FACTBOOK

Zero-Emission Vehicle Policy

How Supply-Side Policies Can Impact Zero-Emission Vehicle Investment

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Acknowledgments: International Council on Clean Transportation, Drive Electric Campaign

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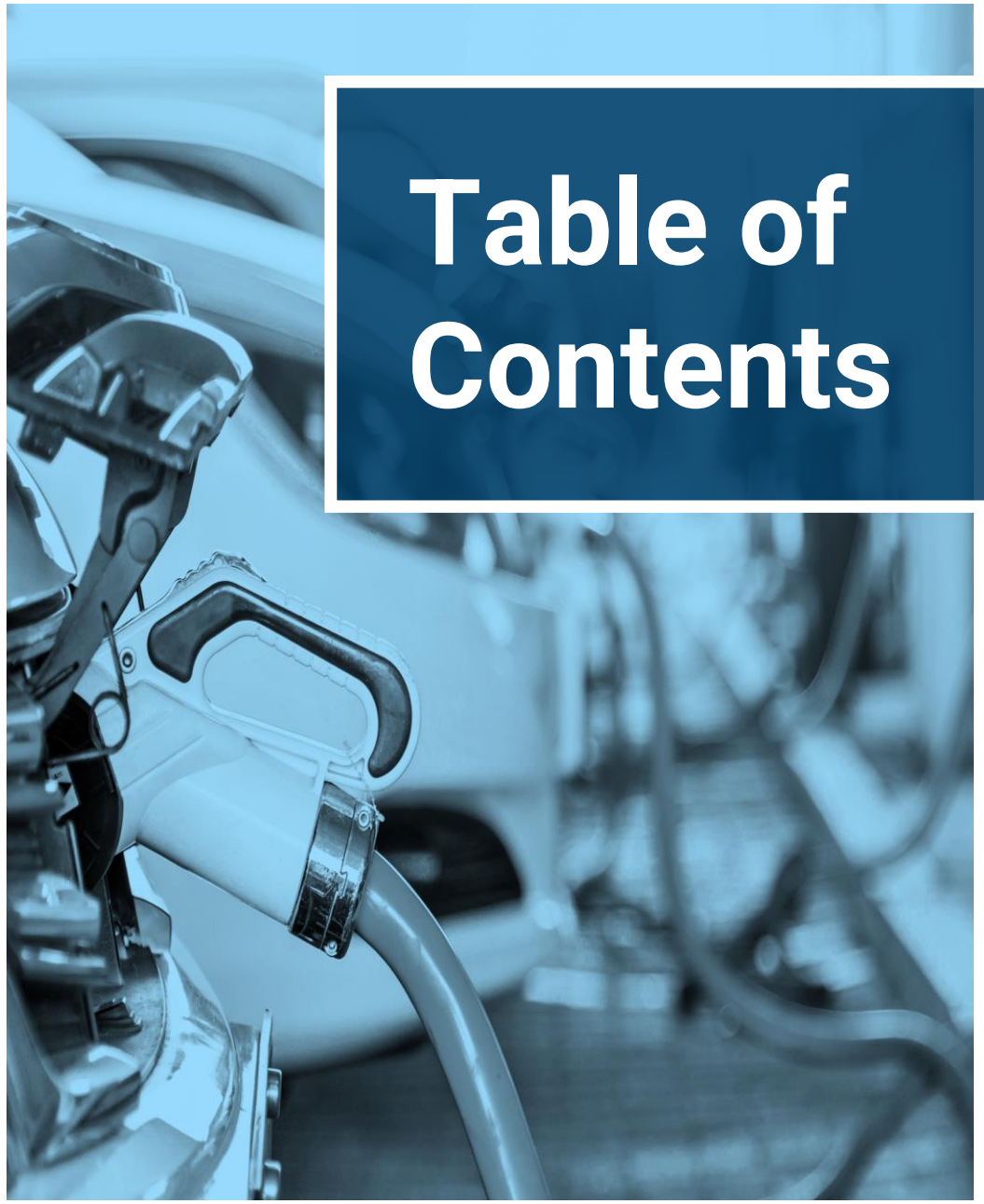

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Acronyms

- ACC – Advanced Clean Cars
- ACC II – Advanced Clean Cars II
- BEV – battery electric vehicle
- BS – Bharat Stage
- CAFE – Corporate Average Fuel Economy
- CAFC – Corporate Average Fuel Consumption
- CARB –California Air Resources Board
- EV – electric vehicle
- FAME – Faster Adoption and Manufacturing of Hybrid and Electric Vehicles
- FCEV – fuel cell electric vehicle
- GHG – greenhouse gas
- ICE – internal combustion engine
- IIJA – Infrastructure Investment and Jobs Act
- IRA – Inflation Reduction Act
- LEV – low emissions vehicle
- LEZ – low-emissions zone
- NEV – New Energy Vehicle
- NOx – nitrogen oxides
- OEM – original equipment manufacturer
- PHEV – plug-in hybrid electric vehicle
- PM – particulate matter
- R&D – research and development
- SOx – sulfur oxides
- TCO – total cost of ownership
- VAT – value added tax
- ZEV – zero-emission vehicle
- ZEZ – zero-emission zone

01 EXECUTIVE SUMMARY

In scaling the manufacturing of zero-emission vehicles (ZEVs), policy plays a crucial role in driving market growth and industry transformation. This document provides detailed:

A. Policy gap analysis of focal geographies/countries: the European Union, Australia, Brazil, China, India, Indonesia, South Africa, and the United States.

B. Analysis of interactions between regulatory measures, fiscal policies, and the mobilization of financing to increase ZEV manufacturing.

C. Lessons learned and best practices exhibited through case studies.

Policy Gap Analysis

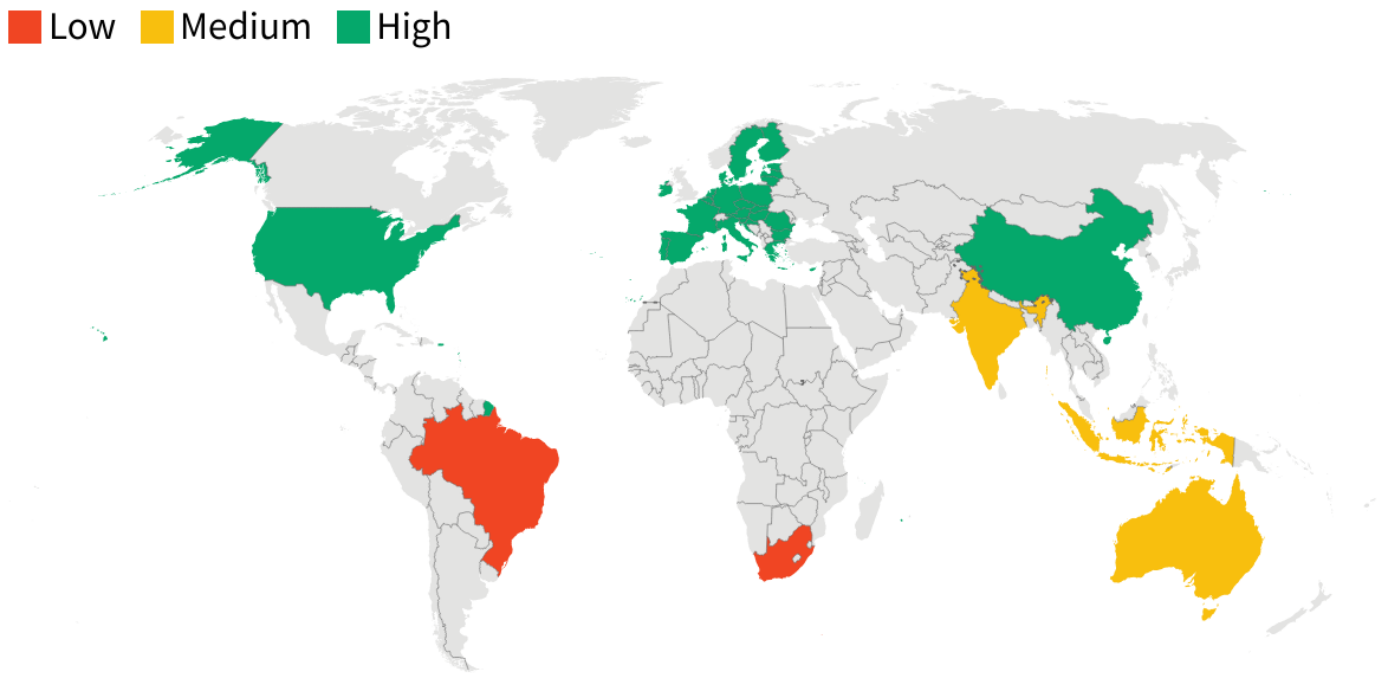
Countries exhibit varying degrees of policy support for ZEV manufacturing. These policies span a broad spectrum, with some countries/regions offering minimal assistance while others implement robust supply- and demand-side policies.

Countries/regions utilize different combinations of supply-side policies and supportive demand-side policies to encourage ZEV manufacturing and adoption.

Policies vary across countries given country-specific context (i.e., history of manufacturing), geopolitical dynamics, and domestic political context.

The map presents a policy analysis using a traffic light grading system, indicating the effectiveness of ZEV policies. The grading is based on how well these policies support ZEV supply and demand to encourage rapid adoption.

ZEV Policy Gap Analysis - Level of Policy Support



The European Union is considered as a bloc, not as individual countries.

Source: RMI Analysis

Note: The overall rating was green when a county or region received 4 of 8 green ratings across all policy categories, as shown on slide 6. See Appendix A for the methodology utilized to identify overall color coding for each country/region.

Policy Gap Analysis Results

The policy gap analysis presents a high-level assessment of supply- and demand-side policies supporting ZEV adoption and manufacturing in each country/region. An in-depth compilation of this analysis can be found in the Policy Analysis section.

Green: Represents the most ambitious standards or most supportive ZEV policies.
Yellow: Indicates a policy that falls short of the highest ambition or standards but offers some support for ZEVs or regulates ICE vehicles to the benefit of ZEVs.
Red: Indicates the absence of a policy in a particular area or a policy that is significantly lagging those in other countries/regions.

	Supply-Side Policies (Regulatory)*			Supply-Side Policies (Fiscal)*		Demand-Side Policies (Regulatory)*	Demand-Side Policies (Fiscal)*	Infrastructure*
	ZEV Sales Requirements	Fuel Economy / Efficiency Standards	Vehicle Emissions Standards (including greenhouse gases [GHGs])**	ZEV Manufacturing Incentives (including tax benefits)	Public Financing	Operational Regulations (including fleet requirements)	Purchase / Operating Incentives (including tax benefits)	Policies / Funding Aimed at the Establishment of Public Infrastructure
European Union								
Australia								
Brazil								
China								
India								
Indonesia								
South Africa								
United States***								

The color coding simplifies comparisons and provides a high-level overview –there are many nuances, exceptions, and vehicle segments with weaker policies. Implementation, which is hard to measure, also affects outcomes but was not assessed in detail. See the Appendix for more details.
*Note: see slides 15 and 16 for additional context and information on these policy structures.
**Note: tailpipe emission standards are developed differently and sometimes do not include GHGs or CO_2. At times, these standards are only set up to control PM, NOx, and SOx. Thus, this study examines and rates emissions standards that seek to include GHGs specifically. See the appendix for more details.
***Note: many items for the United States are contingent on policies enacted in California and other states that have adopted California policies. See the appendix for an explanation of how these regional differences were accounted for in the overarching categorical rating.

Analysis Scope

Market Segment

The focus of this study was primarily on the downstream section of the ZEV supply chain — specifically, policies that impact manufacturers and suppliers of ZEVs and the vehicles they bring to the market.

Upstream mining and refining materials used in batteries and various vehicle components, such as the vehicle body.

Midstream activities are those beyond extraction and processing, and before final vehicle assembly, such as the production of cathode and anode materials and battery cell production.

Downstream activities include assembling battery cells into modules, producing chassis, and assembling vehicles.

ZEV supply-side policies aim to increase the supply of ZEVs, which can mean increased manufacturing or increased imports, depending on the market. Supply-side policies can be supportive in manufacturing and import markets but may be structured differently depending on the presence of domestic production.

Regions and Countries of Focus

This research included a policy gap analysis of eight countries and regions

- **The European Union**
- **Australia**
- **Brazil**
- **China**
- **India**
- **Indonesia**
- **South Africa**
- **The United States**

These markets were selected because they represent some of largest ZEV markets globally, provide socioeconomic and geographic diversity, and represent critical markets for the future of ZEV manufacturing and sales. They were also chosen to represent countries from each continent, excluding Antarctica.

This analysis recognizes that impactful policies driving ZEV market growth have been enacted in additional markets beyond those examined here.

Vehicle Segments

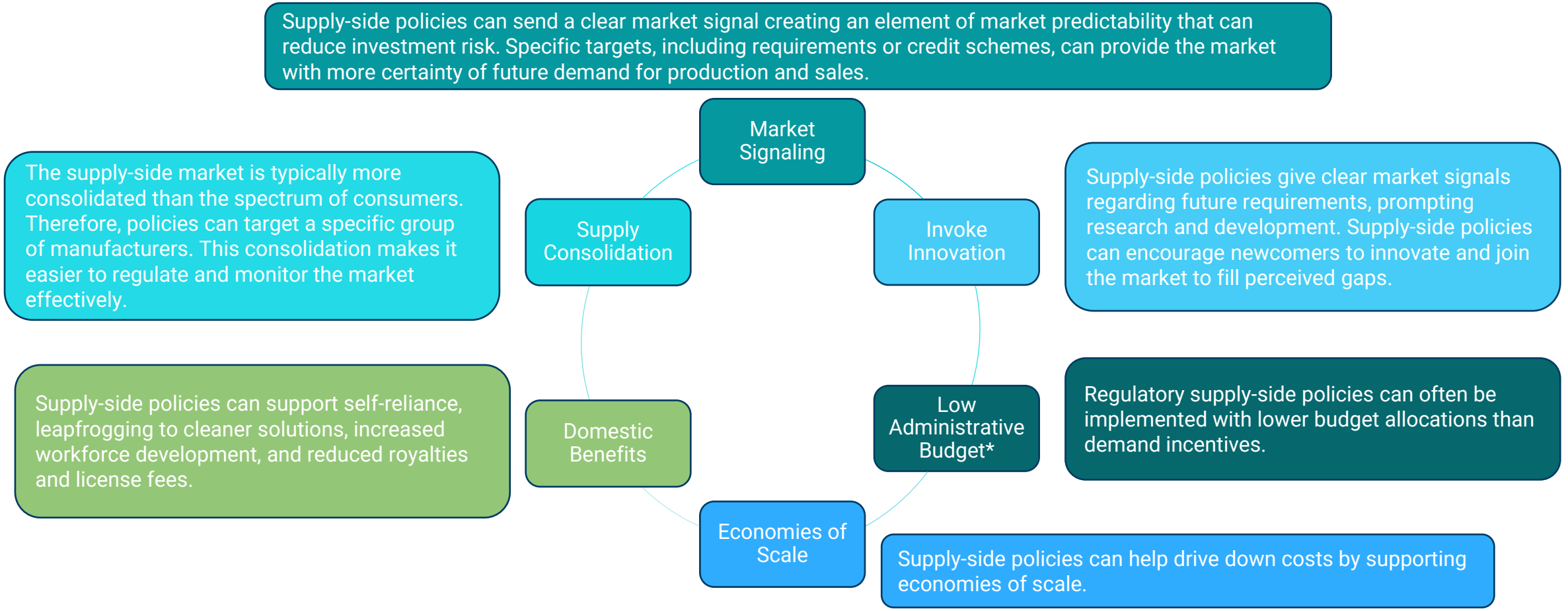
The analysis covers both light-duty passenger vehicles (LDVs) and heavy-duty vehicles (HDVs), with a particular focus on LDV regulations due to their greater share of total vehicle volume.

- LDVs in this analysis include two- and three-wheelers, sedans, SUVs, and light-duty trucks and vans, while heavy-duty vehicles refer to trucks over 3.5 tonnes.
- Historically, LDV regulations have been enacted first, setting a foundation that HDV regulations often follow.
- While the analysis seeks to address policies by vehicle segment, distinctions may not be specified if a policy applies to both LDVs and HDVs.

Note: In some instances, examples beyond the focal regions and countries are mentioned in deep dive slides to provide examples of how specific regulations have been instrumental. It is acknowledged that more analysis will continue to be needed as the policy gap analysis performed is not exhaustive and omits important auto-manufacturing hubs like Japan and South Korea.

Why Adopt Supply-Side Policies

Supply-side policies offer market participants greater certainty, helping to stimulate innovation, attract investment, and achieve economies of scale. This analysis examines how such policies can impact the ZEV market, mobilize investment, and scale adoption. In turn, these efforts help deliver more affordable products to consumers. Below are some key benefits of supply-side policies, many of which will be described in detail in this analysis:



Potential Challenges for Supply-Side Policies

While supply-side policies offer significant benefits, they can also encounter real or perceived challenges, and political will plays a crucial role in their success. Strong political will can drive action and progress, while a lack of political will, often influenced by resistance from industry actors, can result in stagnation and delays in policy implementation.

Challenge	Regulatory Policies	Fiscal Policies
Incumbent Opposition	Existing incumbents (including auto manufacturers), which can have significant political influence, can be resistant to change given the high short-term costs of retooling facilities and retraining staff.	Existing incumbents (including oil and gas producers), which can have significant political influence, can be resistant to fiscal policies that support alternative technologies.
ZEV Demand Uncertainty	Market actors can continue to point to slow consumer adoption and slow charging infrastructure development.	Less applicable.
Market Ripple Effects	Regulatory policies significantly influence market dynamics, shaping industry innovation and competition. However, these policies can have unintended consequences, and care must be taken to avoid favoring specific market actors.	Fiscal incentives influences research and development and sector growth, and steers businesses toward specific technologies. While not inherently problematic, this can lead to issues like "policy lock-in," where industries become reliant on government support to remain economically viable.
ZEV Technology Perception	There is an on-going perception that given advancements in battery technology, ZEVs are still an immature technology impacting policy motivation to implement regulations.	Less applicable.
Nuanced Approach	Supply-side policies can be difficult to replicate from one country to the next, given the need to cater to regional prerogatives and the political and jurisdictional context.	Countries have different budget allocations due to varying economic conditions, priorities, and resource availability. Budget constraints could lead to challenges in sustaining or supporting fiscal polices.
Cost to Implement	Less applicable.	Fiscal policies, specifically incentives, can have high implementation costs.

Examples of Supply-Side Policies Spurring ZEV Adoption

Supply-side policies can have a significant impact on ZEV sales, as evidenced by the 15 largest EV* markets in 2023 having a combination of sales requirements, fuel consumption, and/or CO_2 standards.

EUROPEAN UNION

EV new car sales increased from 3% to 10% in a year after CO_2 standards were put into place in 2020.

UNITED STATES

In 2019 the California Air Resources Board (CARB) projected that EVs would account for 8% of new car sales by 2025 but given California's supportive market and policies, EV sales accounted for 26% of sales by 2023, far exceeding projections.

ZEV states** have 30% more EV models compared to non-ZEV states.

Other US states that have adopted California's ZEV regulations had an average of 12% EV sales in 2023, compared to an average of 6% EV sales in non-ZEV states.

CANADA

Provinces of British Columbia and Quebec both have EV sales requirements and had 3.4x higher EV sales shares in 2023 compared to other provinces.

*Note: Different sources use varying definitions of "ZEV" and "EV" – in some cases "EV" may include only battery electric vehicles and in others it may consist of other types of electric vehicles. If it is possible to confirm a source uses "EV" to include multiple electric vehicle types it will be changed to "ZEV" in this deck, when it is not possible to confirm it will be kept as EV in keeping with the source.

