Transport Decarbonisation Pathways in APEC: Electric Vehicles, Fuel Cell Vehicles, and Informed Decision-Making

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APEC Energy Working Group

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Executive Summary

Transport decarbonisation is a strategic priority for APEC economies as they seek to balance energy security, economic resilience, and climate commitments amid global uncertainty. The transport sector accounts for a significant share of regional energy demand and emissions, and decisions made over the next decade regarding vehicle technologies, infrastructure, and supporting systems will have lasting implications for emissions outcomes, industrial competitiveness, and social equity. This report examines transition pathways away from internal combustion engines (ICE) through electric vehicles (EVs) and fuel cell vehicles (FCVs), recognising that while both can reduce emissions and oil dependence, their suitability, timing, and scale vary widely across economies and transport segments.

Electric vehicles are commercially mature in many light-duty and urban applications, whereas fuel cell vehicles remain at an earlier stage and are mainly relevant for heavy-duty, long-distance, or high-utilisation uses. The report does not promote a single technology. Instead, it emphasises that transport decarbonisation is a system-wide transition shaped by power systems, infrastructure, urban form, institutions, workforce capacity, and public confidence which differ significantly across APEC economies and explain why similar policies often produce very different outcomes.

To address these issues, the report employs an analytical framework that focuses on informed decision-making under uncertainty. It introduces three core concepts:

1. Decisions lie on a continuum of urgency, balancing short-term needs (such as energy security and affordability) with long-term goals (emissions reduction, resilience, and competitiveness).
2. Common-interest inflection points occur when pressures, such as grid stress, climate events, labour shortages, or supply-chain disruptions build up, limiting future options and raising the risk of long-term lock-in.
3. Decisions evolve through before–during–after cycles, as viable choices shift when pressures rise and then ease.

The report adopts an options-based approach rather than providing prescriptive recommendations, reflecting the diversity of APEC economies and the uncertainty surrounding technology costs, supply chains, and external conditions. Options are presented as conditional and context-specific, with emphasis on timing, sequencing, and preserving future flexibility. This approach supports peer learning and dialogue without assuming a single transition model.

The analysis reviews key internal and external factors shaping EV and FCV pathways. Internal factors include governance capacity, infrastructure and land-use constraints, market conditions, fiscal resources, workforce skills, and public attitudes. External factors include concentrated global supply chains, standards and certification frameworks, trade and investment environments, as well as exposure to price volatility and geopolitical risk. Together, these factors define the practical decision space available to each economy.

The report introduces a framework for economy positioning and scenario-based foresighting, based on EV and FCV ecosystem maturity and energy profiles. It distinguishes between established, developing, and early-stage systems, as well as fossil-fuel producers and non-producers. Scenarios are used as exploratory tools rather than predictions to assess how transition choices may evolve under different inflection points, technology developments, and constraints, and to highlight that preserving options often matters more than choosing one path too early.

1. Introduction

1.1 Purpose, Scope, and Strategic Relevance for APEC

Transport decarbonisation has become a strategic priority for APEC economies as they seek to balance energy security, economic resilience, and climate commitments in an increasingly uncertain global environment. The transport sector remains one of the largest consumers of energy and a major source of emissions across the region. Decisions taken over the next decade regarding vehicle technologies, supporting infrastructure, and enabling systems will therefore have long-term implications for emissions trajectories, industrial competitiveness, and social outcomes.

This report examines the transition away from internal combustion engine vehicles (ICEs) through the deployment of electric vehicles (EVs) and fuel cell vehicles (FCVs). Both technologies offer pathways to reduce emissions and dependence on imported oil, but their relevance, timing, and scale differ markedly across economies and transportation segments. EVs have reached commercial maturity in many light-duty and urban applications, while FCVs remain at an earlier stage of deployment but hold potential advantages in selected heavy-duty, long-distance, and high-utilisation contexts. The purpose of this report is not to promote one technology over another, but to support economies in understanding how different transition pathways may align with their specific conditions.

The Asia-Pacific region plays a central role in global transport and energy transitions. APEC economies collectively account for a large share of the world's vehicle fleets, manufacturing capacity, critical mineral supply, and energy demand. Policy and investment choices made within the region influence global technology costs, supply-chain resilience, and the pace of cross-border emissions reduction well. At the same time, APEC economies are highly diverse. They differ significantly in terms of income levels, energy mixes, urban form, institutional capacity, and exposure to climate and supply chain risks. This diversity limits the usefulness of uniform policy prescriptions.

