cannot be understood as a purely technological change. It represents an industrial transformation that is embedded within existing trade relationships and institutional arrangements.

This dynamic is particularly clear in North America, where automotive manufacturing has developed over decades into one of the most integrated cross-border production systems in the global economy. Canadian automotive producers are closely tied to the United States market, while U.S. manufacturers rely heavily on Canadian inputs and intermediate goods. The scale of this interdependence is evident in trade patterns, with the vast majority of Canadian motor vehicle and parts exports destined for the United States and a substantial share of U.S. automotive exports flowing in the opposite direction.[1] Such integration limits the scope for unilateral policy action and ensures that changes in trade or industrial policy on one side of the border have immediate effects on production decisions on the other. As electric vehicles replace internal combustion models, these long-standing trade relationships continue to shape investment choices, assembly locations, and patterns of innovation across the region.

At the global level, electric vehicle production is unfolding within an uneven industrial landscape marked by significant geographic concentration. A large share of electric vehicle and battery manufacturing

[1] Beata Caranci, Andrew Foran, and Likeleli Seitlheko, “Canadians Need to Think Strategically on Electric Vehicles and China” (Toronto, ON: TD Economics, September 8, 2025), 5.

capacity is located in China, reflecting a highly centralized global production structure.[2] This concentration has increased the strategic importance of trade and industrial policy as governments seek to secure supply chains, reduce external dependencies, and encourage domestic manufacturing capacity. As a result, tariffs, domestic content requirements, and incentive programs have become central tools influencing where electric vehicles and their components are produced, rather than secondary policy considerations.

Within this setting, electric vehicle production outcomes in North America are shaped by the interaction of U.S.-Canada trade rules under the United States-Mexico-Canada Agreement, evolving tariff and subsidy policies, constraints linked to battery materials and processing capacity, and the behaviour of multinational firms operating across borders. Together, these factors determine how and where electric vehicle production develops, highlighting the extent to which the electric vehicle transition is governed by institutional design and trade integration rather than technology alone. Rather than assuming that trade rules or industrial policy mechanically determine production outcomes, this article shows how these instruments operate within material and organizational constraints that limit their effectiveness.

2. Trade Rules and the Institutional Foundations of Electric Vehicle Production in North America

The current structure of electric vehicle production in North America is closely tied to the legal and institutional framework established by the USMCA. The agreement creates a stable and predictable environment for cross-border manufacturing by preventing member states from raising existing customs duties or introducing new ones on goods that qualify as originating within the region.[3] This commitment plays a central role in shaping production decisions.

Reducing tariff uncertainty allows automotive manufacturers to spread production stages across borders without facing cumulative cost penalties as components move between jurisdictions. In an industry where value is created across multiple stages and locations, the ability to move qualifying goods tariff-free is essential to maintaining integrated supply chains.

This predictability is especially important for electric vehicle manufacturing. Compared with conventional vehicles, electric vehicle production involves additional layers of complexity, including battery packs, power electronics, and software-intensive systems that often require specialized suppliers and facilities. The ability to source components regionally and transport them across borders without the risk of sudden tariff changes is, therefore, critical for long-term investment decisions. Choices about plant location, capacity expansion, and supplier relationships depend on confidence that qualifying goods will continue to receive preferential access throughout the North American market. Firms operating within this framework are able to plan production strategically rather than reacting to short-term policy uncertainty.

Tariff-free treatment is reinforced by the agreement's national treatment obligation, which requires each party to treat goods from other member states no less favourably than domestically produced goods once they enter the market.[4] This provision extends integration beyond the border and into domestic regulatory systems.

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[2] International Energy Agency, "'Policy Developments and Corporate Strategy' in Global EV Outlook 2023: Catching up with Climate Ambitions," *International Energy Agency (IEA)* (Paris, France: International Energy Agency, April 26, 2024), 104.
[3] Office of the United States Trade Representative, "'National Treatment and Market Access for Goods' in Agreement between the United States of America, the United Mexican States, and Canada" (2020), 4.
[4] Office of the United States Trade Representative, 3.

For Canadian automotive manufacturers, national treatment in the United States reduces the risk that internal taxes, regulations, or procurement practices will be used to indirectly disadvantage imported vehicles or components. By embedding non-discrimination into market operations, the agreement supports the idea of North America as a single production space rather than a set of separate national markets. Within this environment, electric vehicle manufacturers can organize production around comparative advantage, technical expertise, and efficient use of capacity instead of adopting defensive strategies to preserve market access.