**Note: ZEV state(s) are defined as those that have adopted ACC II.

Source: ICCT

How Decision-Makers Can Interpret and Leverage This Factbook

Supply-side policies play a crucial role in driving the ZEV transition. While policies may not always transfer seamlessly across regions, key takeaways can be adapted to foster local market growth. This analysis aims to identify gaps and critical insights into how policies have shaped ZEV markets. This should empower decision-makers to apply global lessons, building a robust, sustainable ZEV ecosystem.

Defining Policies and Identifying Gaps

To provide consistent nomenclature and comprehensive assessment of ZEV policies globally this assessment:

1. Establishes clear definitions for key policy terms,
2. Assesses policies by region, and
3. Performs an in-depth gap analysis.

By providing practical thematic groupings and standardized terminology across regions, this analysis aims to create a cohesive framework for understanding and comparing ZEV policies on a global scale.

Insight Generation

This assessment evaluates the impact of policies on the ZEV market by:

1. Analyzing ZEV sales and manufacturing trends,
2. Providing examples of how policy implementation has aligned with market growth, and
3. Offering supporting evidence for the need for a comprehensive, holistic policy approach to drive sustained market growth.

Impact on Investment

This analysis explores the relationship between policies and ZEV investment by:

1. Identifying how specific policy types can drive investment,
2. Showcasing examples of how policies can expand the project pipeline and reduce risk, and
3. Detailing how financial tools can increase private investment.

Note: Due to the difficulty of isolating the impact of individual policies, this analysis focuses on providing specific examples of policies and their effects. While general trends are discussed, conducting a comprehensive cost-benefit assessment of a policy type, either globally or at the national level, was often not feasible due to the diffuse effects of policies and data limitations. This makes it challenging to establish direct causality with the enaction of policy, as many variables influence vehicle markets.

02 POLICY CONTEXT AND DEFINITIONS

Scaling ZEV manufacturing will require policy shifts in regulations and incentives across the transport sector. This study conducts a comparative country analysis to understand how policy impacts ZEV manufacturing. By assessing both supply- and demand-side policies this analysis seeks to identify how policies are complementary and how policy can be implemented to drive ZEV manufacturing, sales, and investment. This section covers:

A. Define supply- and demand-side policies.

B. Provide an overview of the focal countries and regions.

Regions and countries of Focus

The European Union
Australia
Brazil
China
India
Indonesia
South Africa
The United States

Regions and Countries of Focus

The European Union is considered as a bloc, not as individual countries.

Note: These markets represent several of the largest ZEV markets globally, provide socioeconomic and geographic diversity, and represent critical markets for the future of ZEV manufacturing and sales. They were also chosen to represent countries from each continent, excluding Antarctica.

Defining Different Policy Categories

Terms like ”policy,” “regulation,” and “standard” are often used interchangeably, causing confusion.

POLICY: An overarching term for a government response to an issue. This can be fiscal or non-fiscal and can include laws, regulations, standards, etc.

Policy Types

Policy types with enforcement mechanisms

REGULATION: A policy or law set by the government to achieve a specific objective, including standards or rules regarding what businesses or other organizations can or cannot do. Designed to impact the supply and demand of specific goods and services.

STANDARD: A government policy, rule, or guideline regarding how goods and services should be designed, manufactured, tested, etc.

REQUIREMENT: A policy tool requiring an entity to act.

Policy types without enforcement mechanisms

TARGET: Communicates a policy priority and provides indicators to other government entities and businesses about potential policy direction. Typically, other mechanisms need to be implemented to achieve goals set in targets.

Policy types structured as benefits

INCENTIVE: A fiscal measure utilized to incentivize producers or suppliers. This can be through tax benefits or less directly through mechanisms like land access discounts for manufacturing development.

FINANCING: A fiscal measure utilized to reduce the cost of capital or the cost of producing and/or purchasing a ZEV or corresponding infrastructure.

Sources: UC Berkeley, Oklahoma State University, UK Parliament, Congressional Budget Office

Supply-Side Policies Defined

SCOPE: This study is specifically focused on policies that impact and promote the use of ZEVs.

Supply-side policies are pivotal policies that bolster manufacturers or importers in producing and selling more ZEVs, thereby playing a crucial role in the transition to a greener automotive industry.

Regulatory

ZEV Sales Requirements stipulate that ZEVs, defined as battery-electric vehicles (BEVs), fuel-cell-electric vehicles (FCEVs), and/or plug-in hybrid electric vehicles (PHEVs) must make up a portion of manufacturers' annual vehicle sales. This percentage of sales increases annually and is often accompanied by a credit trading scheme.

Fuel Economy / Efficiency Standards stipulate that vehicles meet fuel usage/efficiency averages. These are often measured in miles per gallon (mpg) or liters per 100 km and calculated as an average across a manufacturer's fleet. They are designed to promote more efficient vehicles that use less fuel.

Vehicle Emissions Standards (including GHGs) are typically structured as performance-based rules where manufacturers must meet specific standards for the number of tailpipe pollutants emitted. For this study and the table on slide 6, the analysis focuses on whether tailpipe emissions standards include stipulations around GHG emissions, such as CO_2.

Fiscal

ZEV Manufacturing Incentives can include many types of incentives to support the manufacturing of ZEVs, such as incentives for pioneer industries and production-based incentives, tax incentives, or land concessions.

Public Financing government funds or financial mechanisms to support ZEV market growth (i.e., low-cost financing or credit enhancement mechanisms to specifically support ZEV manufacturing).

Note: The policy areas listed here are not exhaustive and seek to define the policies most relevant for this ZEV policy analysis. A range of additional industrial policies — such as workforce development initiatives, tariffs, subsidies, etc. may also considered supply-side policies.

Demand-Side and Infrastructure Policies Defined

SCOPE: While this study focused primarily on supply-side policies, it is important to consider the impact of demand-side policies on developing the ZEV market and creating a supportive ecosystem for supply-side policies.

Demand-Side Policies are aimed at spurring increased consumer demand for ZEVs, such as incentives, subsidies, tax exemptions, rebates, and adoption targets, to help develop nascent markets and support the transition to ZEVs.

Regulatory

- **Operational Regulations** can include a fleet electrification timeline for commercial operators, such as incremental purchase requirements with progressively higher percentages over time. It may also involve public procurement requirements, and the establishment of low- and zero-emission zones (ZEZs) where only specific vehicle types are permitted to operate.

Fiscal

- **Purchase/Operating Incentives** are subsidies, typically offered by governments, designed to bring down the upfront costs of ZEVs to unlock their total cost of ownership (TCO) advantage and increase accessibility to more consumers.

Infrastructure Policies aim to support the development of charging infrastructure, which is essential for the consumer transition to ZEVs. For example, incentives for charging providers, including land grants, installation incentives, favorable electricity tariffs, and ”make-ready”* requirements for new building development.

*Note: “Make-ready” requirements stipulate that developments of new buildings (either office, apartment, or both) and/or development of new parking facilities, include the infrastructure and capacity needed to allow for charging infrastructure to be installed easily at a future date.

Global Tariffs and Trade Policies

- **Tariffs and domestic protection:** Globally, tariffs have been implemented to protect domestic ZEV industries and battery production across the supply chain.
- **Market competition:** In the short term, tariffs can raise prices, while in the mid-term, tariffs can support competition. For example, tariffs were implemented to diversify solar production, resulting in some shifts in production locations; however, establishing a clear causal link between tariffs and these shifts is challenging. Careful management, including the implementation of sunset clauses, is necessary to prevent prolonged use of tariffs and the potential economic inefficiencies that could result.
- **Import duties*:** In markets without domestic manufacturing, levying import duties on ICE vehicles imposes a price on the externality of the polluting asset, while waiving import duties for ZEVs supports the use of vehicles that do not pollute.

Examples across the ZEV value chain:

Raw Material Sourcing
Indonesia regulated nickel ore exports, requiring that nickel ore be processed in the country before export. This is designed to support the development of the supply chain within Indonesia.

Material Processing
The US's IRA Clean Vehicle Credit (30D) includes stipulations on the origin of critical minerals.

China placed export controls on critical minerals.

Battery Production
The US government has increased the tariff for EV batteries and battery parts to 25%.

ZEV Manufacturing
The US government has implemented a 100% tariff on Chinese EVs.

US assembly of vehicles is a requirement for qualifying for the IRA Clean Vehicle Credit.

The EU has imposed an up to 45% tariff on EVs from China.

ZEV Import Duties
Costa Rica's elimination of import duties for ZEVs lowered ZEV prices*, which has boosted adoption; this practice aligns with the country's commitment to sustainable transportation.

Note: This study does not provide a comprehensive evaluation of tariffs, their inclusion was provided to recognize the potential impact they can have on the ZEV market and their role as a supply-side policy lever.
*Note: Import duties can act as a quasi-fiscal incentive
Sources: IEA, Congressional Research Service, IEA, The White House, Reuters, US Dept of Energy

03 POLICY ANALYSIS

This section examines policies enacted across the focal countries and regions to analyze supply- and demand-side policies, best practices, and policy deficiencies in each respective geography. This section covers:

A. Overview of ZEV-specific supply- and demand-side policies by geography.

Note: The policies mentioned in this deck are not necessarily comprehensive; the focus is placed on policies that impact the ZEV market. While the assessment occasionally highlights subnational policies, it only does so when such policies have an outsized effect on the ZEV market, as the focus was more specifically on national policies. Lastly, the review is based on the current policy landscape in each country.

The European Union

The CO_2 emission performance standards are the driving supply-side policy, directly and indirectly, encouraging ZEV adoption. This is complemented by supportive demand-side policies.

Supply-Side Policies (Regulatory)	
ZEV Sales Requirements	While the EU does not regulate ZEV sales, it does support the gradual increase of ZEV sales indirectly through its efforts to reduce the sale of vehicles that emit tailpipe pollution (see the description in the vehicle emission standards row below).
Fuel Economy/ Efficiency Standards	The EU does not have a standard specifically for fuel efficiency, rather it regulates CO_2 emissions (see the description in the vehicle emission standards row below).
Vehicle Emissions Standards (including GHGs)	Euro 6 vehicle emissions standards set specific requirements for pollutants such as nitrogen oxides (NOx), particulate matter (PM), and carbon monoxide until they are set to be replaced by Euro 7 standards. More stringent emissions standards are set to come into effect 2025 building upon past standards. The standards aim to significantly reduce air pollution from vehicle emissions, particularly targeting the reduction of NOx emissions from diesel vehicles, which have been a major concern for air quality in urban areas. The CO_2 Emission Performance Standards (complementary to Euro 6, which do not include standards on CO_2) are designed to reduce the average CO_2 emissions from new vehicles sold in the European Union. The rules have specific targets for manufactures to reduce CO_2 emissions of new vehicles sold and work to phase out the sale of vehicles that emit tailpipe pollution. It requires a 100% reduction in CO_2 emissions for new cars and vans by 2035 and 65% reduction target for heavy-duty trucks (ICCT).
Supply-Side Policies (Fiscal)	
ZEV Manufacturing Incentives	The EU has developed several R&D conglomerates to pool information on ZEV manufacturing and to collaborate amongst member nations to develop smart charging solutions. Additionally, the Green Deal Industrial Plan aims to bolster green industrial growth and includes specific mention of ZEV and battery production. It supports manufacturing by simplifying permitting and offers provisions to upskill the workforce to meet the demand for clean technologies.
Public Financing	The Green Deal Industrial Plan seeks to increase public and private investment in clean tech, potentially through an EU Sovereignty Fund and guidance on using the RE-Power EU fund. Specifically, the EU critical raw materials act provides a framework to identify strategic projects and details a streamlined process to create a favorable finical environment to mobilize investment in such projects.

Source: EU commission documents unless otherwise noted

The European Union

Demand-Side Policies (Regulatory)	
Operational Regulations	The EU Clean Vehicles Directive sets public procurement targets for low-emission vehicles through 2025, and in 2026, the regulation is more stringent in the definition of clean vehicles stating that these shall be zero-emission vehicles. Additionally, many major metropolitan areas across the EU have low emissions zones (LEZs), which are areas where polluting vehicles are prohibited from entering. There are also some regions that stipulate parking priority to low emission vehicles.
Demand-Side Policies (Fiscal)	
Purchase / Operating Incentives	The EU does not offer a purchase or operating incentive. However, some member countries have enacted purchase incentives. There are also tax and registration fee waivers, but as ZEV sales have increased, several member countries have gradually rolled back such incentives.
Infrastructure	
Policies / Funding Aimed at the Establishment of Public Infrastructure	The Alternative Fuels Infrastructure Directive (AFID) outlined charging infrastructure guidelines for EU member states. The Alternative Fuels Infrastructure Regulation (AFIR), passed in 2023, was then introduced to build on AFID and introduced concrete goals for charging placement and minimum charging deployment requirements. The European Energy Performance of Buildings Directive (EPBD III) sets requirements for residential and non-residential buildings to improve access to charging points, which impacts how ZEV owners can operate their vehicles in various settings.
Other (additional supportive ZEV fiscal or non-fiscal policies of note)	
Other	The EU introduced the Battery Regulation, which applies to all batteries manufactured or imported into the EU. Compliance with these regulations will significantly affect where and how batteries enter the market. In June 2024, the EU announced plans to impose a tariff of up to 38% on EV imports from China in addition to the existing 10% tariff. This decision is based on the EU Commission's assessment of "unfair subsidization" by China.

Source: EU commission documents unless otherwise noted

Australia Policy Analysis

Australia has supportive supply-side policies including fuel economy/efficiency standards and vehicle emission standards, but no sales requirements and limited targets. The country has some supportive demand-side policies.

Supply-Side Policies (Regulatory)	
ZEV Sales Requirements	Australia does not have a ZEV sales requirement, but the country does have a government fleet target of 75% of new passenger vehicle purchases and leases to be low emissions* by 2025 and 100% ZEV light-duty vehicle acquisition by 2035 (and aspire for the same for medium- and heavy-duty vehicle acquisitions).
Fuel Economy/ Efficiency Standards	See below for information on the New Vehicle Efficiency Standard (NVES) which is both a fuel economy/efficiency standard and a vehicle emissions standard.
Vehicle Emissions Standards (including GHGs)	The minimum standard for new light-duty vehicles in Australia is Australian Design Rules (ADR) 79/04, based on the standard Euro 5 (though many vehicles meet Euro 6). New ADRs based on Euro 6 for light-duty vehicles (including cars, SUVs, and light commercial vehicles) will be phased in as follows: • Newly approved light-duty vehicle models from December 1st, 2025. • All light-duty vehicles on or after July 1st, 2028. In 2024, Australia passed NVES, which will take effect January 1, 2025, and apply to new cars. It is projected to cut emissions from new passenger cars by over 60% by 2030 and half from new light commercial vehicles. It sets the first CO_2 emissions standards for Australia's light-duty vehicles, setting annual gCO_2/km emission targets from 2025–2029 for passenger cars, SUVs, and vans.**
Supply-Side Policies (Fiscal)	
ZEV Manufacturing Incentives	The Australian government has committed $15 billion through the National Reconstruction Fund (NRF) to provide financing for projects that diversify and transform the country's industry and economy in priority areas. Transportation is considered a priority area.
Public Financing	Funding from The Clean Energy Finance Corporation (a government owned green bank) and Angle Auto Finance provide short-term loans to dealerships to getting 20,000 new EVs on the road in the next two years. The Clean Energy Finance Corporation is working with Taurus and Angle Auto Finance to reduce interest rates for EVs. Some state level governments are offering reduced interest rates for EVs and infrastructure. The government of the Australian Capital Territory (ACT) offers zero interest loans up to $15,000 for ZEVs and charging infrastructure. The Tasmanian government has the Energy Saver Loan Scheme, which provides interest free loans for $500-$10,000 for three years, for EV charging infrastructure.

Sources: Australian Government Dept. of Finance, Australian Government, National Electric Vehicle Strategy, New Vehicle Efficiency Standard (NVES), ICCT, Minister for Climate Change and Energy, Australian Electric Vehicle Industry Recap 2023, CEFC
*Note: defined as battery electric vehicles, fuel cell vehicles, and plug-in hybrid vehicles.
**Note: some components of NVES are vehicle emissions standards, and some could be considered fuel economy standards.

Australia Policy Analysis

Demand-Side Policies (Regulatory)	
Operational Regulations	Research did not yield policies in Australia for this category.
Demand-Side Policies (Fiscal)	
Purchase / Operating Incentives	Australia offers fringe tax benefit exemptions for company fleets and salary-sacrifice arrangements. There are some state specific incentives, including stamp duty and registration incentives (Northern Territory), and a rebate scheme (Queensland), as some examples.
Infrastructure	
Policies / Funding Aimed at the Establishment of Public Infrastructure	Multiple sources of public funding for charging infrastructure exist in Australia, including the Driving the Nation Fund which aims to expand a nation-wide EV charging network, as well as hydrogen refueling stations.
Other (additional supportive ZEV fiscal or non-fiscal policies of note)	
Other	Import tax exemptions for EVs below the luxury car tax threshold. Federal and state-level support for critical minerals exploration, including the Critical Minerals Development Program, rent reduction for permits (Queensland), and exploratory drilling grants (Tasmania).

Sources: Electric Vehicle Council, Australian Electric Vehicle Industry Recap 2023, Driving the Nation Program, Driving the Nation Fund, Minister for Climate Change and Energy, CEFC

Brazil Policy Analysis

Brazil does not have many supply-side policies in place to support EVs and has limited local level demand-side policies.

Supply-Side Policies (Regulatory)	
ZEV Sales Requirements	Research did not yield policies in Brazil for this category.
Fuel Economy/ Efficiency Standards	Brazil has had multiple fuel efficiency standards over time. The INOVAR Auto standard was replaced in 2018 by Rota 2030. This standard, amongst other components, included a reduction target of 11% of the average fuel consumption for new vehicles by 2022 compared to 2017. Rota 2030 fuel efficiency standards will be replaced by standards in the Mobilidade Verde e Inovação (MOVER)* program, though the details on the standards included are still to be determined.
Vehicle Emissions Standards (including GHGs)	The MOVER program will require OEMs to reach CAFE standards by 2027 for well-to-wheel emissions. The target for LDVs has not yet been announced. The country has adopted Euro 6 emissions standards. The MOVER program will also regulate HDV emissions, but the targets have not yet been set.
Supply-Side Policies (Fiscal)	
ZEV Manufacturing Incentives	The MOVER program will include incentives for OEMs, including tax breaks for OEMs that reach emissions targets, incentives for R&D, and import tax exemption for parts and components without nationally produced substitutes.**
Public Financing	The Brazilian government recently launched an initiative to coordinate financing for climate action. This includes “electric urban mobility.” Details on how this platform will facilitate the materialization of funding for mobility projects remain limited.

*Note: The MOVER program was passed in mid-2024, however many of the implementation details and specific targets were still being set at the time of this report being published.
**Note: These incentives are not exclusively for ZEVs.

Source: Bloomberg, Ministry of Finance, IEA

Brazil Policy Analysis

Demand-Side Policies (Regulatory)	
Operational Regulations	Research did not yield policies in Brazil for this category.
Demand-Side Policies (Fiscal)	
Purchase / Operating Incentives	9 of 26 states have purchase/operating incentives, but they are not consistent and change often. The MOVER program mentions implementing a feebate, however the details are still to be determined.
Infrastructure	
Policies / Funding Aimed at the Establishment of Public Infrastructure	Research did not yield policies in Brazil for this category.
Other (additional supportive ZEV fiscal or non-fiscal policies of note)	
Other	Previously ZEVs were exempt from import tax, but in 2023 Brazil announced it would start ramping up import taxes for ZEVs. In January 2024 vehicles were subject to 10%-15% import tax (10% for EVs, 15% for HV/PHEV), this increased in July 2024 to 18%-25% and will reach 35% in July 2026.

Sources: Reuters, MarkLines, Business Wire

China Policy Analysis

China's NEV* dual credit policy encouraged ZEV adoption and is complemented by supportive demand-side policies.

Supply-Side Policies (Regulatory)	
ZEV Sales Requirements	ZEV sales are regulated via the NEV dual credit policy. This policy uses a credit-based system with specific credit targets for light duty vehicles, requiring manufacturers to either meet or exceed their annual targets or purchase additional credits to ensure compliance (see the next slide for more details).
Fuel Economy/ Efficiency Standards**	China's fuel efficiency standards are governed by China's Corporate Average Fuel Consumption (CAFC) standards. As part of China's dual credit accounting mechanisms, the accounting system and targets for the CAFC standard are linked to the NEV credit program (see the next slide for more details).
Vehicle Emissions Standards (including GHGs)	China's Stage 6 emission standards, implemented in two phases (6a and 6b), set stringent limits on various pollutants, including carbon monoxide, hydrocarbons, NOx, PM, and particle number. While it primarily focuses on tailpipe emissions and does not directly regulate GHGs, it does include a limit for nitrous oxide, which is a potent GHG.
Supply-Side Policies (Fiscal)	
ZEV Manufacturing Incentives	China offers ZEV manufacturing incentives at both national and subnational levels, including corporate income tax benefits, R&D subsidies, etc. For example, qualifying ZEV and battery manufacturers benefit from a reduced corporate income tax rate of 15%, compared to the standard 25%.
Public Financing***	A series of government initiatives, including procurement grants, and concessions for research and development, along with concessional loans, have been mobilized to support the automotive sector. Various state-owned banks in China, such as the Bank of China and the China Development Bank, play an active role in funding the production of ZEVs, battery components, and the refining and processing of critical minerals at scale.

*Note: NEVs are specifically referred to in Chinese policy documents; the definition of NEV is basically that of a ZEV defined as battery-electric vehicles (BEVs), fuel-cell-electric vehicles (FCEVs), or plug-in hybrid electric vehicles (PHEVs).
** Note: China regulates the fuel economy of both light and heavy-duty vehicles. The CAFC standard existed before the dual credit system came into effect. The dual credit system applied a credit-based system to the fuel efficiency standards for the light-duty sector only.
***Note: Some international actors point out that China's use of public financing schemes has unfairly distorted the global ZEV marketplace, giving Chinese companies an unfair advantage; assessment of the policies on these merits is outside of the scope of this study.

Source: CSIS, Government documents unless otherwise noted

DEEP DIVE

NEV dual credit policy

Region: China

The dual credit accounting policy was issued and is managed by the Ministry of Industry and Information Technology (MIIT). The dual credit system includes CAFC and NEV credits, with a 1:1 ratio. To comply with the NEV dual credit policy, manufacturers must produce and sell enough NEVs to meet or exceed their annual credit targets or purchase credits from other manufacturers if they fall short. The government controls the total credit supply, influencing credit prices. NEV credits can be used to offset CAFC deficits, but CAFC credits cannot be used to offset NEV deficits, creating a one-way interaction that incentivizes manufacturers to produce more NEVs. The calculations for both credits are presented below.

CAFC credits = (CAFC compliance value - CAFC actual value) × Passenger car production volume or import volume

CAFC actual value refers to the corporate average fuel consumption. The lower the fuel consumption of the passenger cars produced the lower the CAFC actual value.

CAFC compliance value is the corporate average fuel consumption target. The fuel consumption target for passenger cars decreases with time or seeks to become more efficient or stringent over time. For example, from 2020 to 2025, the average target value was lowered by 20%.

NEV credits = NEV actual value - NEV compliance value

NEV actual value: The NEV credits for each vehicle type are calculated by multiplying the production volume by the NEV credits per vehicle.

NEV compliance value: The NEV compliance value is determined by applying a percentage target to the number of newly produced ICE vehicles each year, with exceptions for smaller manufacturers. This target increases annually, from 12% in 2020 to 18% in 2023, and reaching 38% in 2025. While the production of fuel-efficient vehicles can help lower the NEV compliance target, the impact of fuel-efficient vehicles diminishes over time, reflecting the government's growing focus on encouraging ZEV production.

Impact

China's NEV credit scheme is a market-based approach to regulating and encouraging the manufacturing of ZEVs.

- In 2023, China accounted for 60% of global ZEV sales.
- The increasing availability of ZEVs in the market has positively impacted pricing, 60% of ZEVs sold in 2023 were less expensive than their ICE equivalent.

Source: MIIT, Gov.cn

China Policy Analysis

Demand-Side Policies (Regulatory)	
Operational Regulations	Several Chinese regions, including Hainan and Beijing, have implemented LEZs and zero-emission zones that restrict or prohibit the operation of ICE vehicles in designated areas, aiming to reduce air pollution, improve urban air quality, and accelerate the adoption of NEVs. Additionally, Shenzhen implemented fleet purchase requirements.
Demand-Side Policies (Fiscal)	
Purchase / Operating Incentives	China previously offered national purchase subsidies for NEVs, but these subsidies gradually phased out over time, and by the end of 2022, they had been removed; subnational subsidies still exist. China waives the 10% purchase tax for NEVs and the vehicle and vessel tax for NEVs that meet certain range requirements. China's Action Plan for Promoting Large-scale Equipment Renewal and Trade-in of Consumer Goods significantly increases subsidies for consumers replacing old vehicles with NEVs, doubling the incentive to 20,000 yuan for NEV passenger cars and 15,000 yuan for conventional fuel vehicles.
Infrastructure	
Policies / Funding Aimed at the Establishment of Public Infrastructure	China has established guidelines for constructing a high-quality charging infrastructure system by 2030 focused on creating a comprehensive network of charging stations across cities, highways, and rural areas. Cities like Shanghai have implemented comprehensive measures to encourage the development of charging and battery-swapping facilities, subsidizing up to 30% of the charging or swapping infrastructure costs, with a cap of $84/kW for DC facilitates and $42/kW for AC.
Other (additional supportive ZEV fiscal or non-fiscal policies of note)	
Other	Chinese cities and provinces offer various license plate privileges to NEVs, either reducing the waiting time to obtain a license plate or waiving the license plate fee, which can be as high as 100k CNY ($13,000) in cities like Shanghai. China has national and subnational NEV sales targets. At the national level, the country aims for 45% of total vehicle sales to come from NEVs by 2027.

Source: Government documents unless otherwise noted

India Policy Analysis

India has an effective incentive scheme and strong demand-side policies but has not extensively leveraged supply-side policies.

Supply-Side Policies (Regulatory)	
ZEV Sales Requirements	India does not have a ZEV sales requirement but does have national ZEV targets*. India formally aims to achieve 30% electric vehicle penetration by 2030.
Fuel Economy/ Efficiency Standards	In 2015, the Indian government introduced fuel efficiency standards known as Corporate Average Fuel Efficiency (CAFE) for passenger cars. These standards were updated in 2017 and 2023 to set more stringent fuel efficiency targets for passenger cars. Under such standards, car manufacturers must report certified CO_2 emissions. Over time, these standards have become more stringent, and the next iteration of targets to be effective in 2027 will target a fleet average economy standard of 91.7 g CO_2/km. The CAFE standards include super credits, which are a multiplier for producing EVs and reward manufacturers for producing and selling the vehicles by granting them additional emissions credits, which can offset emissions from ICE vehicles.
Vehicle Emissions Standards (including GHGs)	Bharat Stage (BS) emissions standards limit pollutants (e.g., PM, NOx, SOx, carbon monoxide, hydrocarbons, and methane) from vehicles by setting specific standards and requiring all new vehicles (passenger and commercial) to comply by meeting real-world testing norms. BS-VI is modeled after the Euro 6 emissions standards.
Supply-Side Policies (Fiscal)	
ZEV Manufacturing Incentives	Offers incentives based on production of qualifying automotive components. The incentive includes some ICE components for automotive manufacturing, but the focus is on providing financial incentives for ZEV and battery production.
Public Financing	Several projects are being financed by multilateral and development finance institutions to support the growth of the e-mobility sector. The State Industries Development Bank of India (SIDBI) has created a de-risking facility for light-duty electric vehicle loans and supportive services.

*Note: Such aims are not bound by regulation
Source: Indian Government Documents unless otherwise noted

India Policy Analysis

Demand-Side Policies (Regulatory)	
Operational Regulations	Several state and city policies include parking and operational restrictions on ICE vehicles, waving these traffic regulations for ZEVs. Additionally, states and cities have implemented feebate programs where the tax on fossil fuel is used to fund a significant portion of the demand incentives for ZEVs.
Demand-Side Policies (Fiscal)	
Purchase / Operating Incentives	The Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) scheme, launched in 2015, offers subsidies for EV purchases and charging infrastructure. The FAME II program ran through July 2024. A new incentive program (PM E-DRIVE) was announced in September 2024, incentivizing the purchase of electric buses, electric two and three-wheelers, and electric trucks; the scheme's total budget is $1.3 Billion.
Infrastructure	
Policies / Funding Aimed at the Establishment of Public Infrastructure	As part of FAME there are incentives set aside to develop chargers. Cities like Delhi have also provided land concessions for the deployment of charging infrastructure to defray the cost.
Other (additional supportive ZEV fiscal or non-fiscal policies of note)	
Other	The vehicle scrappage policy by the Ministry of Road Transport and Highways requires that commercial vehicles failing the fitness test must either be repaired or scrapped. Owners of scrapped vehicles may get incentives for buying a new vehicle and a scrap value. Renewal fees increase for commercial vehicles older than 15 years to discourage high emissions. International commitments and bilateral: India is a signatory to the Clean Energy Ministerial's EV 30@30 campaign, with a target of achieving at least 30% of new EV sales by 2030. India aims to achieve about 50% of its installed power capacity from non-fossil fuel sources by 2030. This includes a target of 500 GW of renewable energy capacity by 2030.

Source: Indian Government Documents unless otherwise noted

Indonesia Policy Analysis

Indonesia has limited supply-side policies (but is increasingly developing more) along with supportive demand-side regulations.

Supply-Side Policies (Regulatory)	
ZEV Sales Requirements	Indonesia does not have a ZEV sales requirement but does have a target to produce 600,000 electric four-wheelers and 2.45 million electric two-wheelers by 2030*.
Fuel Economy/ Efficiency Standards	Indonesia does not have a direct fuel efficiency standard, but it does have indirect measures in place. This includes the Low-Carbon Emission Vehicle program which accounts for engine efficiency and emissions when determining vehicle tax rates.
Vehicle Emissions Standards (including GHGs)	The country has adopted Euro 4** emission standards for light duty vehicles, and Euro 2 or 3 for two-wheel vehicles (depending on the engine size), which make up a significant portion of the market.
Supply-Side Policies (Fiscal)	
ZEV Manufacturing Incentives	Indonesia has a tax holiday for corporate income tax for “pioneer industries” — this includes electric motor vehicle manufacturers.
Public Financing	Research did not yield policies in Indonesia for this category.

Sources: Asian Transportation Outlook, ICCT
*Note: This target is not bound by regulation
**Note: while light duty vehicles must meet Euro 4 standards, most of the fuel sold in Indonesia that goes into the vehicles does not meet Euro 4 standards.

Indonesia Policy Analysis

Demand-Side Policies (Regulatory)	
Operational Regulations	Electric four-wheelers are exempt from odd-even traffic policy in Jakarta where vehicles are only allowed on the road on odd or even dates dependent on their license plate, which is designed to reduce city congestion.
Demand-Side Policies (Fiscal)	
Purchase / Operating Incentives	Indonesia offers purchase subsidies toward electric two-wheelers of up to IDR 7 million (~$450). There are also incentives in place for ICE to EV conversion (IDR 10 million per conversion) for two-wheel vehicles. Electric two-wheelers and electric four-wheelers are exempt from one-time title transfer tax of 10% and annual vehicle tax of 2%. Reduced value added tax (VAT) from 11% to 1% for electric four-wheelers and e-buses (for those that meet 40% local content requirements).
Infrastructure	
Policies / Funding Aimed at the Establishment of Public Infrastructure	There are maximums on charging infrastructure service fees, and safety and streamlining standards for infrastructure.
Other (additional supportive ZEV fiscal or non-fiscal policies of note)	
Other	Completely built-up (CBU) electric vehicles have 0% import tax. Completely knocked-down (CKD) electric four-wheelers that meet the 20-40% local content requirement qualify for a 0% import tax. The government exempts electric vehicles from the luxury sales tax. (Note that completely CKD vehicles are only eligible if they meet the 20-40% local content requirements)

Sources: Asian Transportation Outlook, Reuters
*Note: completely built-up vehicles are those that are imported as a complete, fully assembled vehicle.
**Note: completely knocked-down vehicles are those that are shipped in parts and assembled locally.

South Africa Policy Analysis

South Africa does not have significant supply-side or demand-side policies.

Supply-Side Policies (Regulatory)	
ZEV Sales Requirements	Research did not yield policies in South Africa for this category.
Fuel Economy/ Efficiency Standards	Research did not yield policies in South Africa for this category.
Vehicle Emissions Standards (including GHGs)	South Africa has adopted Euro 2 emissions standards.
Supply-Side Policies (Fiscal)	
ZEV Manufacturing Incentives	Tax breaks for EV manufacturers are expected to take effect March 1st, 2026. This will allow producers to claim 150% of qualifying new investment spending in the first year.
Public Financing	Research did not yield policies in South Africa for this category.

Sources: South African Government, South Africa National Treasury, ICCT, ICCT, EY, PwC

South Africa Policy Analysis

Demand-Side Policies (Regulatory)	
Operational Regulations	Research did not yield policies in South Africa for this category.
Demand-Side Policies (Fiscal)	
Purchase / Operating Incentives	An environmental levy is in place for passenger vehicles per gram of CO_2 produced per kilometer, this acts as a lever to drive demand and aims to influence consumer behavior more broadly.
Infrastructure	
Policies / Funding Aimed at the Establishment of Public Infrastructure	Research did not yield policies in South Africa for this category.
Other (additional supportive ZEV fiscal or non-fiscal policies of note)	
Other	The import of used vehicles is prohibited in South Africa unless special permission is provided.

Source: Brooking Institute

United States Policy Analysis

The United States has several supply-side policies, including a ZEV sales requirement (in some states) and demand-side support from policies such as the Inflation Reduction Act (IRA).

Supply-Side Policies (Regulatory)	
ZEV Sales Requirements	Advanced Clean Cars II (ACC II)* decreases emissions by increasing ZEV sales through two programs. (1) the ZEV program requires that ZEVs (BEVs and FCEVs) make up an increasing portion of annual vehicle sales. (2) the Low-Emission Vehicle (LEV) program, which strengthens pollutant emissions standards and updates the emissions test procedures. ACC II has been adopted the following states: California, Colorado, Delaware, Maryland, Massachusetts, New Jersey, New Mexico, New York, Oregon, Vermont, and Washington (as of date of publication). Advanced Clean Trucks (ACT)* requires that manufacturers of medium- and heavy-duty vehicles sell ZEVs or near-ZEVs (such as PHEVs) at an increasing percentage of annual sales from 2024 to 2035. The requirement includes a credit trading mechanism, allowing manufacturers to comply either through sales of vehicles to generate credits or by trading credits with others. ACT has been adopted in 12 states: California, Colorado, Maryland, Massachusetts, New Jersey, New Mexico, New York, Oregon, Rhode Island, Vermont, Virginia, and Washington (as of date of publication).
Fuel Economy/ Efficiency Standards	Corporate Average Fuel Economy (CAFE) standards are measured by calculating the average fuel economy (in mpg) of a manufacturer's fleet of passenger cars and light trucks for a given model year. Exceptions: Light trucks that exceed 8,500 lbs gross vehicle weight rating do not have to comply with CAFE standards. Compliance is via fleet-wide average. The general attainment index is based on a fleet's average mpg. A reduction in fuel consumption leads to reduced GHG emissions (including CO_2) since emissions are generated through the combustion of fuels. Producing ZEVs is one way to comply with CAFE standards.
Vehicle Emissions Standards (including GHGs)	US tailpipe emission regulations limit pollutants from vehicle exhaust pipes and are enforced by the EPA under the Clean Air Act. The Multi-Pollutant Emissions Standard comprises of two performance-based rules regulating GHG emissions and criteria pollutants (mg/g). GHG emissions are measured in g/mile of CO_2e emissions by fleet. These performance-based standards are technology-neutral and provide automakers with the flexibility to comply by using a combination of advanced gasoline, hybrid, plug-in hybrid, and battery electric powertrains. The standards require an industry-wide average target for light-duty vehicles of 85 grams of CO_2 per mile in model year 2032, a nearly 50% reduction from the 2026 standard. Medium-duty vehicles must achieve a final standard of 274 grams of CO_2 per mile by 2032, a 44% reduction from the 2026 standard.
Supply-Side Policies (Fiscal)	
ZEV Manufacturing Incentives	The Advanced Manufacturing Production Tax Credit (Section 45X) offers credits for critical mineral and subcomponent production, and battery cell and module production. This includes 10% of costs for domestic refining of electrode active minerals and production of subcomponents. It also includes up to $45/kWh for the manufacturing of battery cell packs and modules. 45X is uncapped. The Domestic Conversation Grant Program provides financial assistance to support the conversion of existing manufacturing facilities in the United States to produce ZEVs and components. The Advanced Energy Property Credit Program (Section 48C) is a competitive program with a $10 billion total allocation that provides a credit of up to 30% for different types of energy projects. Qualifying project types include those that re-equip, expand, or establish a facility for processing, refining, or recycling critical minerals, those that re-equip a facility with equipment designed to reduce GHG emissions by at least 20%, and those that re-equip, expand, or establish a facility for the production or recycling of various types of technology including ZEVs and charging infrastructure.
Public Financing	The US Loan Program Office (LPO) provides loans and loan guarantees for EV manufacturing and infrastructure, including the Advanced Technology Vehicles Manufacturing Loan Program.

Sources: RMI, RMI, RMI, Grant Thornton

*Note: ACC II and ACT are significant policies paving the way for EV policy development in the United States, however, they have been enacted by California with select states following suit

DEEP DIVE

How ZEV Sales Policies Work

Region: United States

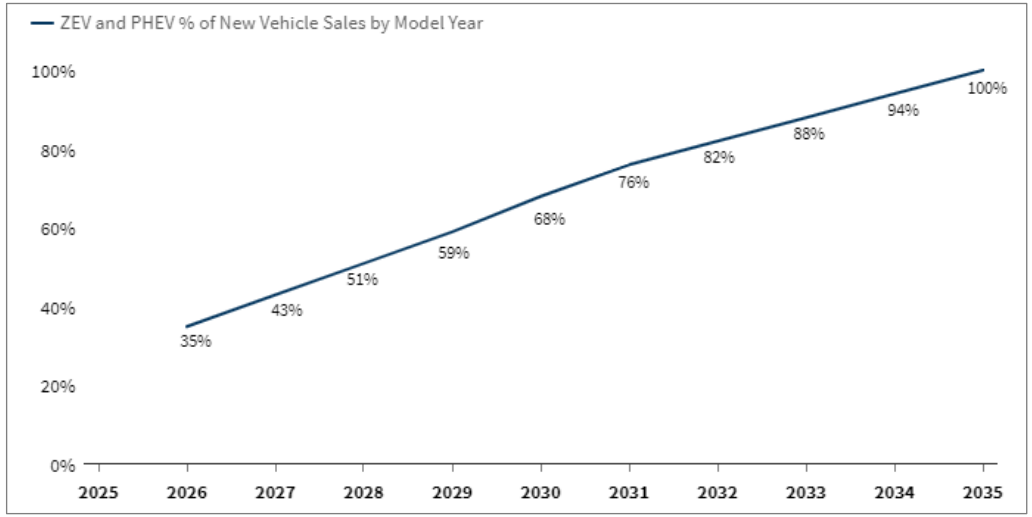
The ACC II regulation builds on the ACC rule passed in 2012. ACC II decreases emissions by increasing ZEV sales primarily through the ZEV program. That stipulates that ZEVs, defined as BEVs or FCEVs, must make up an increasing portion of annual vehicle sales.