Access to these protections, however, is not automatic. The agreement's rules of origin define what qualifies as an originating good and therefore determines eligibility for tariff-free and non-discriminatory treatment.[5] These rules link trade privileges directly to production geography by specifying where and how value must be created within the region. Vehicles and components must either be produced entirely within North America or meet detailed requirements governing the use of non-originating materials. This has significant implications for electric vehicle supply chains. High-value components such as batteries, electric drivetrains, and power management systems are particularly affected, as sourcing decisions for these inputs directly determine whether a finished vehicle qualifies for preferential treatment.

Compliance with rules of origin is therefore a strategic choice rather than a purely technical exercise. Firms must weigh the costs of regional sourcing, administrative compliance, and supplier network restructuring against the benefits of tariff exemption and regulatory certainty. Trade rules influence how supply chains are designed and where investment occurs, not simply how goods move once production is complete. While the agreement does not dictate where production must take place, it reshapes incentives in ways that encourage regional value creation and reinforce existing patterns of integration.

The significance of this framework becomes clearer when viewed alongside the size and structure of the Canadian automotive market. As of 2022, Canada has more than twenty-six million registered road vehicles, underscoring the continued economic importance of automotive production and consumption.[6] At the same time, electric vehicles still account for a relatively small share of light-duty vehicle registrations, despite recent growth.[7] This combination of scale and early-stage transition makes institutional design particularly consequential. As electric vehicle adoption accelerates, decisions about where new manufacturing facilities, battery plants, and component assembly operations are located will be strongly influenced by the incentives embedded in the current trade framework.

In this context, the USMCA functions as both an enabler and a constraint. It supports integrated production by preserving tariff-free access and non-discriminatory treatment, while also limiting policy autonomy by locking in commitments that restrict unilateral intervention. As electric vehicle production expands, firms must navigate this established framework alongside newer industrial policies that impose additional conditions on sourcing and eligibility. The interaction between long-standing trade commitments and emerging policy instruments continues to shape where and how the next generation of vehicles is produced across North America.

3. Incentive-Based Industrial Policy and Electric Vehicle Production

[5] Office of the United States Trade Representative, "'Rules of Origin' in Agreement between the United States of America, the United Mexican States, and Canada" (2020), 4.
[6] Government of Canada, "Automotive Statistics," www.statcan.gc.ca (Government of Canada, December 4, 2018), 1.
[7] Government of Canada, 1.

Recent developments in U.S. industrial policy reflect a clear shift in how governments seek to influence electric vehicle production. Rather than relying primarily on traditional border tariffs, policymakers have increasingly turned to indirect regulatory tools that shape production incentives through domestic policy design. Trade and sourcing conditions are now embedded directly into incentive structures, allowing governments to influence supply chains without formally restricting imports. The Inflation Reduction Act illustrates this approach by linking consumer tax credits to the geographic origin of battery components, making access to incentives conditional on meeting specific production and assembly requirements within North America.[8] Although firms remain free to import batteries or components from abroad, doing so may disqualify vehicles from key subsidies, altering market competitiveness in practice.

This framework reshapes sourcing decisions across the electric vehicle value chain. Battery producers and vehicle manufacturers must now evaluate suppliers not only on cost and performance, but also on whether they satisfy increasingly strict regional content thresholds. As the required share of battery component value produced in North America rises, firms face growing pressure to reorganize supply chains, relocate assembly processes, or invest in new facilities within the region. Those unable or unwilling to adjust are placed at a disadvantage regardless of their technological sophistication. In this way, the Act functions as a trade-regulating mechanism implemented through domestic tax law rather than through customs barriers, reshaping incentives without violating existing tariff commitments.

A similar logic governs the treatment of critical minerals. Beginning in 2025, vehicles will no longer qualify for tax credits if battery minerals are extracted, processed, or recycled by entities designated as foreign entities of concern.[9] This provision does not prohibit imports or impose punitive duties. Instead, it narrows the set of commercially viable supply chains by attaching financial consequences to sourcing choices. For manufacturers operating in global markets where mineral processing is highly concentrated, compliance entails significant adjustment costs. New supplier relationships must be developed, processing capacity expanded or relocated, and long-term contracts renegotiated. These changes unfold over years rather than months, demonstrating how industrial policy interacts with existing material and infrastructural constraints rather than bypassing them.

Although incentives now play a central role, traditional tariffs remain part of the electric vehicle policy landscape, particularly in relation to Chinese electric vehicles. In the United States, such tariffs are imposed under domestic legal authority rather than through multilateral approval, highlighting the use of Section 301 as a unilateral enforcement tool.[10] This distinction has practical consequences. By relying on national law, the United States avoids immediate adjudication within the WTO system, reducing legal exposure in the short term. At the same time, it introduces uncertainty for firms operating across borders, as future tariff levels and dispute outcomes depend on domestic political decisions rather than predictable multilateral processes.