ACC II uses a vehicle "value" accounting system that awards roughly one value for the sale of a ZEV and a portion of a value for the sale of a PHEV. A value is closely correlated to the sale of actual vehicles and so the vehicle value percentage targets outlined in ACC II can reasonably be considered a representation of ZEV sale share percentage.

To comply with ACC II, manufacturers must submit an annual compliance report from 2026 onward. A manufacturer complies when it can show that their sale of ZEVs and PHEVs resulted in enough total vehicle value to meet their ACC II ZEV and PHEV target for a given model year.

The total ZEV fleet milestone is calculated by taking the ZEV percentage target and multiplying that by the number of vehicles sold. The result is the number of ZEV values that a manufacturer obtains to comply with ACC II.

ACC II Milestones



This figure shows the ZEV sales share targets that the policy aims to achieve

Impact: the American Lung Association estimates that from 2020 to 2050, a zero-emission transportation sector (driven by this policy and others) would help avoid 110,000 premature deaths, 2.78 million asthma attacks, and 13.4 million lost workdays.

Source: RMI

DEEP DIVE

How Production Tax Credits Work

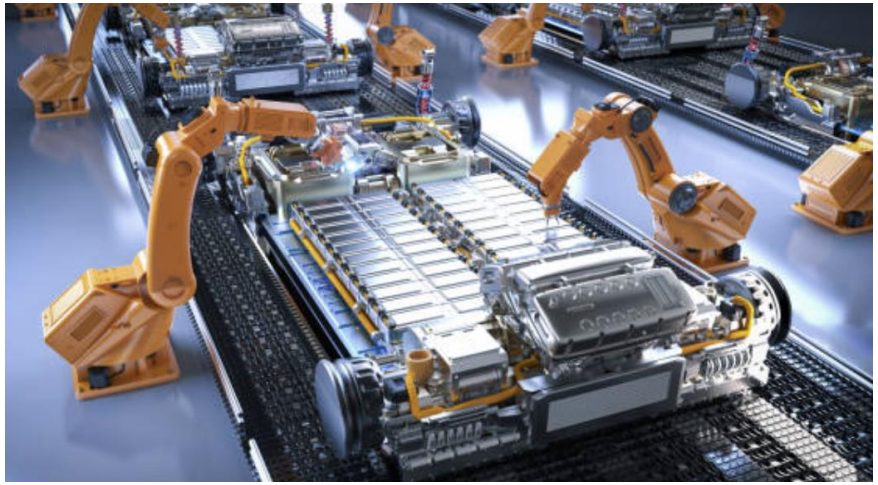
Region: United States

Context: Under the *Advanced Manufacturing Production Credit (45X),* which is a component of the IRA, domestic battery manufacturers can receive a credit for critical mineral and subcomponent production, and battery cell and module production. This credit is designed to make US-made battery cells and packs more competitive by covering the cost gap between domestic-made and foreign-made battery cells and packs. The 45X credit is uncapped. The component pieces of the tax credit are:

- 10% of the costs are covered for the domestic refining of electrode active minerals (lithium, cobalt, nickel, and manganese) and domestic production of subcomponents (including cathodes, anodes, and electrolytes).
- Up to $45/kilowatt-hour (kWh) will be credited for the manufacturing of battery cell packs and modules. This is comprised of $35/kWh for battery cells and $10/kWh for battery modules. The full $45/kWh is available for battery modules that do not use battery cells.

Impact: 45X can attract substantial private investment in the battery supply chain. North America only accounts for 6% of global lithium-ion cell manufacturing, and the announced battery cell manufacturing capacity is likely to only meet a low share of the region's EV demand.*

Additionally, the tax credit benefit could be passed through to consumers in the form of reduced upfront vehicle prices.



Source: RMI, ICCT, iStock

*Note: Statistic on battery manufacturing is for North America, however a large number of these projects are located in the United States.

United States Policy Analysis

Demand-Side Policies (Regulatory)	
Operational Regulations	Advanced Clean Fleets (ACF) is designed to phase out the sale of tailpipe-polluting medium- and heavy-duty trucks, by requiring fleets to adopt an increasing percentage of ZEVs. Compliance terms vary based on truck type and use. This standard has been created and adapted by California; Washington has also adopted this rule. Clean Miles Standard (CMS) is designed to reduce GHG emissions from transportation network companies, such as ride-hailing fleets. CMS requires that by 2030 service providers' emissions from passenger miles traveled must be 0, and 90% of all vehicle miles traveled must be powered by EVs. This standard has been created and adapted by California.
Demand-Side Policies (Fiscal)	
Purchase / Operating Incentives	Clean Vehicle Credit (IRA - 30D) a federal tax credit available for qualifying consumers and EV models of up to $7,500 contingent on factors including where the vehicle's battery components are manufactured or assembled, where critical minerals are sourced from, and vehicle price. Commercial Vehicle Credit (IRA - 45W) available for light, medium, and heavy-duty EVs, a federal tax credit worth 30% of vehicle cost, up to $7,500 for vehicles with gross weight rating of under 14,000, or $40,000 for all other vehicles, when purchased or leased for commercial business purposes. Clean School Buses & Ferries funding available through the Infrastructure Investment and Jobs Act (IIJA), including $5 billion to replace existing school buses with clean school buses, with an emphasis on low-income, rural, and tribal schools. This includes funding for ZEV buses and buses that use alternate fuels.
Infrastructure	
Policies / Funding Aimed at the Establishment of Public Infrastructure	National Electric Vehicle Infrastructure (NEVI) Formula Program provides funding of up to 80% of eligible project costs for states to deploy an interconnected network of EV charging stations along alternate fuel corridors designated by the Federal Highway Administration. The Alternative Fuel Infrastructure Tax Credit (30C) is available for qualifying fueling infrastructure installed in qualifying locations, from 1/2023 – 12/2032. This includes ZEV charging infrastructure, and labor costs for construction and installation. Businesses are eligible for a tax credit of 6% of depreciable costs up to $100,000 per item or 30% of depreciable costs up to $100,000 per item if installation meets prevailing wage and apprenticeship requirements. Consumers that install qualifying equipment at home may receive a tax credit of 30% of the cost up to $1,000.
Other (additional supportive ZEV fiscal or non-fiscal policies of note)	
Other	A 100% tariff on EVs imported from China is effective as of September 27th 2024.

Sources: RMI, RMI, RMI, US Dept of Energy, US Dept of Energy

SECTION SUMMARY

Supply-Side Policy Enactment

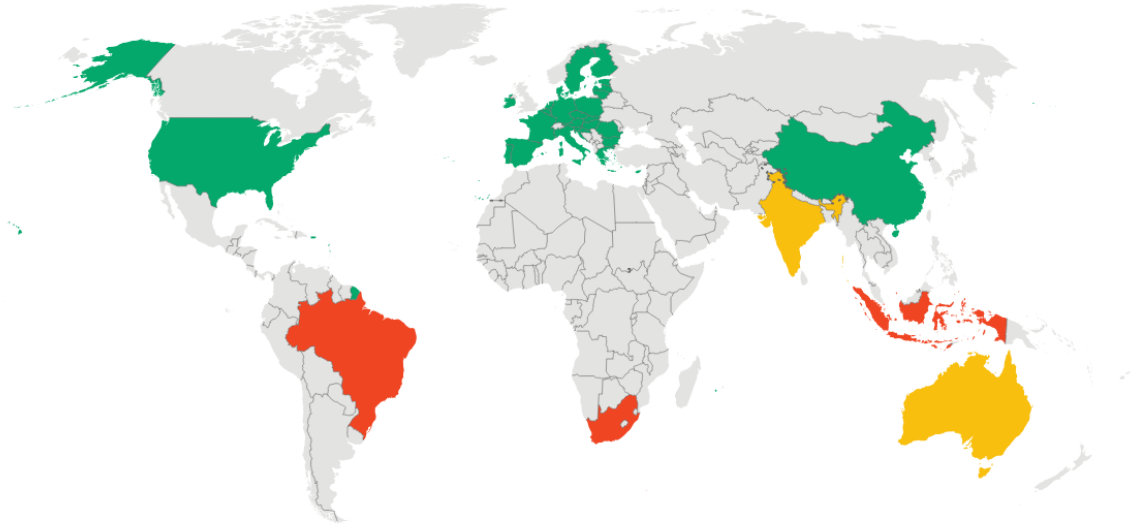
There are varying degrees of ZEV supply-side policy implementation globally. This analysis considers the supply-side policies of countries and regions, including ZEV sales requirements, fuel economy/efficiency standards, vehicle emissions standards, ZEV manufacturing incentives, and public financing. Below are examples of countries/regions with impactful supply-side policies:

European Union: The EU's CO_2 emissions standard, along with its commitment to phase out new vehicle registrations with tailpipe emissions by 2035, represents one of the most comprehensive policies for reducing vehicle emissions.

China: China's NEV credit scheme incentivizes manufacturers to produce more ZEVs, exemplifying a market-based approach to regulating and encouraging ZEV manufacturing.

United States: The US has significant ZEV manufacturing incentives, including 45X, and strong vehicle emissions standards.

The Prominence of Supply-Side Policies to Support ZEVs Across Studied Regions



Supply-Side Policies Not Utilized
Supply-Side Policies Partially Utilized
Supply-Side Policies Fully Utilized

The European Union is considered as a bloc, not as individual countries.

Source: RMI Analysis

Supply-Side Policies Not Utilized:
There are little to no supply-side policies supporting the ZEV transition.

Supply-Side Policies Partially Utilized:
Either supply-side policies have only been enacted at the subnational level, or the country has not enacted robust supply-side regulations that directly govern ZEV manufacturing.

Supply-Side Policies Fully Utilized:
Direct ZEV stipulations have been enacted, driving ZEV manufacturing.

Note: The overall rating was green when a county or region received 2.5 of 5 green ratings in supply-side policy categories, as shown on slide 6. See Appendix A for the methodology utilized to identify overall color coding for each country/region.

Nuances for Consideration

Country Nuances

Differences in how countries are structured, their investment focus, history, and international standing can have a significant influence on policy design and impact. What works in one geography may not work in another, but it is challenging to isolate specifically why.

Country Specific

- A history of domestic manufacturing, either generally or automobile-specific.*
- Presence of critical minerals.
- Driving force for environmental goals (i.e., decreased carbon footprint vs increased independence).

Geopolitical

- International trade tensions.
- Import reliance and the ways in which policy may reinforce dependency rather than foster local capacity development.
- Relevant tariffs.

Political

- Government structure.
- Shifting government priorities (i.e., what is politically ”in”).
- Socio-economic standing of the country and the impact of investment decisions.
- Country credit rating and impact on borrowing.

Policy Nuances

Policies are not implemented in a vacuum, making it challenging to isolate the impact of specific policies.

Supply-side policy is often implemented as part of a policy package.

Policy effectiveness is often contingent on how they are implemented.

A holistic approach to policy design and implementation, in which a group of policies work in tandem, is most effective.

*Note: The implementation of supply-side policies may have varying impacts on domestic markets, depending on whether the market primarily produces or imports vehicles. In markets that rely heavily on imports and have limited purchasing power, such policies could have a more acute impact on consumer price and may not sway international manufacturers to dramatically adjust their overall production of ZEVs and business strategies.

04
ZEV SALES AND MANUFACTURING TRENDS

The relationship between implemented ZEV policies and sales trends and manufacturing. This section covers:

A. ZEV sales.

B. ZEV exports.

C. Electric engine manufacturing.

ZEV Sales in Select Countries

Countries with high levels of policy support have higher – and increasing – ZEV sales.

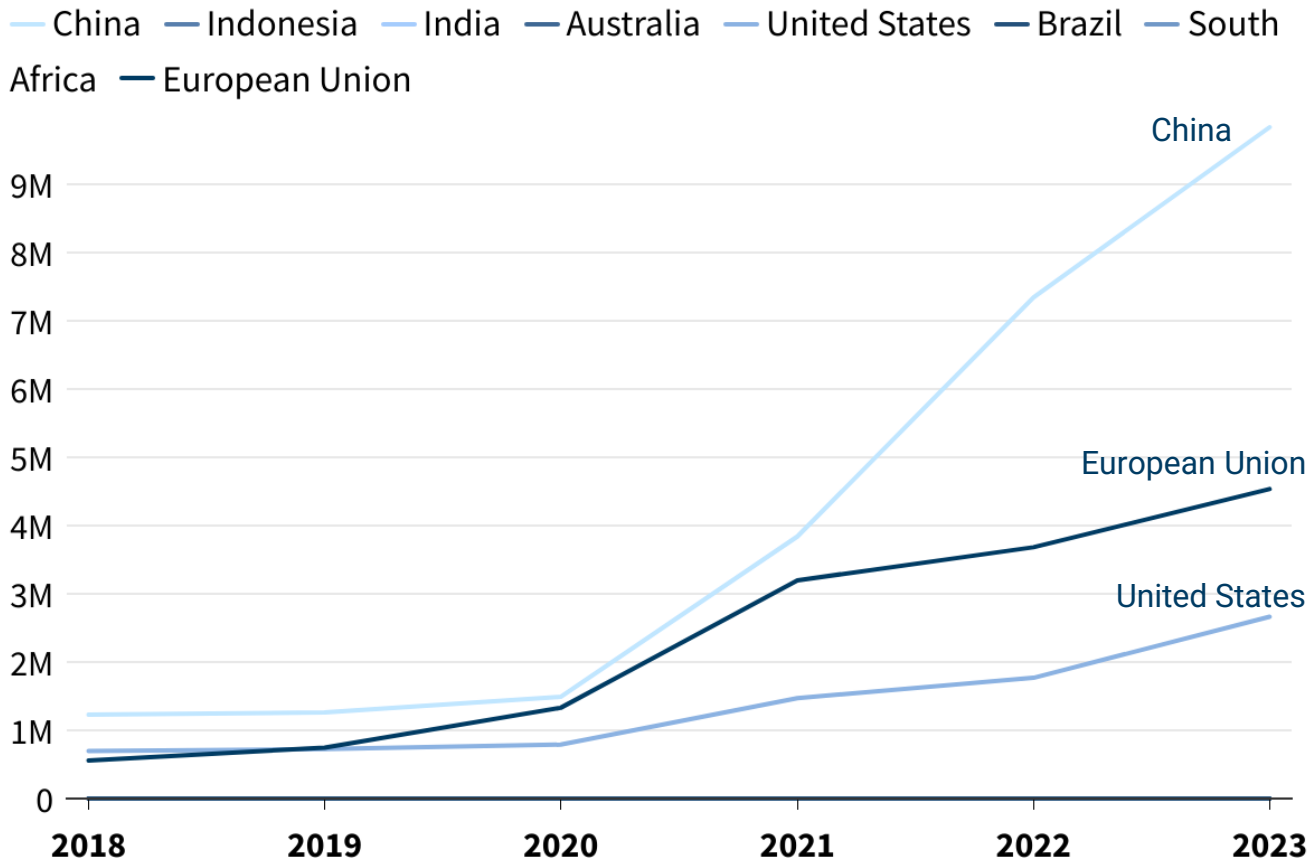
ZEV sales indicate demand, which is an essential component of the ZEV ecosystem as increased demand can provide confidence to manufacturers to increase supply. Three of the countries and regions with the highest quantity of ZEV sales currently offer or have previously offered favorable demand-side incentives.

In **China,** incentives for NEVs were previously offered, but they were phased out at the end of 2022.

In the **EU,** some member states have offered purchase incentives as well as tax and registration benefits.

The **United States** saw an uptick in ZEV sales after CAFE standards were revised in 2022 and in 2023 when IRA EV tax credits came into effect.

ZEV Sales - Select Country Analysis by Year (2018-2023)



Note: Data for European Union includes data from 23 countries within the EU. Includes vehicles for which powertrain information is available. Powertrains include EVs, PHVs, mild HV, and FCV. Vehicle segments include sedans/hatchbacks A-F, MPVs, SUVs A-E, pick-up trucks, and some light trucks.

Source: MarkLines

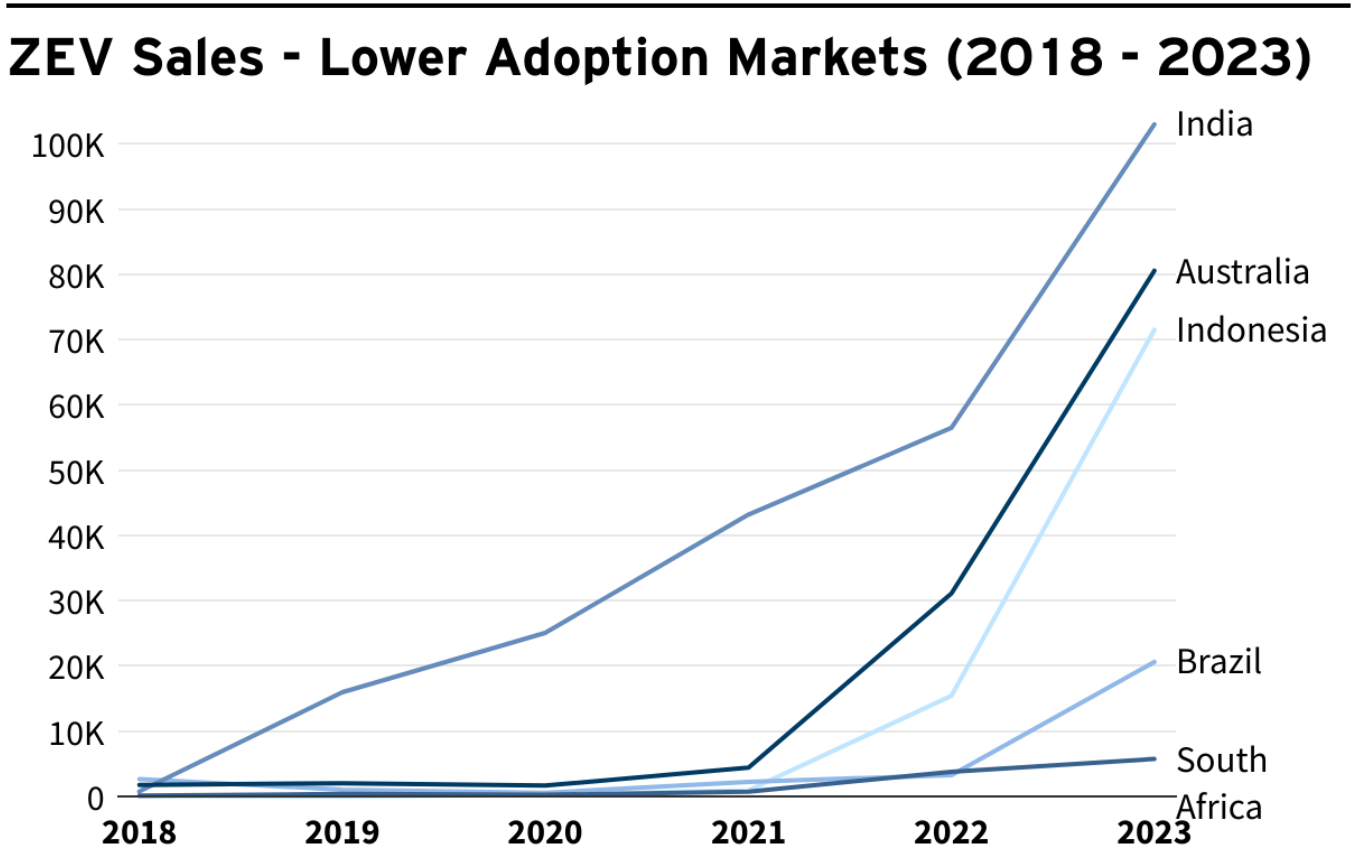
Sources: MarkLines, IEA, ICCT, IEA

ZEV Sales in Lower Adoption Markets

Removing the higher adoption markets of China, the EU, and the United States allows for increased graphical detail about ZEV sales in other countries included in this study.

India, Australia, and Indonesia were all previously classified in this study as having a "medium" level of policy support in the ZEV policy gap analysis. However, that is somewhat generalized. For example, India has more impactful purchase incentives and has a fuel efficiency standard that mildly supports ZEV adoption which is beyond that of either Australia or Indonesia.