Canada's approach illustrates how differences in legal framing can produce divergent economic effects even when policy objectives align. Like the United States, Canada has imposed high tariffs on Chinese electric vehicles. Unlike the European Union, however, Canada did not ground its measures in a formal subsidy

[8] United States Congress, "Inflation Reduction Act of 2022 (Pub. L. No. 117–169)" (2022), 48.
[9] United States Congress, 48.
[10] Gil Lan, "Electric Vehicle Tariffs by the US, EU, and Canada: Different Approaches and Implications for the WTO," *ASIL Insights* 28, no. 12 (December 13, 2024): 2.

investigation using WTO language.[11] This difference affects Canada's exposure to retaliation, its ability to defend its measures in trade forums, and the level of uncertainty faced by firms operating in cross-border supply chains. For manufacturers active in both Canadian and U.S. markets, these asymmetries complicate strategic planning and heighten regulatory risk.

The consequences of these choices are already visible. While Canadian tariffs align with broader efforts to protect domestic industry, they have also limited access to some of the most advanced battery technologies currently available.[12] This outcome points to a central tension in contemporary industrial policy. Measures intended to promote domestic production or strategic autonomy can also raise costs, slow adoption, or restrict technological options, particularly in sectors characterized by rapid innovation and global specialization. In electric vehicle markets, where battery performance is a key determinant of competitiveness, such constraints affect both manufacturers and consumers.

Taken together, tariffs and incentives operate continuously rather than as isolated interventions and now function as tools that reshape the geography of production rather than simply regulating trade flows. Their effects emerge through firm behaviour, investment decisions, and gradual supply chain reorganization. Contemporary trade and industrial policies operate through conditional requirements rather than outright prohibition, influencing which production strategies remain viable over time. As a result, the development of electric vehicle manufacturing capacity reflects not only technological progress but also the cumulative influence of regulatory design, legal authority, and cross-border policy interaction.

4. Battery Materials and the Structural Constraints on Electric Vehicle Production

Batteries sit at the core of electric vehicle production, and this dependence introduces constraints that differ sharply from those found in conventional automotive manufacturing. Unlike internal combustion vehicles, which rely on inputs that are widely traded and technologically stable, electric vehicles depend on a narrow group of critical minerals. These include lithium, cobalt, nickel, graphite, and rare earth elements that are essential for battery production and electric motor systems. These minerals must be extracted, processed, and transformed into usable battery materials through capital-intensive stages, technically demanding and concentrated in a small number of jurisdictions worldwide. This reliance places material supply chains at the centre of the electric vehicle transition and helps explain why trade and industrial policy have become so closely tied to production outcomes. Canadian policy documents explicitly acknowledge this reality by identifying critical minerals as indispensable to the energy transition, without which batteries, electric vehicles, and associated clean technologies cannot be produced at scale.[13] The implication is that material availability, rather than consumer demand or assembly capacity alone, plays an important role in determining both the speed and geography of electrification.

From a policy perspective, the challenge extends beyond securing raw material supply to integrating the entire battery value chain. Canadian strategy, therefore, emphasizes capabilities across mining, processing,

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[11] Lan, 3.
[12] Caranci et al., "Canadians Need to Think Strategically on Electric Vehicles and China", 2.
[13] Natural Resources Canada, "The Canadian Critical Minerals Strategy: From Exploration to Recycling—Powering the Green and Digital Economy for Canada and the World," *The Canadian Critical Minerals Strategy* (Ottawa, ON: Government of Canada, 2022), 1.

manufacturing, and recycling, reflecting an understanding that value creation and strategic leverage are unevenly distributed across these stages.[14] Mining alone offers a limited economic or geopolitical advantage if downstream activities remain offshore. In the case of electric vehicle batteries, this distinction is particularly important. The most technologically complex and economically valuable stages of production are found not in extraction, but in chemical processing, cathode and anode manufacturing, and cell assembly. Without domestic or regional capacity in these areas, countries rich in natural resources risk remaining peripheral suppliers rather than becoming central participants in electric vehicle production networks. Efforts to build full value-chain integration represent a strategy to convert resource endowments into durable industrial competitiveness rather than relying on raw material exports as an end in themselves.

The feasibility of this ambition is shaped by technological and time-related constraints. Establishing a domestic lithium battery supply chain requires not only significant capital investment but long-term commitments to scientific research, skilled labour development, and advanced manufacturing infrastructure, particularly as battery chemistry continues to evolve.[15] Battery technologies are not static. Improvements in energy density, safety, durability, and cost depend on sustained experimentation and gradual scaling, introducing uncertainty that complicates industrial planning. Governments can offer subsidies and coordinate policy frameworks, but they cannot eliminate development timelines or technological risk. As a result, progress toward localized battery supply chains is uneven, with bottlenecks emerging where research capacity, workforce availability, or supporting infrastructure lag behind policy objectives.

These challenges are intensified by continued dependence on foreign processing capacity. Despite growing interest in domestic battery manufacturing, the United States remains heavily reliant on international markets for processing most lithium battery raw materials.[16] Processing, rather than mining, remains the most concentrated and strategically sensitive segment of the supply chain, dominated by a limited number of countries. When trade and industrial policies seek to restrict sourcing from particular jurisdictions or prioritize domestic inputs, they quickly encounter practical limits if alternative processing capacity does not yet exist at scale. Firms responding to these policies must navigate a narrow space between regulatory compliance and operational feasibility, often accepting higher costs, longer lead times, or transitional inefficiencies as supply chains are restructured.

The interaction between these material constraints and trade policy becomes even more pronounced when considering the limited international tradability of electric vehicles themselves. Only a small share of electric vehicles are traded across borders, with most production occurring close to end markets and China emerging as the dominant exporter.[17] This pattern reflects both the physical characteristics of vehicles and the regulatory fragmentation of automotive markets, where safety standards, incentive eligibility, and industrial priorities vary across jurisdictions. Limited tradability increases the importance of production location decisions, as firms cannot rely on global trade to offset regional supply disruptions or policy shifts. Instead, they

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[14] Natural Resources Canada, 5.
[15] Federal Consortium for Advanced Batteries, "National Blueprint for Lithium Batteries 2021–2030 (Executive Summary)," *Federal Consortium for Advanced Batteries (FCAB)* (Washington, DC: Federal Consortium for Advanced Batteries, June 2021), 3.
[16] Federal Consortium for Advanced Batteries, 6.
[17] International Energy Agency, "'Policy Developments and Corporate Strategy' in Global EV Outlook 2023: Catching up with Climate Ambitions", 104.

must embed production within specific institutional environments, aligning sourcing, assembly, and market access strategies accordingly.

In North America, these dynamics reinforce the significance of regional integration. Because electric vehicles are primarily produced for local or regional markets, the availability of battery materials, processing capacity, and manufacturing infrastructure within the region becomes a decisive factor shaping investment decisions. Trade and industrial policies that encourage regional sourcing interact directly with material constraints, accelerating some forms of capacity development while revealing gaps elsewhere. Incentives tied to regional content requirements, for example, may stimulate investment in battery assembly plants even when upstream processing remains globally concentrated. This can produce transitional inefficiencies, where formal compliance with policy objectives masks continued dependence on external suppliers and exposure to upstream disruptions.

Multinational firms are central to managing these tensions. Their ability to coordinate sourcing across jurisdictions, allocate capital strategically, and absorb short-term inefficiencies allows them to respond more effectively to evolving policy environments. Smaller firms face higher adjustment costs, reinforcing concentration within the sector and shaping competitive outcomes. As a result, the geography of electric vehicle production reflects not only policy intent but differences in firms' capacity to navigate material, technological, and institutional constraints as they interact across borders.

Throughout the electric vehicle transition, decisions about battery materials, processing capacity, and production location are shaped by the interaction of trade frameworks, industrial strategies, and physical supply-chain realities. These forces operate continuously rather than sequentially, ensuring that electrification advances unevenly across regions and firms. The organization of mineral and battery supply chains exerts a sustained influence over production outcomes, embedding electric vehicle manufacturing firmly within the broader architecture of trade relationships and institutional design.

5. Multinational Firms and the Organization of Electric Vehicle Production

Multinational firms occupy a central position in converting trade rules and industrial policy signals into practical production decisions by structuring operations across borders in ways that balance efficiency, compliance, and market access. Rather than serving foreign markets solely through cross-border trade, multinational enterprises frequently rely on affiliates located within or near key markets, reflecting the continuing importance of physical proximity for coordination, regulation, and customer engagement.[18] This organizational strategy helps explain why deeply integrated production networks persist even as formal trade barriers decline. Firms respond not only to price signals but also to the advantages of being embedded within specific regulatory and commercial environments where policy interpretation and enforcement shape daily operations.