Factors like a focus on demand mechanisms, limited enforcement mechanisms, or limited scope of policies may contribute to why these countries are continuing to see increasing levels of ZEV sales but have not reached the sales figures seen in major ZEV markets.



Note: Includes vehicles for which powertrain information is available. Powertrains include EVs, PHVs, mild HV, and FCV. Vehicle segments include sedans/hatchbacks A-F, MPVs, SUVs A-E, pick-up trucks, and some light trucks.

Source: MarkLines

Sources: MarkLines

Electric Engine Production

ZEV manufacturing is still a relatively new area countries are investing in and incentivizing. Many factors — such as policy, historical, and geographical context — contribute to the development of ZEV manufacturing capacity. Using the proxy of electric engine production, countries with high supply-side policy support also have higher rates of electric engine production, but it is difficult to know if this is a correlation or causation.

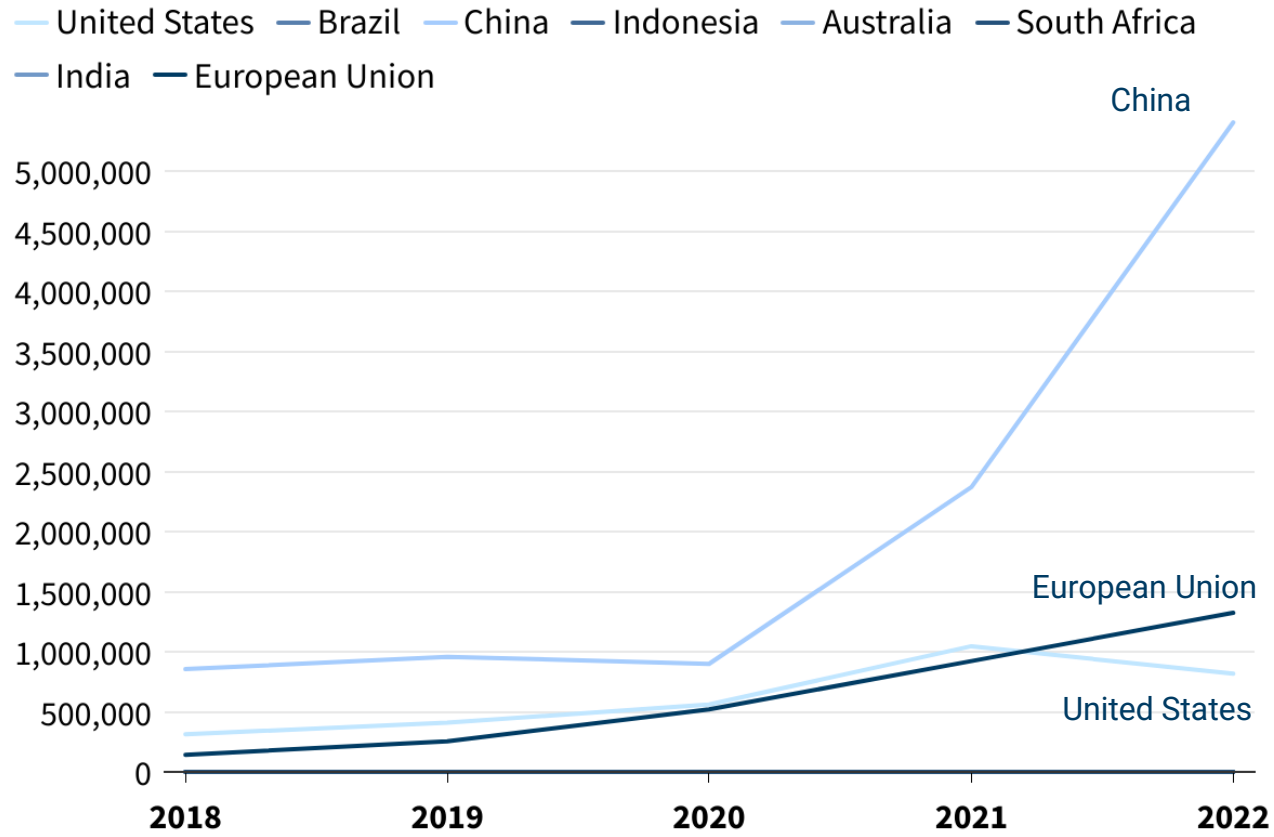
China, the EU, and the United States have the highest rates of electric engine manufacturing. This corresponds with the countries that have significant supply-side policy support for ZEV markets.

- In **China**, 75 producers created electric engines between 2018 and 2022.
- In the **EU**, a significant majority of electric engines are produced in Germany and France, with some also produced in Italy and Sweden.
- In the **United States,** nine producers created electric engines during this period; the supply is significantly driven by Tesla.

India has slowly increased electric engine production, including a significant increase between 2021 and 2022, with almost 42,000 electric engines produced in 2022.

Brazil, Indonesia, Australia, and **South Africa** had no record of electric engine production between 2018 and 2022.

Electric Engine Production by Country



Note: Data represents engine production not vehicle production. Vehicle types include passenger cars and commercial vehicles with gross vehicle weight below 6 tons. This data set defines electric engines as those for battery-electric vehicles, it does not include those for hybrid electric vehicles.
European Union includes data from 11 countries within the EU for which engine production data is available, of which only four countries produced electric engines in 2022.

Source: MarkLines

Sources: MarkLines

The Financial and Market Implications of Rising ZEV Production

Evidence for how and why ZEV production is a proxy indicator for decreasing capital costs	• **Economies of Scale:** Higher production volumes allow manufacturers to spread fixed costs over a more significant number of units, reducing the per-unit cost of production. This economies-of-scale effect drives down manufacturing costs, enabling more competitive pricing for ZEVs over time. • **Technological Advancements:** Increased production often correlates with advances in technology, such as improvements in battery efficiency and production processes. • **Increased Efficiency:** Increased production can lead to process improvements, resulting in increased efficiency and reduced costs over time.
Examples of how increased ZEV production has led to increased investment and market expansion	• **Investment Growth:** Global investment in clean transportation is accelerating, reaching $685 billion in 2023, a fourfold increase from 2020's $162 billion. This surge reflects significant financial commitment toward EVs, charging infrastructure, and ZEV-related industries. • **Market Diversity:** The number of ZEV models has doubled year-over-year, reaching nearly 600 models available globally in 2023. This model expansion enhances consumer choice, strengthens the market, and indicates manufacturers' dedication to developing ZEVs despite initial profitability hurdles. • **Strategic Positioning:** These trends highlight a strong focus on ZEV development as manufacturers position themselves for long-term success in the EV market, even as they work to achieve profitability in a rapidly evolving industry.

DEEP DIVE

Electric Vehicle Supply Chain

Region: United States

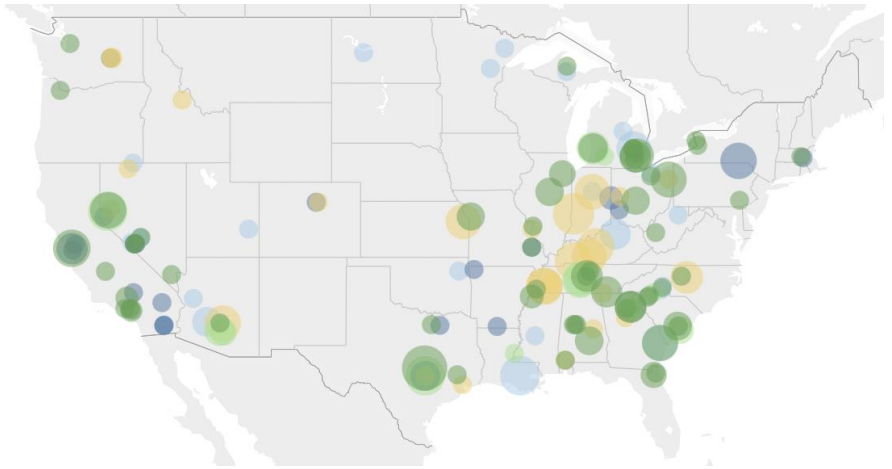
The United States EV supply chain has experienced a transformative shift catalyzed by targeted supply-side regulations like the Inflation Reduction Act (IRA)

Impact: There are 295 current projects across the country, ranging from planned to operating.150 of these projects have been announced since the IRA.

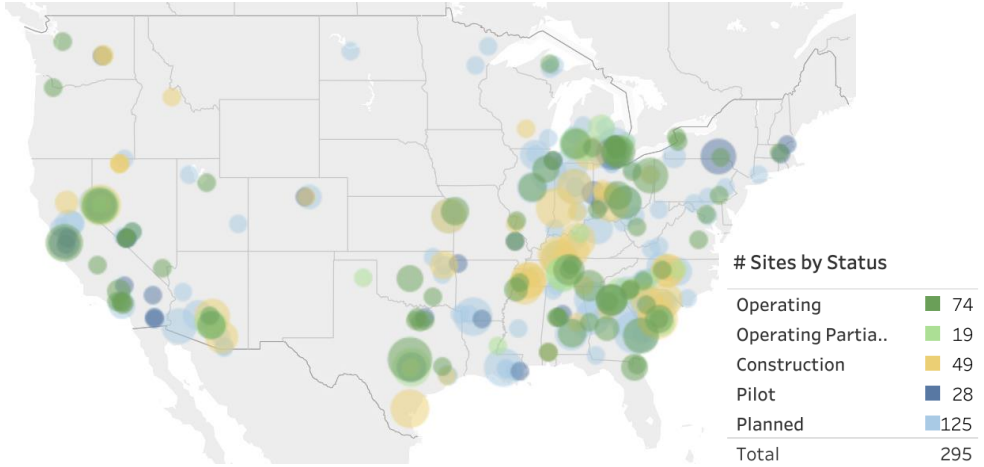
Since the IRA was passed, there have been approximately 60,000 new jobs in the sector, with battery production and EV manufacturing representing the largest segments.

Mobilizing Investment: The sector has seen approximately $100 billion in announced investments, underscoring how supply-side policies have stimulated private capital investment to build out domestic production capabilities.

Pre-IRA: US Electric Vehicle Supply Chain Dashboard



Aggregate: US Electric Vehicle Supply Chain Dashboard*



Maps shows projects at various stages of development ranging from planned to operating, across various elements of the supply chain including extraction, manufacturing, materials processing, and recycling. Charged data as of October 16, 2024.
*Note: ”aggregate” map shows projects that existed before the IRA was passed and those that have been developed since the IRA was passed.

Sources: Charged

05 SUPPLY-SIDE POLICIES AND THEIR IMPORTANCE

Supply-side policies are most effective when they are supported by a sound policy ecosystem. They are not enacted in a vacuum, and adequate demand-side policies are needed to harmonize ZEV supply and demand so market growth can be self-sustaining. This section covers:

A. Key challenges.

B. Spectrum of policy design complexity.

C. The reasons to adopt ZEV policies.

D. A review of best practices and case studies.

E. The complementary role of demand-side policies.

Note: Policies mentioned in this deck are not necessarily comprehensive but provide a thorough review of the current policy landscape in each country

The Utilization of Supply-Side Policies

Despite their effectiveness, supply-side policies are often underutilized as a tool to drive the ZEV transition.

Potential challenges to enacting supply-side policies

While supply-side policies may not face real or perceived challenges in all markets, it is important to be aware of potential challenges during the design of policies:

Incumbent opposition – existing incumbents (including manufacturers) can be resistant to change, given the high costs of retooling existing product lines and retraining staff; they can also be resistant to fiscal policies that support alternative technologies.

Market uncertainty around ZEV demand – market actors point to wavering consumer adoption rates and concerns around the pace of charging development and access, which supply-side policies may not directly address.

Market ripple effects – regulatory policies influence market dynamics and shape innovation and competition. However, care needs to be taken not to favor specific market actors. Fiscal incentives can influence research, development, and sector growth. This can lead to "policy lock-in," where industries become reliant on government support to be economically viable.

A perception that ZEVs have low technology readiness levels – there is a largely false perception that, given the advancements in battery technology, ZEVs are still an immature technology, a product to be invested in tomorrow rather than today. This can impact motivation to implement regulations.

Nuanced approach – supply-side policies can be challenging to replicate from one geography to the next, given the need to cater to regional needs, political context, and economic conditions.

Cost to implement – supply-side fiscal policies, specifically incentives, can have high implementation costs.

Sources: ZEV Transition Council

Spectrum of Policy Design Complexity

Below are examples of how ZEV sales requirements have been designed to be more and less complex.

More Complex ← → Less Complex

Fuel Economy/ Efficiency Standards

Fuel economy and efficiency standards introduce significant complexity, as they require the establishment of drive-cycle protocols, testing procedures, certified testing facilities, and treatment standards for non-internal combustion vehicles. This complexity increases administrative burden* and demands greater interagency coordination across national and regional bodies.

Sales Percentage Stipulations

Sales percentage stipulations require that OEMS sell enough ZEVs to meet a certain percentage of the total number of vehicles sold in a year.

This approach requires a centralized system where administrators track vehicle sales against required ZEV sale percentage thresholds, often accounted for as credits and deficits, making compliance easier to monitor and enforce.

Increased policy complexity can have several impacts: increased administrative burden, which can require additional staff and budget to operate; decreased duplicability as other countries/regions may experience challenges replicating credit and accounting procedures; and lastly, it may impact political will as opposition can focus on how difficult the policy is to understand and operate. However, in certain cases, added complexity may be needed, depending on the specific market where the system is implemented. Tailoring the policy to the local context can help ensure that its design effectively meets the unique needs and conditions of that market.

Source: ICCT

Note: This graphic does not address the cost-effectiveness of policies, as the administrative burden in this analysis refers to the time, effort, and paperwork required to comply with and implement policies—it is distinct from direct costs. Although administrative burden contributes to administrative costs, supply-side policies, such as fuel economy/fuel efficiency standards, are often less costly for the public budget than incentive schemes.

Supply-Side Policies Create a Supportive Foundation Invoking Scaled Investment

Supply-side policies support ZEV market growth by setting clear regulations and can create a stable regulatory environment to incentivize manufacturing, innovation, and domestic production. These policies can lower initial investment costs, reduce capital risk, and help achieve economies of scale.

Planning: Clear sales requirements enable planning, as actors can better justify the need for complementary policies and investments to stimulate demand and create a harmonious market.

Risk reduction: Policies can demonstrate government commitment to ZEV growth, encouraging sustained investment in technology and production capacity. Policies with specific targets and financial support help justify ZEV investments to risk-averse manufacturers, providing more certainty about future market demand and thereby reducing investment risk.

Innovation: Supply-side policies can encourage traditional automakers and startups to innovate in ZEV manufacturing. Tax waivers and accelerated depreciation stipulations can invoke investment in R&D and ZEV production.

Supply-Side Regulations Offer a Practical and Relatively Low-Cost Lever to Scale ZEV Manufacturing

Supply-side regulations, a subset of supply-side policies*, outline stipulations on production, helping to stimulate the manufacturing of ZEVs by providing clear stipulations and guidelines; such measures can be a direct and cost-effective method for invoking market action.

Low administrative budget

Low administrative budget required to implement cost-effective policies. Regulatory supply-side policies such as CO_2 emissions standards and ZEV sales regulations incur minimal administrative costs while driving significant industry changes; comparatively, incentives and fiscal policies can cost governments billions.

Consolidated market group

Manufacturers are a clearer market group to regulate. Adopting supply-side policies is advantageous because the supply-side market is more consolidated. This consolidation means there is a clear market group from which to regulate and seek compliance. In contrast, demand offtake is diffuse and more convoluted, making it harder to manage and influence through policy measures.

Technical knowhow

Manufacturers have the technical aptitude to achieve compliance, and industry actors have the expertise and capacity to comply with regulatory frameworks. Additionally, flexibility mechanisms, such as credit trading schemes, allow manufacturers to meet compliance requirements in a way that best suits their business.

* Note: See slide 6 and slide 15 for a more detailed explanation of how supply-side regulations are a subset of supply-side policies

Examples of Supply-Side Policies Spurring ZEV Adoption

Supply-side policies can have a significant impact on ZEV sales, as evidenced by the 15 largest ZEV markets in 2023 having a combination of sales requirements, fuel consumption and/or CO_2 standards.

EUROPEAN UNION

EV new car sales increased from 3% to 10% in a year after CO_2 standards were put into place in 2020.

UNITED STATES

In 2019 CARB projected that EVs would account for 8% of new car sales by 2025, but given California's supportive market and policies, EV sales accounted for 26% of sales by 2023, far exceeding projections.

ZEV states have 30% more EV models compared to non-ZEV states.

Other states that have adopted California's ZEV regulations had an average of 12% EV sales in 2023, compared to an average of 6% EV sales in non-ZEV states.

CANADA

Provinces of British Columbia and Quebec both have EV sales requirements and had 3.4x higher EV sales shares in 2023 compared to other provinces.

Source: ICCT

DEEP DIVE

Canadian Provinces with Sales Requirements Had 3.4x Higher ZEV Sales in 2023

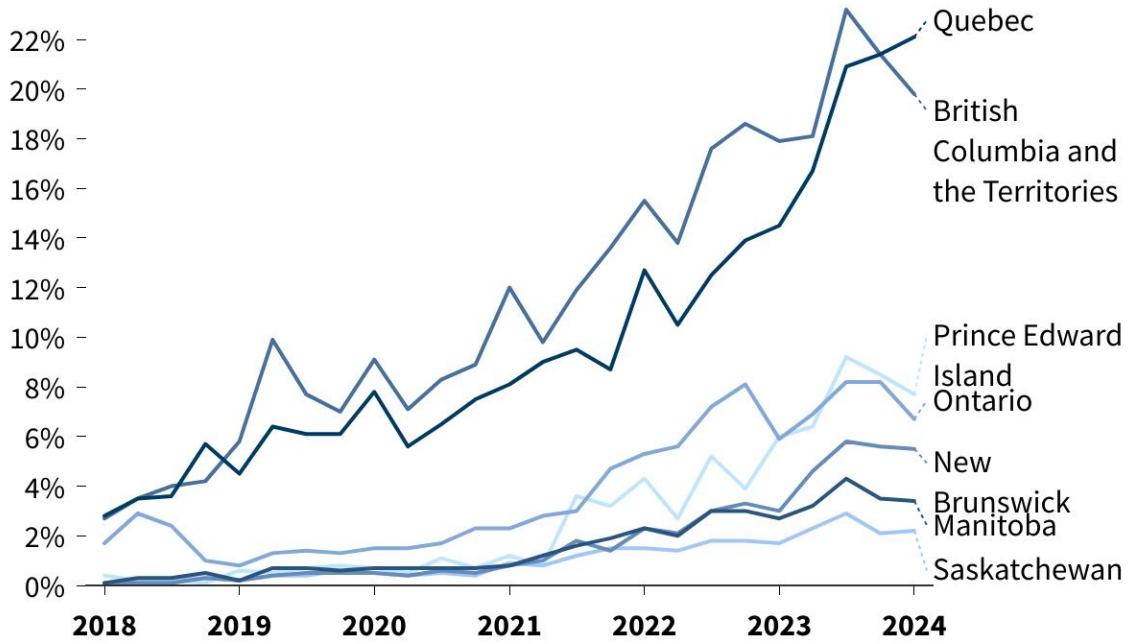
Region: Canada

Context: In 2018 Quebec launched a ZEV standard that required manufacturers to earn credits for new light vehicle sales and leases, with increasing credit requirements each year.

In 2019 British Columbia launched a Zero-Emission Vehicle Act, which required automakers to escalate sales of ZEVs over time.

Impact: In 2023 Canadian provinces of Quebec and British Columbia had EV sales percentages 3.4x higher compared to other provinces. This noteworthy market spike in ZEV sales temporally corresponded to ZEV supply-side regulations, but a direct linear connection between policy action and sales is difficult to draw a straight line to given the influence of multiple macroeconomic factors (ICCT).

ZEVs As Percent of New Motor Vehicle Registrations by Canadian Province



Note: Includes data on battery electric and plug-in hybrid vehicles

Source: Statistics Canada

Sources: Statistics Canada, Quebec Government, British Columbia Government, ICCT

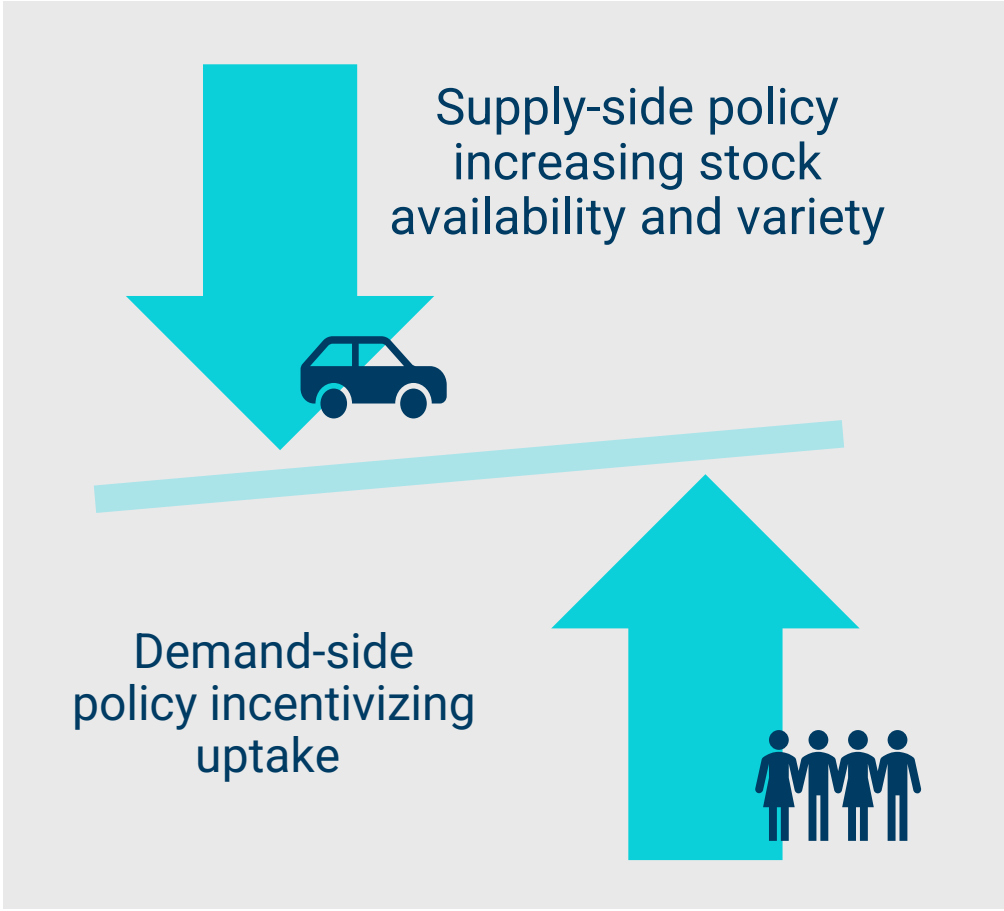
The Need for a Comprehensive Supply-Side Approach and the Complementary Role of Demand-Side Measures

A comprehensive approach that integrates both supply-side and demand-side policies is crucial for the successful transition to ZEVs as it addresses the needs and challenges of both manufacturers and consumers. Such an approach ensures a balanced, sustainable, and accelerated adoption of ZEVs.

Collaboratively reduce significant market barriers: Balancing demand-side measures with supply-side levers will be key to efficiently and rapidly increasing ZEV adoption. Supply-side regulations can then push market actors to reallocate investments and move toward broader adoption beyond early movers.

Shift consumer behavior toward clean vehicle technology: Supply-side policies increase the availability and variety of ZEVs, while demand-side policies can provide fiscal incentives or regulatory provisions to spur adoption. For instance, a manufacturer may ramp up ZEV production following a ZEV sales requirement, and consumers are more likely to buy these vehicles if they benefit from tax incentives.

Create favorable economics for both consumers and manufacturers: Supply-side and demand-side policies offer a comprehensive solution. Supply-side policies drive economies of scale, while demand-side measures make ZEVs more affordable for consumers by lowering purchase prices through incentives.



Sources: University of Exeter with EEIST and s-curve economics

06 POLICY MOTIVATORS

Political context is crucial; therefore, decision-makers must be aware of political motivators and regional nuances. Within this context, policies should be framed and developed to ensure they are attractive, timely, and socially responsible. This section covers:

A. Identified impetus of ZEV policies to date, by geography.

B. Pathways to frame and devise more attractive, timely, and socially responsible ZEV policies.

Observed Political Context

The political context is a significant factor in understanding motivations or deterrents for transitioning to ZEVs.

Country / Region	Description of motivators and deterrents for transitioning to ZEVs
EU	• One of the primary motivations to adopt ZEVs is to significantly reduce GHG emissions from the transportation sector, which is a major contributor to climate change. The EU aims to achieve net-zero carbon emissions by 2050, and transitioning to ZEVs is a crucial part of this strategy. • The EU aims to stay a leading force in automotive manufacturing, a sector that has contributed to its GDP for over a century. To ensure this, they are focused on supporting future investments.
China	• China's zero-emission policies are closely tied to its economic development goals. The country has invested heavily in low-carbon technologies, such as solar cells, lithium-ion batteries, and ZEVs, which are driving economic growth and exports of high-value products. • China had limited domestic production of vehicles in the early 2000s, and investment in ZEV manufacturing was seen as a way to promote domestic production. • Most of China's policies around ZEVs can be categorized as industrial policies that encourage the development of the ZEV while also not directly regulating or inhibiting the growth of the ICE market.
United States	• Reducing vehicle emissions, including GHG pollutants, has been a priority to support air quality measures. • The transition to ZEVs is seen as a major opportunity to create high-quality jobs in the United States auto industry and related sectors. This includes jobs in manufacturing EVs and batteries, as well as developing and maintaining charging infrastructure.
India	• Road transport is a major source of air pollution in India and a major strategy has been to couple air quality and CO_2 emission reductions benefits of ZEV adoption. • India is interested in self-reliance with an emphasis to promote domestic industry. "Make in India" and "Self-reliant India" (known as '*Atmanirbhar Bharat*') are two initiatives which embody this idea and promote electric mobility.
Indonesia	• A domestic transition to ZEVs can strengthen the country's role as a key supplier of critical minerals and position it as a regional leader in battery manufacturing and vehicle assembly.
South Africa	• Transportation electrification is a critical piece of South Africa's Just Energy Transition (JET) plan. • South Africa wants to maintain its position as the largest car manufacturer on the African continent, but given South Africa exports a significant number of vehicles it produces to countries that have increasingly stringent ZEV policies, like the EU, it will be critical for the country to increase ZEV manufacturing.
Australia	• A domestic ZEV transition can support the country's position as a crucial source of critical minerals.
Brazil	• Given the electric mix is mostly renewable based sources, Brazil is well-positioned to maximize the environmental benefits of ZEVs. • Manufacturers in Brazil present significant pushback on transitioning to ZEVs, and the strength of the agriculture sector creates a strong dynamic to support biofuels rather than BEVs.

ATTRACTIVE

Finding Geographically Contextual Policy Motivators

Crafting arguments that resonate with voters and policymakers beyond just reducing carbon emissions can make policies more appealing. Highlighting the co-benefits of ZEV adoption can help build a broader coalition of support. Additionally, understanding regional economic factors can further influence support for these measures. Below are a few observed co-benefits of ZEV adoption that can be emphasized to build a broader coalition of support.

Self-Reliance: The ability to meet domestic demand and access export markets can be a key motivator. Early investments in ZEVs and the on-shoring of production can support a country's economic growth trajectory.

Leapfrogging: Early investment in ZEV manufacturing is an opportunity to invest in cleaner solutions with a more promising long-term investment return. Early investment can enable global actors to capture initial market shares and enable such economies to decouple dependence on foreign oil.

Workforce Development: The creation of ZEV manufacturing hubs can secure and create new regional job opportunities to promote livelihoods.

Eliminate Royalties and License Fees: Early investment in domestic R&D for ZEVs and infrastructure can enable local affiliates to eliminate and reduce reliance on foreign intellectual properties.

DEEP DIVE

Coupling Opportunities, to Advance the ZEV Market

Region: Indonesia

Context

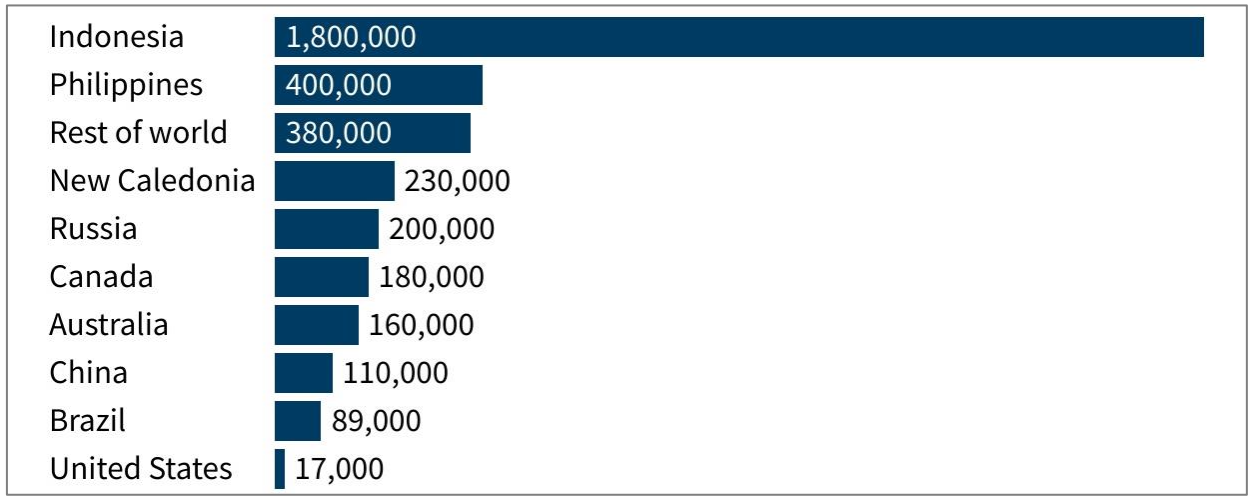
- Indonesia holds the world's largest nickel reserves, and Indonesia is in a prime position to play a more prominent role in the international ZEV and battery supply chain.

Opportunity

- By processing nickel domestically and producing batteries, Indonesia can add significant value to its raw material economy.
- The shift from exporting raw nickel to exporting high-value battery products can increase national revenue.
- The country can look to couple its production of ZEV batteries with policies to encourage increased demand to support its own ZEV market growth.

Impact

- Driving ZEV adoption and the enactment of ZEV-supportive can increase economic development and energy security.



2023 Nickel mine production (in metric tons)

Source: Statisa, USGS

TIMELY

Consider Timing and Work to Capitalize on Market and Political Opportunities

Regulatory action is more challenging when the issue is gradual and long-term, as seen with climate change. Immediate, visible crises (e.g., COVID-19) often spur quicker responses. It's critical to seize moments of heightened urgency to drive ZEV-related policies. Consider the following:

Fuel Price Volatility: When oil prices are high and volatile, the timing is more apt to promote ZEVs and reduce reliance on fossil fuels. Investing in ZEVs now can help improve energy security while reducing vulnerability to fuel price fluctuations.

Energy Security Concerns: Geopolitical risks highlight the potential vulnerabilities of over-reliance on imports for goods, such as fuel and batteries. Strengthening domestic ZEV supply chains can reduce these risks and bolster national energy independence.

Moments of Increased Public Awareness: Regulatory change is more likely when an issue is at the forefront of public consciousness. When public awareness and concern about climate or energy issues spike, ZEV policy advancements become more feasible.

DEEP DIVE

Timing Vehicle Policy Enactment

Region: United States

The United States' ability to create policies to support ZEV adoption is in large part due to three historical events.

The Energy Conservation Act was enacted in 1975, following the 1973-74 Arab oil embargo. The Energy Conservation Act provided the grounds for the National Highway Administration to enact CAFE standards.

The Clean Air Act (CAA) underpins and provides the EPA with statutory authority to regulate tailpipe emissions. CAA was signed into law in 1970 because smog and water pollution were key political topics in the 1960s.

California enacted its first policy on tailpipe pollution in the 1960s largely because of the severe air pollution and smog impacting cities like Los Angeles. It enacted regulation prior to the CAA, so it was awarded a waiver to continue with regulation (which was more stringent than the CAA). This has also enabled California to enact ZEV requirements above and beyond the United States government and for other states to elect to follow suit.

Key takeaways and motives for policy action

Regulators tend to be more focused on enforcing industry regulations under specific conditions or after notable events that draw public attention. Therefore, it is crucial to 1) understand this context and 2) highlight the compelling air quality and health benefits of relevant policies (e.g., as seen in California).

Energy security matters as a motivator. The real and perceived risk of energy security leads to policy action (e.g., the US Energy Conservation Act and the EU push to decrease natural gas and crude imports from Russia).

SOCIAL

Building Public Support and Momentum for ZEV Adoption

Building public support and momentum for ZEV adoption can involve a range of tactics. Observed strategies are to 1) frame the transition to ZEVs as a key factor in improving public health and quality of life to foster broader community engagement and advocacy, 2) focus on job creation and development of new industries, and 3) build diverse coalitions through stakeholder engagement.*

Emphasize Health and Air Quality Benefits: Framing the transition to ZEVs as a social issue highlights their significant impact on public health. Communicating how ZEVs can reduce harmful emissions and improve air quality underscores their role in enhancing community well-being. This approach builds public understanding and broadens support by showing how cleaner transportation contributes to a healthier, more vibrant society.

Job Creation: The transition to ZEVs can create new jobs and increase industry development within several markets, including battery and vehicle manufacturing. By focusing on the job benefits of the ZEV transition, apolitical backing for the transition can be developed.

Stakeholder Engagement: Involve government agencies, consumer advocacy groups, and auto manufacturers early in the process to align interests. Building social momentum requires collaboration and shared goals across these groups. Regularly assess satisfaction levels and potential concerns among different stakeholders. Proactively addressing sensitive issues will help mitigate resistance and ensure smoother adoption.

*Note: This list is not designed to be comprehensive of all potential strategies to build public support, but just to highlight some key approaches.

DEEP DIVE

Navigating Entrenched Actors

Region: Brazil

Context: The agriculture sector influences the prioritization of biofuels, which is slowing the transition to ZEVs.

- Brazil is estimated to have produced 32.95 billion liters of ethanol in 2023, a 7% increase from 2022.
- Brazil is a top-5 producer of 34 agricultural goods and the world's largest net agricultural exporter.
- The mandatory biodiesel blending percentages continues to increase rising from 12%-14% in 2024 to 15% in 2025.
- "Flex-fuel"* cars made up 84.5% of all auto sales in June 2023.

Impact: The absence of domestically owned vehicle manufacturers (except for buses) changes the equation when deciding whether to support local manufacturing or incentivize foreign companies to invest in domestic production. This situation gives international companies like BYD greater potential influence.

- Between January and March of 2024, passenger vehicle imports rose 46.4% from the same time frame in 2023. Chinese vehicles accounted for 40% of the total, with a 450% increase from the same time frame as 2023.
- Sales of ZEVs in Brazil increased 145% in the first quarter of 2024 compared to 2023, with 41% coming from BYD.

Source: USDA, USDA, Reuters, Reuters, Bloomberg

*Notes: flexible-fuel vehicles can run solely on bio-fuels

07
HOW POLICY SHAPES ZEV MARKETS

A look at how policy impacts markets to inform opportunities for ZEV market creation. This section includes:

A. An overview of policies that impact market formulation.

B. A look at lessons learned from other clean tech markets.

C. Synthesis of prominent global tariff and trade policies shaping the market.

ZEV Markets Are Impacted by Government Interventions, Such As:

Tariffs

Tariffs on imported products critical for ZEV manufacturing can encourage vertical integration, on-shoring*, and friend-shoring**.

Fiscal policies

Tax policies and financial assistance programs impact the availability of capital for new ventures, directly affecting market creation potential.

Lower corporate tax rates can encourage business formation and investment, potentially leading to new market opportunities.

Tax incentives for specific industries or activities (e.g., clean energy) can spur innovation and market growth in those sectors.

Patents and trademarks

Intellectual property regimes and regulatory measures influence the level of competition, affecting how markets develop and evolve.

Patents provide inventors with temporary monopolies, incentivizing innovation and the development of new products. This is especially true in a sector with rapid technology innovation like ZEVs.

Trademark protection allows startups and incumbents to help establish and grow market share in the emergent ZEV market.

Regulatory measures

Environmental regulations can drive companies to develop new technologies and processes, potentially creating entirely new markets for cleaner solutions.

Clear regulatory frameworks can provide certainty for investors, directing capital and encouraging investment towards budding markets and technologies.

Government policies can shape consumer preferences and create demand for certain products or services, driving market growth in specific sectors.

Sources: Humanities and Social Sciences Communications, Economics of Innovation and New Technology

*Note: On-shoring is building a supply chain domestically.

**Note: Friend-shoring is developing a supply-chain within a close network of allied countries.

DEEP DIVE

The Impact of Tax Waivers on the ZEV Market

Region: Norway

Norway has achieved remarkable success in ZEV adoption, with nearly 82.4% of new car sales being ZEVs in 2023.

Success is largely due to high taxes on ICE vehicles, making ZEVs comparatively more affordable. These fiscal policies, in turn, make ZEVs more profitable for manufacturers and dealers to sell, leading to the prioritization of their sales over ICEs.

Additionally, Norway has promoted ZEV adoption through a range of demand incentives, mainly by offering tax exemptions and waivers on road taxes, tolls, and fees.

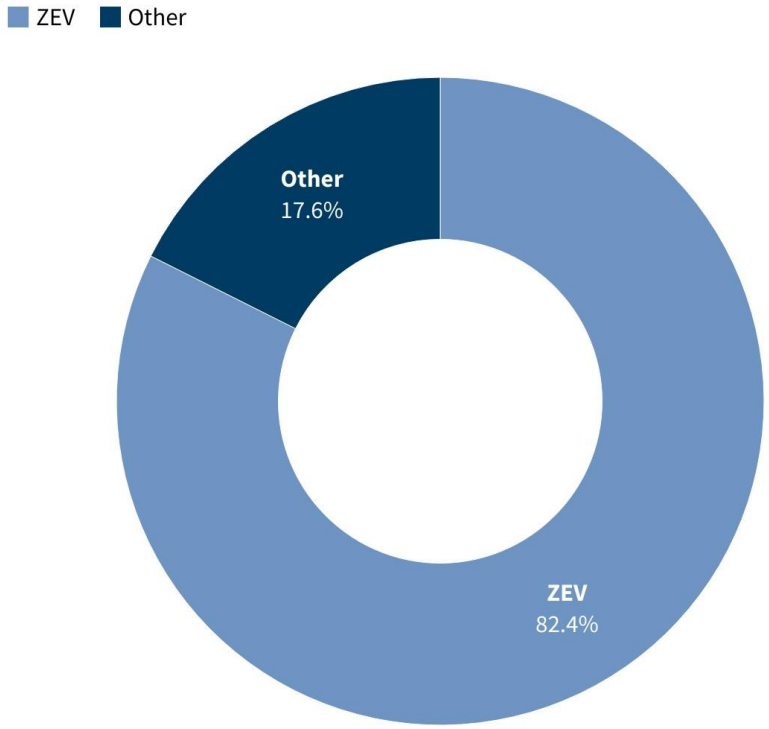
Until 2023, BEVs in Norway were exempt from the country's car purchase taxes, averaging $27,000 per vehicle, which helped drive rapid early adoption. However, as BEV adoption reached high levels and price parity with traditional ICE vehicles, these tax exemptions were rolled back to recover value-added tax (VAT).