For electric vehicle production, this mode of organization is particularly consequential. Electric vehicle manufacturing requires close coordination among vehicle assembly, battery integration, software calibration, regulatory compliance, and post-sale services. Many of these functions benefit from proximity to end markets

[18] David Stein et al., "U.S. International Services: Trade in Services in 2023 and Services Supplied through Affiliates in 2022," *Survey of Current Business*, October 18, 2024, 1.

and policymakers, especially as incentive regimes and sourcing requirements vary across jurisdictions. Affiliates allow firms to adjust individual stages of production without dismantling broader supply networks. Rather than relocating entire production systems, firms can shift discrete functions, such as final assembly, compliance testing, or battery pack integration, to align with national or regional policy requirements while maintaining overall operational continuity.

This flexibility has become increasingly valuable as trade rules, subsidy eligibility criteria, and sourcing thresholds evolve simultaneously. Industrial policy now operates largely through conditional incentives rather than overt trade restrictions, requiring firms to respond to detailed regulatory design as much as to headline policy objectives.[19] Multinational structures allow firms to manage this complexity internally, coordinating responses across subsidiaries while preserving access to key markets. Cross-border integration, therefore, functions less as a cost-minimization strategy than as an institutional adaptation to regulatory fragmentation.

However, the capacity to reorganize production in this manner is uneven. Large multinational firms possess the capital, managerial expertise, and geographic reach necessary to absorb compliance costs and restructure supply chains across jurisdictions.[20] They are better positioned to establish new affiliates, expand existing facilities, or renegotiate supplier relationships in response to changing incentive structures. Smaller firms face higher adjustment costs and more limited strategic options. For these producers, responding to evolving trade and industrial policies may require disproportionate investment or operational disruption, placing them at a competitive disadvantage.

These differences shape how policy is translated into production outcomes. When access to incentives or markets depends on meeting specific sourcing or organizational requirements, firms with greater internal flexibility are more likely to adjust successfully. Over time, this dynamic influences not only where production occurs, but also which firms expand their role within the electric vehicle sector. Cross-border integration reflects both policy design and firm capacity, reinforcing certain production models while constraining others.

Within the electric vehicle industry, multinational organizations have become a key mechanism through which firms navigate overlapping trade commitments and industrial policy objectives. Production decisions emerge from the interaction between regulatory conditions and organizational structure, rather than from technological considerations alone. The resulting pattern of electric vehicle production in North America reflects how firms adapt to policy signals through internal coordination, incremental adjustment, and strategic deployment of affiliates across borders.

6. Conclusion

The transition to electric vehicles in North America is best understood not as a stand-alone technological change, but as a restructuring of an already integrated industrial system. The analysis developed in this article shows that electric vehicle production outcomes are shaped by the interaction of trade rules, industrial policy, and material supply constraints that operate across national borders. In a region where automotive manufacturing has long relied on cross-border specialization, adjustments to tariffs, incentive eligibility, and

[19] International Energy Agency, "'Policy Developments and Corporate Strategy' in Global EV Outlook 2023: Catching up with Climate Ambitions", 107–110.
[20] International Energy Agency, 103.

sourcing requirements do not simply alter trade flows. They influence where investment occurs, how supply chains are organized, and which production locations gain or lose strategic importance.

The U.S.–Canada automotive relationship, institutionalized through tariff-free treatment and shared rules of origin under USMCA, has historically provided a stable foundation for regional integration. This framework has allowed firms to distribute production stages across borders with a high degree of predictability. More recent policy initiatives, particularly those designed to strengthen domestic manufacturing capacity, modify this environment by attaching conditions to market access and incentives. These measures do not operate as traditional barriers at the border. Instead, they shape firm behaviour by rewarding compliance with specific sourcing and production criteria, thereby influencing investment decisions throughout the integrated North American market.

At the same time, the ability of policy to redirect production is constrained by material and technological realities. Battery manufacturing and critical mineral processing remain highly concentrated globally, and efforts to expand capacity face long timelines, high capital requirements, and persistent technological uncertainty. Industrial and trade policies interact with these constraints rather than overriding them, sometimes easing exposure to external dependencies while in other cases reinforcing bottlenecks that slow adjustment.

Firms respond to these conditions through adaptation rather than wholesale restructuring. Multinational enterprises, in particular, translate policy signals into production outcomes by adjusting supply chains, reallocating functions across affiliates, and sequencing investment over time. Their responses highlight that electric vehicle manufacturing decisions emerge within existing trade and investment structures, shaped as much by institutional context as by technological capability.

The pace, cost, and location of electric vehicle production in North America will therefore be determined by how effectively trade frameworks, industrial incentives, and supply chain capacities align across borders. The electric vehicle transition is unfolding through coordination, constraint, and gradual adjustment within an established industrial system, rather than through abrupt technological substitution or isolated policy action.

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