Once strong demand is established, incentives can be reduced as market forces take over. Norway still maintains other, less costly incentives, keeping BEVs an attractive option for consumers.

Norway's approach shows how fiscal policy helped shift the cost burden from manufacturers to the government, making ZEVs more attractive to buyers and driving demand.

Source: Norsk Elbilforening

Norway Passenger Car Sales by Powertrain (2023)



"Other" includes all non EV powertrains

Source: Norsk Elbilforening

Incumbent OEMs, Startups and Building Domestic ZEV Production Capacity

Manufacturer Influence: Manufacturers play a crucial role in market readiness through their investments, the range of ZEV products they introduce, and the competitive ZEV prices they seek to offer.

Incumbent Manufacturers vs. Startups: Incumbent manufacturers and startups often behave differently — incumbents, driven by the desire to maintain market share and recover sunk costs, may delay investment in ZEVs until the risk of losing market share is clear.

Impact of Domestic Incumbents: Markets with fewer domestic incumbents are often more open to adopting new technologies. For example, China, lacking a strong history of ICE manufacturing, strategically invested early in ZEV research, development, and incentives to capture the nascent ZEV market.

Example: The presence of prominent incumbent auto manufacturers in the ZEV market is gradually increasing. Just two years ago, emerging players like Tesla dominated the ZEV market outside China. However, many traditional manufacturers, particularly German ones, have since aggressively entered the market. Starting in 2020, driven by government initiatives and the need to catch up in this crucial future market, German automakers rapidly launched new all-electric lines and models. Mercedes-Benz introduced the EQ line, Volkswagen launched the ID series, Audi expanded its e-tron brand, and BMW revitalized its i-series. As a result, Germany quickly became the second-largest market after Norway in terms of available EV models, with 158 models. Similar trends were observed in markets like the UK and the United States, where major automakers, including Ford and GM, also accelerated their EV offerings.

Sources: EDF, WRI, ICCT, NRDC, ICCT, Arthur D Little

Coordinating Policy Deployment with S-Curve Adoption

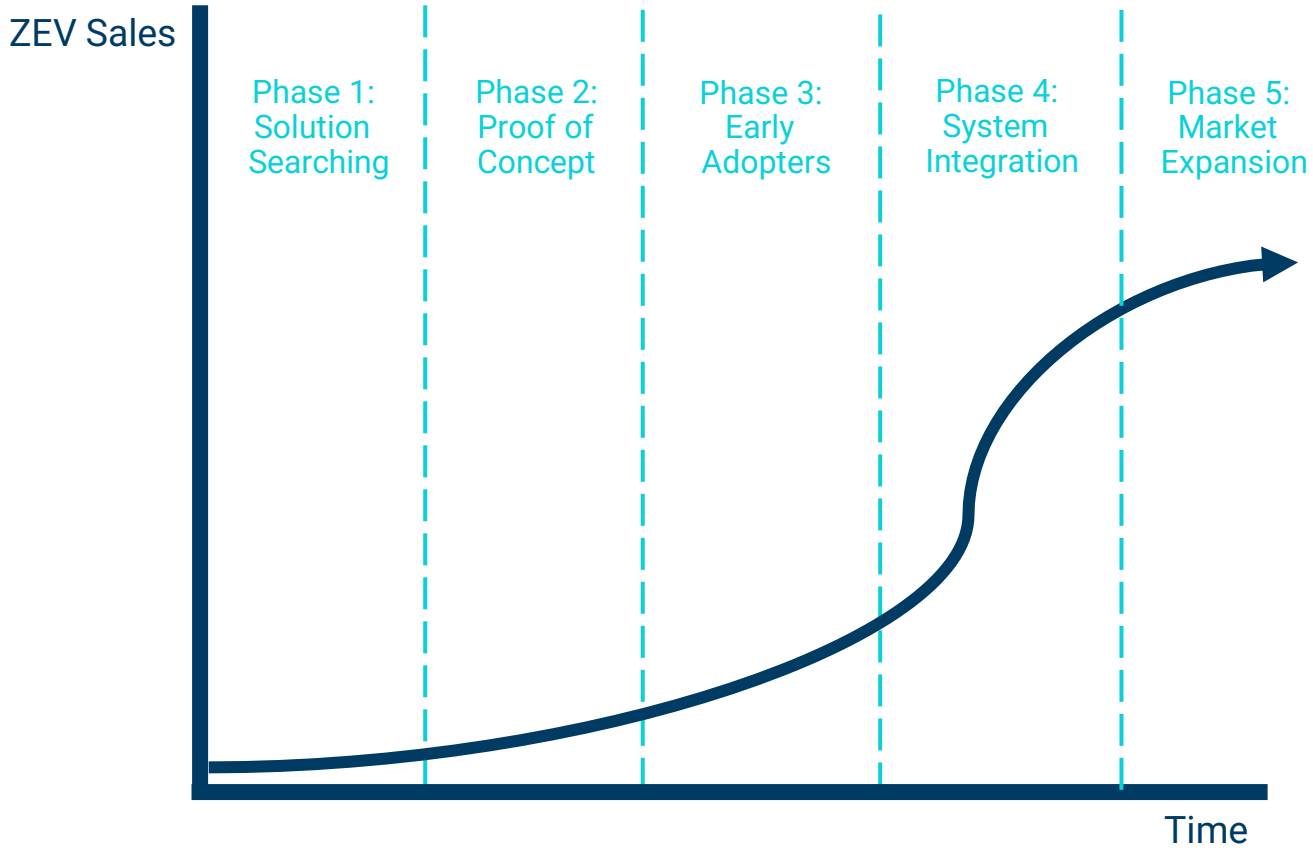
ZEV adoption across multiple countries is following an s-curve trend. Once a country's ZEV sales reach 1% of total sales, adoption then accelerates, although at different rates in different locations.

S-curve trajectories include different phases of technology development and adoption, and consumers with different motivators adopt the technology at various times.

It is essential to coordinate the correct policy mechanism with the current adoption phase and consider what thresholds the market has reached. For example, is there sufficient product variety and cost competitiveness, and has preliminary infrastructure been deployed? These are necessary prerequisites to expand ZEV adoption and ensure ZEVs cater to the mass market.

Targeted subsidies to overcome technology and operational risk can support transitions in their early phases, for example, phases 1-2. Sales requirements can then be leveraged to support broader adoption through phases 3-4. The operational, driving, and cost savings from adopting ZEVs should then sustain and support the transition of the entire vehicle stock, enabling consumer choice to shape the market.

Identifying and deploying the most supportive policy mechanism for the phase of the adoption is essential for effectively supporting market growth.



Sources: RMI, WRI, University of Exeter with EEIST and s-curve economics

08 MOBILIZING ZEV FINANCING

Financing plays a pivotal role across the entire ZEV value chain. It serves as a critical enabler supporting supply through the scale of ZEV production, facilitating the demand for and purchase of ZEVs, and funding the development of charging and grid infrastructure networks. This section covers:

A. Examples of how policy has shaped ZEV investment.

B. A description of differing financial tools to spur ZEV market growth.

C. The role of public-private partnerships.

D. Investment risk and the role of policy.

Spurring Investment Through Policy

Policies can positively impact the ZEV market to drive investment, support innovation, and scale production.

Policy type	Impact on markets and investment	Example
Supply-Side (Regulatory): Stipulations regarding the sale and production of vehicles	Regulatory frameworks can create certainty for investors, guiding capital flow and encouraging investment in emerging markets and technologies.	China's NEV credit scheme is a market-driven policy designed to regulate and incentivize ZEV production. In 2023, China represented 60% of global ZEV sales, with policy signals like this shaping domestic production and steering the growth of its automotive sector toward ZEVs (see slide 26).
Supply-Side (Fiscal): Tax benefits, the allocation of public financing, or other beneficial fiscal measures	Tax benefits and other incentives can encourage business formation and investment, potentially leading to new market opportunities.	In the US, the Advanced Manufacturing Production Credit (45X) can attract substantial private investment in the battery supply chain by offering significant financial incentives of up to $45/kWh for battery manufacturing, thereby reducing capital costs and improving the economic viability in domestic battery production (see slide 36).
Demand-Side (Regulatory): Operational regulations including fleet electrification requirements, and low-emission zones	Such provisions impact ZEV demand, aiming to build a stable and predictable customer base that enhances investor confidence and supports ZEV adoption.	Advanced Clean Fleets, enacted in California and Washington, is designed to phase out the sale of tailpipe-polluting medium- and heavy-duty trucks, by requiring fleets to adopt an increasing percentage of ZEVs. This policy gives a clear picture of demand, increasing investment in ZEV fleets and manufacturing in subsequent states (see slide 37).
Demand-Side (Fiscal): Purchase incentives or tax waivers for consumers	Fiscal incentives can make ZEV adoption more affordable and attractive for consumers, invoking lending and capital flow towards ZEV procurement.	FAME II has driven ZEV sales in India by offering substantial purchase subsidies and incentives, making ZEVs more affordable and attractive to consumers, particularly in the two-wheeler and three-wheeler segments. This policy helped spur the creation of a robust domestic ZEV market (see slide 29).
Infrastructure Policy: Fiscal or nonfiscal incentives to establish public charging infrastructure	Public resources can be leveraged to reduce investment risk, close revenue-cost gaps and address a market failure to create connected and conducive public infrastructure systems.	The Alternative Fuels Infrastructure Regulation (AFIR) in the EU is designed to significantly expand and standardize EV charging infrastructure across the region. The regulation is expected to create new business opportunities in the EV charging sector and drive innovation (see slide 20).

Fiscal Supply-Side Policy Interventions and Their Impact on the ZEV Market

Below are the ways public finance and fiscal measures can shape market conditions to stimulate investment.

Blended finance mechanisms, the use of public funds to de-risk and attract public capital, can ***mobilize investment*** and lower the cost of capital.

Publicly funded credit enhancement mechanisms can provide backstops, ***reducing risk*** by lowering expected loss for financiers and subsequently increasing funding for ZEV projects.

Public investment in R&D and infrastructure through public-private partnerships can ***expand the project pipeline*** by increasing the number of investable projects.

Policies that invest in public charging infrastructure can ***address market failures*** and help overcome knowledge spillovers and other barriers that prevent private investment.

Mobilizing Investment

This slide explores how government or public investment can promote holistic, sustained growth in the ZEV market, reducing the cost of capital to accelerate the transition to ZEVs

To support holistic and sustained growth in the ZEV market, it is crucial to facilitate investment flows across three core activities:

- ZEV manufacturing
- ZEV purchases
- Charging infrastructure and grid infrastructure deployment

The table presents a few specific financing tools that have been leveraged to stimulate investment across these key areas. These financial interventions aim to:

- Accelerate mass production of ZEVs to foster market growth
- Reduce risk
- Attract private-sector investment

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	Concessional Loans	Credit Enhancement Mechanisms	Public-Private Partnerships
ZEV Manufacturing	Below-market-rate loans and bonds with fixed rates of return have been leveraged by manufacturers to retool manufacturing lines and lower the cost of capital.	Loan guarantees have been allocated specifically for investment in ZEV and low-emission vehicle production; such schemes have been designed to attract private investment.	Public-private partnerships have supported the upstream mining and refining of critical minerals as well as midstream production of battery grade materials.
ZEV Demand Uptake	Loans with more favorable terms compared to traditional loans, such as lower interest rates and/or longer repayment schedules have been leveraged to make ZEV purchases more affordable from a cost of capital perspective.	Loan guarantees have been used to increase investor confidence in providing ZEV loans to fleets and everyday drivers.	Less applicable.
Infrastructure (Charging and Requisite Grid Upgrades)	Green bonds with fixed rates of return have served as patient capital to develop public charging infrastructure.	Loan guarantees have been used to backstop lending allocated for infrastructure deployment.	Joint ventures have been formulated by public and private entities to develop public charging; distributing the capital and ownership liability amongst actors.

Impacts of Differing Finance Tools for ZEV Manufacturing

Concessional loans have been a catalyst for manufacturers to receive lower-cost capital.

Activity funded: ZEV manufacturing

Example: Tesla received a $465 million loan from the United States Department of Energy in 2010 under the Advanced Technology Vehicles Manufacturing (ATVM) loan program, which was crucial for developing and bringing the Model S to market.

Loan guarantees have helped mobilize capital, offering consumers more affordable and available financing options.

Activity funded: ZEV adoption

Example: The Small Industries Development Bank of India has supported ZEV lending efforts by launching a risk-sharing facility pilot with the Shell Foundation. This pilot consists of a $6 million jointly funded partial credit guarantee program for lenders extending loans for electric two- and three-wheelers (e-2/3Ws) used for commercial purposes. This facility alone is estimated to unlock approximately $81 million of commercial capital for e-2/3W financing.

Private partnerships have enabled the expansion of public charging networks within cities and along highways, expanding public charging access.

Activity funded: Charging and grid infrastructure for ZEVs

Example: The Chinese government partnered with the State Grid Cooperation of China (SGCC). This partnership has been instrumental in accelerating the development of a comprehensive charging network across the country. The SGCC, leveraging its extensive power grid infrastructure, has worked alongside various private sector companies to establish thousands of charging stations, particularly focusing on urban areas and major highways.

Source: The Verge, SIDBI, China Daily

Addressing a Market Failure: Public Sector Role in ZEV Infrastructure Investment

Challenge: ZEV and charging deployment coordination

Actors are hesitant to adopt ZEVs without robust charging access, and infrastructure providers are hesitant to deploy chargers without ZEV charging demand. Since the inception of the marker, the question of which should come first, ZEV charging demand or the charging infrastructure, has been ever-present.

No single market actor has sufficient incentive to develop a national charging network quickly enough to meet climate goals.

Solution: Public-private partnerships

Public-private partnerships are an effective way to deploy public charging infrastructure. Governments can provide funding and grants, while private companies contribute investments and operational expertise. This collaboration reduces the financial burden on a single entity and accelerates infrastructure development.

By simultaneously investing in both ZEVs and charging infrastructure, the government reduces the risk for private investors. This coordinated approach encourages private companies to invest in manufacturing and deploying ZEVs and related infrastructure.

Manufacturing and the Role it Plays in Driving Broader ZEV Market Growth

The relationship between manufacturing and investment

Local manufacturing or access to affordable vehicle imports is essential for attracting and expanding private investment in the ZEV market.

Manufacturing capability plays a pivotal role in achieving market scale and needs to be present to attract financing to further scale the market.

India’s example

In India, manufacturers have announced approximately $515 billion in investments in ZEV-related technologies and manufacturing plants. This commitment of their own capital has attracted additional private investment, signaling strong growth potential in the sector.

India's ZEV startup ecosystem has demonstrated its capability to produce quality products, particularly in the two- and three-wheeler segments. The sector is experiencing rapid growth: there are now 535 recognized EV-related startups in India, up from just 15 in 2012.

In 2022 alone, 43 of these startups raised a total of $673 million in funding.

This growth indicates increasing investor confidence and an uptick in ZEV manufacturing in India.

Solution pathway

Established firms and startups can attract more capital by demonstrating their ability to produce quality products, diversifying their product supply, and showing growth potential.

Automakers can make investments more attractive to financiers by sharing asset risks through measures like offering warranties and product buyback guarantees, which display confidence in their products and commitment to sharing financial risk.

Source: Government of India

09 CONCLUSION

ZEV policy plays a critical role in accelerating ZEV adoption and generating market confidence. This section details the implications of policy gaps and highlights critical insights to support future ZEV policy development.

A. Reconciling policy and data gaps.

B. Cross-geographical learnings.

Identifying and Reconciling ZEV Policy and Data Gaps: Lessons from Global Experiences

Limited manufacturing data

A significant gap exists in the availability of reliable manufacturing data. This lack of data presents a challenge, as sales figures are not always directly correlated with manufacturing output. It is especially important to have accurate manufacturing data when structuring supply-side policies that are specifically designed to support increased manufacturing. This disconnect makes it difficult to accurately assess market dynamics and hampers the ability to make informed investment and policy decisions.

Lack of a whole-systems approach

Regulators face challenges in adopting a fully integrated, systems-wide approach to ZEV policy implementation. Without a well-defined plan and strong coordination across agencies, the execution of these policies can sometimes become less cohesive. This can lead to difficulties for stakeholders, who may encounter inconsistencies, delays, and occasional regulatory overlaps while working to implement ZEV policies.

Complexity*

The intricate nature of ZEV policies, such as fuel economy and efficiency standards, can pose challenges regarding implementation. For example, these policies require detailed drive-cycle protocols, testing procedures, certified facilities, and tailored standards for non-ICE vehicles like EVs. This complexity increases administrative burdens, demanding more staff, resources, and interagency coordination. Additionally, such complexity can hinder replicability, making it difficult for other regions to adopt similar credit and accounting systems, and weaken political support. Clear communication and coordination across implementing bodies and streamlined processes are crucial to overcoming these barriers.

*Note: see slide 48 for additional insight regarding policy design complexity.

Critical Insights from ZEV Policy Evaluation

ANALYZE TRENDS

China, the EU, and parts of the United States (i.e., ACC II states) lead in comprehensive ZEV policy frameworks, while developing markets show emerging policy landscapes.

HARMONIZE SUPPLY AND DEMAND THROUGH POLICY

Supply-side policies (i.e., ZEV regulations) are most impactful when supported by demand-side incentives and infrastructure development policies as these measures evoke demand and enable compliance to be less disruptive.

SUPPORT MARKET GROWTH

Policies that align with consumer preferences and promote long-term market growth can help new markets mature. These policies can be scaled back once demand is stable. For example, financial incentives could be tied to factors like total range and range efficiency to encourage manufacturers to invest in what customers value most.

MOBILIZE FINANCE

Clear, long-term policy signals are crucial for attracting private investment in ZEV manufacturing. Effective policy measures that have spurred ZEV market growth include a mix of grants, tax incentives, and public-private partnerships. As an additional note, the gradual phase-out of incentives should seek to align with ZEV market maturity trends.

LEVERAGE GLOBAL BEST PRACTICES

As the global ZEV market continues to evolve, policymakers must remain adaptive, learning from successful case studies globally, all while adjusting strategies to local contexts to effectively drive the transition to ZEVs.

10 APPENDIX POLICY GAP ANALYSIS METHOD

The appendix describes the method and approach used to complete the Policy Gap Analysis, offering insights into how policies across the eight countries/regions were assessed.

B. Highlights the approach taken to assess policies and critical considerations.

A. Provides a rationale for color-coded analysis on each country.

Photo by NASA on Unsplash

Policy Gap Analysis

The color coding of each country/region across the eight policy categories can be seen on slide 6 of this deck.

The policy gap analysis is comparative, meaning the analysis assesses policies on how they specifically can and have supported ZEV adoption. The overarching map color coding is an aggregated assessment that reviews the eight policy categories, each of which has its color coding for each country/region.

The color coding serves as a tool to simplify comparison. However, it's important to note that there are numerous nuances, exceptions, and vehicle segments with less stringent policies. Policy implementation plays a significant role, though it is difficult to measure effectively. The analysis completed is a high-level comparative study only.

Policy Gap Analysis: Method

This study took the following approach to developing the policy gap analysis:

- Categorize policies in each region by thematic area.
- Identify the most comprehensive policy within a country/region, based on the stringency of standards or support for ZEV adoption, and use that as the benchmark to compare other countries/regions.
- Compare policies across geographies, classifying policies into three color categories:

  Green represents the most ambitious standards or most supportive ZEV policies.

  Yellow indicates a policy that falls short of the highest ambition or standards globally but offers market intervention to support ZEVs or regulate the manufacturing of ICE vehicles in some regard.

  Red indicates the absence of a policy in a particular area or a policy that is significantly lagging behind those in other countries/regions.

Policy Gap Analysis: Country/Region Ratings

- **Overall country/region rating (see map on slide 5)**
  - A country/region received a green overall if it had a green rating in 4 of 8 categories, a yellow if it had a combination of green and yellows across 4 of 8 categories, and a red overall if it had a red in 4+ categories.
  - See each country/region slide for a summary statement with regional justification.
- **Supply-side country/region rating (see map on slide 38)**
  - A country/region received a green supply-side analysis rating if it had a green in 2.5 or more of the 5 supply-side categories, a yellow if it had a combination of green and yellows across 2.5+ of the 5 categories, and a red if it had a red in equal to or greater than 2.5 categories.

Policy Gap Analysis: Constraints

- **Temporal focuses:** This study focuses on enacted policies, whether newly implemented or set to take effect in the future, and the focus was on policies that were ratified or passed. As a result, the analysis is present-focused and does not deeply explore historical impacts. Additionally, quantifying the effects of newly enacted policies can be challenging due to their early implementation stage and broader macroeconomic implications.
    - For example, prior to the Bipartisan Infrastructure Bill and the Inflation Reduction Act (IRA), the US lacked policy at a national level to significantly influence EV market growth, while the EU and China had supportive policies earlier on. We did not factor in this temporal difference in assessing policies on a comparative basis, nor were we able to assess the full impact of these policies due to their recent adoption.
    - Our analysis did not evaluate whether a rule or regulation may be stayed or rolled back. It simply evaluated policies as they have been passed as of October 2024.
- **Evaluating Impact:** One of the limitations of this study is the lack of research isolating the impact of a single policy or policy type. Given the diffuse nature of policy, it is arguably not feasible to attribute ZEV market development to explicit policy or policies. Thus, policies were rated and evaluated primarily based on the merits of the policy document, and less regard was given to implementation and overall effectiveness. This is also because many of the policies evaluated have been enacted in the last year or come into effect in a specific model year in the future. Thus, this analysis was constrained by the emergent nature of these policies and their effects.

Supply-Side Policies: Regulatory

ZEV Sales Requirements

This study assessed policies that mandated the sale of zero-emission vehicles or the use of a credit scheme that explicitly sought to increase ZEV sales.

Green distinction: The threshold for obtaining a green rating was a national stipulation on ZEV sales or a regulation stipulating the phase-out of ICE vehicles.

- In China, the NEV vehicle policy creates a nationwide standard with precise mechanics to prioritize the sale of ZEVs.
- The EU policy stipulates that all new cars and vans sold in the EU must achieve a 100% reduction in CO_2 emissions by 2035.
- In the US (green/yellow hatched), ACC II is a strong sales requirements. However, it has not been adopted nationally.

Yellow distinction: A country/region was given a yellow rating under several different circumstances, including a ZEV sales requirements does exist but only regionally, not nationally, or no ZEV sales requirements exists but national ZEV targets exist.

- India (yellow/red hatched) does not have a ZEV sales requirements but does have national ZEV targets.
- Indonesia (yellow/red hatched) does not have a ZEV sales requirements but does have national ZEV targets.

Red distinction: A country/region was given a red rating if it had no sales requirements and no national ZEV target.

- Australia does not have a ZEV sales requirements or a national ZEV target, the country does have a ZEV target for government fleets.
- For Brazil, research did not yield a ZEV sales requirements or a ZEV target.
- For South Africa, research did not yield ZEV sales requirements or a ZEV target.

Supply-Side Policies: Regulatory

Fuel Economy / Efficiency Standards

The analysis aimed to compare policies setting average fleet standards. "Fuel economy" and "fuel efficiency" are often used interchangeably but have slightly different meanings. RMI assessed the stringency of fuel economy and efficiency standards, focusing on how ZEVs were integrated into these performance standards to achieve fleet-wide averages. In some jurisdictions, credits or multipliers were given for producing ZEVs, encouraging a higher ZEV mix in fleets.

This study aims to distinguish between fuel economy and fuel efficiency standards. While categorized under one policy type, they have distinct functional meanings. Both standards provide guidance on how vehicles use fuel, but their measurements and focus differ. Fuel economy refers to the distance a vehicle can travel using a specific amount of fuel, typically measured in miles per gallon (mpg) in the United States or kilometers per liter (km/L) in other countries. It broadly describes how effectively a vehicle uses fuel to generate power or energy. Factors such as engine design, aerodynamics, and drivetrain efficiency influence fuel economy. Fuel efficiency, on the other hand, measures how effectively a vehicle converts fuel into mechanical energy. This metric considers how well fuel is utilized to produce the desired performance, making it more focused on energy conversion than distance traveled. The study also highlights that not all jurisdictions regulate fuel economy or efficiency. Some regions have adopted emission standards that functionally lead to similar results (see the next slide for more details). Since burning fossil fuels releases CO_2, regulating CO_2 emissions even at the fleet average level effectively limits the amount of fuel that can be consumed. These standards can drive similar outcomes, such as promoting ZEV adoption.

Green distinction: A green rating was given for ambitious fuel economy standards, including incentives or credits to support ZEVs.

- China has a robust fuel efficiency standard for both LDVs and HDVs and, through the system, has an established credit mechanism for ZEVs.
- The EU (green/yellow hatched) does not have a standard for fuel efficiency; instead, it regulates CO_2 emissions.

Yellow distinction: A country/region was given a yellow rating if its fuel economy standards are comparatively less ambitious.

- India's CAFE standards received a yellow rating for setting comparatively low economy targets and but offering credits for ZEV sales.
- In the US, CAFE standards include a credit mechanism; they were rated yellow due to the size-based distinctions. Larger vehicles like SUVs and trucks face less stringent standards. CAFE standards use a vehicle's "footprint" (wheelbase multiplied by track width) to determine fuel economy targets, leading to two key issues:
  - Larger vehicles have lower fuel economy targets.
  - "Light trucks" (including SUVs and pickups) are subject to less stringent standards than passenger cars. Given the high penetration of larger vehicles and light trucks in the US, the CAFE standards are not as effective as they could be.
- Australia recently announced the New Vehicle Efficiency Standard (NVES), both a fuel economy/efficiency standard and a vehicle emissions standard. However, NVES will not take effect until January 1, 2025, and so Australia was given a yellow rating.
- In Brazil (yellow/red hatched), there were previously the Rota 2030 standards in place, which aimed to reduce average fuel consumption by 11% for new vehicles by 2022 compared to 2017. New standards will be implemented under the recently passed MOVER program, but the details have not yet been announced.

Red distinction: A country/region was given a red rating if fuel economy standards were not in place, and while it was noted if there was a tax provision on low-carbon emission vehicles, this was considered an indirect measure.

- Indonesia does not have a direct fuel efficiency standard but does have indirect measures in place, like the low-carbon emission vehicle program, which determines vehicle tax rates.
- South Africa research did not yield policies for this category.

Supply-Side Policies: Regulatory

Vehicle Emission Standards (GHGs)

Performance-based rules require manufacturers to meet specific standards for tailpipe pollutant emissions. This study focuses on whether these tailpipe emissions standards include stipulations for greenhouse gas (GHG) emissions, such as CO_2, as regulations targeting CO_2 have a more direct impact on the zero-emission vehicle (ZEV) market.

This study acknowledges the significance of regulations aimed at minimizing pollutants such as NOx, PM, CO, and HC, given their critical role in improving air quality, even though they are less directly tied to advancing the ZEV transition. However, the analysis places greater emphasis on the regulation of CO_2 and other GHG standards. While CO_2 and other tailpipe pollutants like NOx and PM are often regulated through separate standards, they are sometimes addressed within the same broader regulatory framework, which is why these regulations are highlighted.

Furthermore, the analysis recognizes the importance of distinguishing between fleet-level and individual vehicle-level regulations. However, its focus is on broadly assessing the existence and stringency of emissions regulations rather than conducting a detailed evaluation of how the regulatory framework is applied.

Green distinction: To receive a green distinction, a country/region needs to set specific CO_2 thresholds by year.

- The EU: The CO_2 emission performance standards have specific targets that will work to reduce CO_2 emissions and work to phase out the use of ICE vehicles. It requires a 100% reduction in CO_2 emissions from new cars and vans by 2035, effectively banning the sale of new fossil fuel-powered vehicles. Additionally, Euro 7 will come into effect in 2025, building upon past standards. The standards aim to significantly reduce air pollution from vehicle emissions, particularly targeting the reduction of NOx emissions from diesel vehicles, which have been a significant concern for air quality in urban areas. This is one of the most forward for PM and NOx regulations.
- US: The multi-pollution emissions standards for Model Year 2027 will significantly reduce emissions of greenhouse gases (GHG), hydrocarbons, nitrogen oxides (NOx), and particulate matter (PM2.5) from new passenger cars, light trucks, and larger pickups and vans. The rule will set specific GHG standards by regulatory class measured in CO_2 grams/mile.
- Australia (yellow/green): In 2024, Australia also approved the New Vehicle Efficiency Standard (NVES), which sets the first CO_2 emissions standards for Australia's light-duty vehicles; it will be phased in as of January 2025, and the credit and penalty scheme which will monitor manufactures fleet average CO_2 emissions awarding a penalty if more than the limit.

***Yellow distinction*:** A yellow threshold was provided when an emission regulation sought to regulate other pollutants but may not have directly monitored or set standards for CO_2 emissions.

- Brazil has adopted Euro 6 standards. Additionally, the recently passed MOVER program will require OEMs to reach CAFE standards by 2027 for wheel-to-well emissions. However, the details are still to be announced. The MOVER program will also regulate HDV emissions, but the targets have not been set.
- China's stage 6 emissions standards do not directly seek to curtail CO_2 emissions. The policy does, however, include a limit for nitrous oxide, which is a potent GHG.
- India Bharat Stage (BS) emissions standards limit pollutants, including PM, NOx, SOX, carbon monoxide, hydrocarbons, and methane from vehicles by setting specific standards and requiring that all new vehicles, both passenger and commercial, comply. BS-VI is modeled after Euro 6 emissions standards.

***Red distinction*:** A red threshold was provided for a country/region with less aggressive and/or comprehensive CO_2 emissions standards.

- Indonesia has adopted Euro 4 emissions standards, but most of the fuel sold in Indonesia does not meet Euro 4 standards.
- South Africa has adopted Euro 2 emissions standards.

Supply-Side Policies: Fiscal

ZEV Manufacturing Incentives

While functionally different* from regulatory supply-side policies, incentives are a supply-side policy that has shaped ZEV markets in specific countries and hence was included in our assessment. Our analysis in this category focused on examining policies that offer tax breaks, incentives, or other support to reduce the costs of retooling or developing ZEV production capacity, including related sectors such as battery production and assembly. ZEV manufacturing incentives often fall under broader industrial policies.

Green distinction: A green distinction was provided for a country/region with broad and impactful ZEV manufacturing incentives.

- China has provided substantial subsidies to ZEV manufacturers over time to encourage production and reduce costs, which was instrumental in jumpstarting the industry. While some subsidies have been phased out, China offers various tax breaks for manufacturers, including reducing corporate income tax and defraying some R&D expenses.
- The US has the IRA provision 45X, which is substantial. However, it takes time for manufacturers to leverage incentives, and data on their market impact is not available and is still nascent.

Yellow distinction: A yellow distinction was provided for a country/region that comparatively has fewer and/or less far-reaching manufacturing incentives.

- The EU: Individual countries in the EU have limited jurisdiction to offer manufacturing incentives as it has to be determined as a bloc. There have been some grants to promote research and development, but it is lower compared to China and even the US.
- Australia has committed $15 billion through the National Reconstruction Fund (NRF) to provide financing for projects that diversify and transform the country's industry and economy in priority areas – transportation is considered a priority area.
- In Brazil (yellow/red hatched), the MOVER program will include incentives for OEMs, including tax breaks for those that reach emissions targets, incentives for R&D, and import tax exemptions for parts and components without nationally produced substitutes. However, these incentives are not exclusively for ZEVs.
- India was given a yellow distinction as its production-linked incentive for Auto Parts (including ZEVs) and battery manufacturing. PLI was approved in 2021 but has underperformed, and actors note the incentives are difficult to avail.
- Indonesia has a tax holiday for corporate income tax for "pioneer industries," which includes electric motor vehicle manufacturers.
- South Africa (yellow/red hatched) has announced that starting March 1st, 2026, EV manufacturers will be eligible for a tax break, allowing producers to claim 150% of qualifying new investment spending in the first year. However, additional details are yet to be announced.

*Note: Incentives are functionally different from regulatory supply-side policies because they require government funding and because they do not stipulate that market actors are to meet specific standards but instead work to influence behavior via provided incentives or tax measures. They may be most relevant for the HDV segment, given the nascency and cost delta between diesel trucks.

Supply-Side Policies: Fiscal

Public Financing

Favorable financing is facilitated by government entities and can include low-cost financing or credit enhancement mechanisms.

Green distinction: A green distinction was given to a country/region with wide-reaching and available public financing options to support the ZEV transition.

- In China, government procurement, grants, and concessions were made for research and development, which supported the ZEV transition. Additionally, concessional loans were offered for the automotive sector. The China Development Bank is actively involved in funding ZEV production.
- In the US (green/yellow hatched), the Loan Program Office (LPO) provides loans and loan guarantees for EV manufacturing and infrastructure, including the Advanced Technology Vehicles Manufacturing Loan Program.

Yellow distinction: A yellow distinction was assigned to countries/regions with limited public financing options for EV adoption. These options are available but are narrowly targeted, small in scale, or lack the resources needed to accelerate ZEV adoption significantly.

- In the European Union, the Critical Raw Materials Act provides a framework to identify strategic projects and details a streamlined process to create a favorable financial environment to mobilize investment in such projects.
- In Australia, the government-owned green bank, in partnership with other organizations, provides short-term loans to dealerships to get new EVs on the road and to support reducing interest rates. Additionally, some state-level governments are offering reduced interest rates for EVs and infrastructure.
- In India, several projects are being financed by multilateral and development finance institutions to support the growth of the e-mobility sector, but there are limited flows of public financial resources allocated for this purpose.
- In Brazil (yellow/red hatch), the government recently launched an initiative to coordinate financing for climate action from multilateral institutions, including those with an “electric urban mobility” focus. Details on how this platform will facilitate funding for mobility projects are still limited.

Red distinction: A red distinction is for a country/region that does not have public financing mechanisms to support ZEVs.

- For Indonesia, research did not yield policies for this category.
- For South Africa, research did not yield policies for this category.

Demand-Side Policies: Regulatory

Operational Regulations

Regulations are reshaping vehicle movement within and around certain regions by establishing fleet purchase requirements or operating regulations restricting ICE vehicle use while offering favorable conditions for ZEVs.

Green distinction: A green distinction is for a country/region that stipulates ZEV use or discourages ICE vehicle use.

- The EU stands out with ZEV-friendly regulations in terms of the number of countries and municipalities that have adopted these, such as allowing EVs access to bus lanes and creating low-emission zones in several major jurisdictions. The EU also has minimum procurement targets for public authorities.
- In the US (green/yellow hatched), California has enacted ambitious policies like the Advanced Clean Fleets (ACF) rule for truck fleets and the Clean Miles Standard (CMS), but these regulations have not been adopted at the national level.
- In China (green/yellow hatched), several regions have implemented LEZs and ZEZs, which restrict the use of ICE vehicles. There are also some cities that require fleet purchasing requirements.

Yellow distinction: A yellow distinction is for a country/region with operational requirements supporting ZEVs or discouraging ICE vehicles but only in specific subnational areas.

- In India, several states and cities have parking and operational restrictions on ICE vehicles, and some have implemented feebate programs for ICE vehicles.
- In Indonesia, electric four-wheelers are exempt from Jakarta's odd-even license plate traffic policy.

Red distinction: A red distinction is for a country/region that does not have operational requirements that impact ZEVs or ICE vehicles.

- For Australia, research did not yield policies for this category.
- For Brazil, research did not yield policies for this category.
- For South Africa, research did not yield policies for this category.

Demand-Side Policies: Fiscal

Purchase / Operating Incentives

These include mechanisms that provide direct financial or tax incentives to help close the price gap or total cost of ownership (TCO) difference between fossil fuel vehicles and electric vehicles.

Green distinction: A green distinction highlights a country/region with significant and/or far-reaching incentives for purchasing ZEVs and/or operating ZEVs. The green/yellow hatched areas indicate regions where purchase incentives were once significant but have been gradually rolled back over time. This signifies that these incentives initially played a critical role in market creation but have now been reduced as the ZEV market has matured.

- India's FAME II and PM Electric Drive Revolution in Innovative Vehicle Enhancement scheme represent robust incentive policies that have and continue to drive EV adoption.
- The US has the IRA, which provides incentives nationwide. While the federal regulation provides favorable incentives, there are some limitations due to domestic production requirements. Additionally, several US states offer additional attractive purchase incentives.
- China (green/yellow hatched) previously offered purchase subsidies for new NEVs, but these had been gradually phased out as of 2022. China offers a favorable tax exemption for ZEVs through 2025, but it will decrease in value in 2026 and 2027. China's Action Plan for Promoting Large-scale Equipment Renewal and Trade-in of Consumer Goods increases subsidies for consumers replacing old vehicles with NEVs.
- The European Union (green/yellow hatched) does not offer purchase or operating incentives as a Bloc, but some member states have enacted purchase incentives, tax, and registration fee waivers. As ZEV sales have increased, several countries have rolled back some of these incentives.
- Indonesia (green/yellow hatched) offers purchase subsidies for electric two-wheelers and an incentive for ICE to EV conversion for two-wheelers; electric two- and four-wheelers are exempt from a one-time title transfer tax and an annual vehicle tax; electric four-wheelers and e-buses that meet local content requirements are eligible for a reduced value-added tax.

Yellow distinction: A yellow designation was provided when a country had issued some form of tax break, registration waiver, or incentive that supported ZEVs.

- Australia offers fringe tax benefit exemptions for company fleets and salary-sacrifice arrangements, which have somewhat limited reach. Some specific incentives, such as stamp duty and registration incentives, are offered in specific states, but given that they are regional, not national, this resulted in a yellow distinction.
- In Brazil, 9 of 26 states have purchase/operating incentives, but they are inconsistent and change often. The MOVER program also mentions implementing a feebate. However, the details are still to be announced.
- In South Africa (yellow/red hatched), the environmental levy is a tax applied to passenger vehicles based on their CO_2 emissions per kilometer.

Policies / Funding Aimed at the Establishment of Public Infrastructure

These are policies that support the deployment of infrastructure networks to support ZEVs.

Green distinction: A green distinction is given to a country/region that has developed wide-reaching policies to support a comprehensive infrastructure network.

- China has developed guidelines for constructing a comprehensive charging infrastructure system by 2030 across cities, highways, and rural areas. Additionally, cities like Shanghai have implemented measures to encourage the development of EV charging and battery swapping, specifically by offering subsidies.
- In the EU, the Alternative Fuels Infrastructure Regulation (AFIR) regulation is designed to expand EV charging infrastructure across the region by stipulating that the installation of fast-charging stations (at least 150 kW) occur every 60 km along major trans-European transport networks and requiring a minimum charging capacity of 1.3 kW per registered battery-powered vehicle.
- In the US (green/yellow hatched), the Bipartisan Infrastructure Bill and incentives through the IRA have been enacted, including funding for the National Electric Vehicle Infrastructure (NEVI) Formula Program. Still, there currently remains a lack of cohesive, nationwide charging infrastructure.

Yellow distinction: A yellow distinction is given when a country/region has made attempts or has implemented some policies to support infrastructure development, but efforts remain incomplete or inconsistent.

- In Australia, there are multiple sources of funding for charging infrastructure, including the Driving the Nation Fund.
- In India, although regions like Delhi have taken proactive steps to develop charging policies, and there is a national target regarding EV infrastructure deployment, India lacks comprehensive national incentives and directives.
- In Indonesia, there are maximums on charging infrastructure service fees and safety stipulations.

Red distinction: A red distinction is for a country/region that does not have policies to support infrastructure development.

- For Brazil, research did not yield policies for this category.
- For South Africa, research did not yield policies for this category.