Recent regional trends illustrate both the scale of the challenge and the uneven pace of transition across APEC economies. Globally, the transport sector accounts for approximately 30% final energy demand and nearly 60% of oil consumption, underscoring its central role in energy security and emissions outcomes.[1] Within APEC, vehicle fleets exceed 1 billion units, spanning highly diverse markets, income levels, and usage patterns.[2] EV adoption has accelerated rapidly in a small number of leading economies, with penetration rates surpassing 40 per cent of new sales in China and over 50 per cent in select global markets such as Norway, while most APEC economies remain far lower.[3,4] Charging infrastructure has expanded rapidly, with publicly accessible charging points surpassing 5 million worldwide in 2024, concentrated

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[1] IEA. Energy Efficiency 2025: Transport. Paris: IEA, 2025. https://www.iea.org/reports/energy-efficiency-2025

[2] APEC. APEC AD Plans 2022–2025 and Decarbonization of Transportation. APEC Secretariat, 2022. https://www.egnret.ewg.apec.org/Upload/2025051210196096eedd1.pdf

[3] WRI. "These Countries Are Adopting Electric Vehicles the Fastest." December, 2025. https://www.wri.org/insights/countries-adopting-electric-vehicles-fastest

[4] S&P Global. "EV Adoption Rates: How the US and Other Markets Compare in 2025." October, 2025. https://www.spglobal.com/automotive-insights/en/blogs/2025/10/ev-adoption-rates-how-us-and-other-markets-compare-2025

in China and Europe.[5] At the same time, many economies and transport segments remain at early or pilot stages of deployment, constrained by infrastructure readiness, grid capacity, fiscal space, or institutional conditions. Taken together, these trends highlight the diversity of starting points across the region and reinforce the need for transition pathways that are sensitive to context, scale, and sequencing rather than uniform across economies.

Against this backdrop, the scope of this report is deliberately defined. It provides a structured basis for informed discussion and comparison across economies without ranking performance or prescribing a single transition model. Instead, it seeks to clarify key drivers, constraints, and opportunities that shape EV–FCV transition pathways, and to highlight where choices are likely to differ across contexts. In doing so, the report aims to facilitate context-sensitive strategies, regional learning, and constructive dialogue within APEC on how transport decarbonisation can be advanced in ways that are resilient, flexible, and aligned with broader development objectives.

1.2 Equitable Technology Transition and Systemic Change

The transition from ICEs to EVs and FCVs is progressing at very different speeds and velocity across APEC economies. Some economies have achieved high levels of EV adoption, supported by extensive charging networks and established manufacturing capacity. Others remain at an early stage, constrained by limited infrastructure, fiscal capacity, or institutional readiness. Deployment of FCVs is even more uneven. It is largely limited to pilot projects, industrial clusters, and selected freight corridors. These differences reflect not only policy ambition, but also deeper structural conditions that determine what is feasible and when.

Decisions on EVs and FCVs cannot be assessed in isolation from the systems in which they operate. Electricity generation and grid capacity influence both the emissions benefits and the scale of EV deployment. Urban form, land availability, and housing patterns affect where and how charging infrastructure can be installed. Workforce skills, standards, and regulatory coordination shape how quickly new technologies can be deployed safely and reliably. In many economies, these system-level factors, rather than vehicle performance alone, are the main constraints on transition pathways.

Understanding transport decarbonisation as a system change, rather than a simple technology substitution, also brings equity issues into focus. Economies with limited fiscal space or weak infrastructure face higher upfront barriers, even when long-term benefits are clear. Within economies, differences in income, housing type, and access to reliable energy affect who can adopt new technologies and who bears adjustment costs. If these distributional effects are not addressed, transition strategies may widen existing inequalities or create new ones.

These dynamics help explain why similar policies produce different outcomes across economies. Incentives for vehicle uptake may be effective where grids are resilient and infrastructure can expand quickly, but they perform poorly where power systems are stressed or urban space is limited. Early investment in hydrogen refuelling infrastructure may be appropriate in economies with concentrated freight demand and existing industrial hydrogen use, but premature in others. Recognising these interactions shifts attention away from identifying a single “best” technology and towards understanding how energy systems, infrastructure, institutions, and markets interact to shape viable transition pathways.

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[5] IEA. Global EV Outlook 2025: Electric Vehicle Charging. Paris: IEA, 2025. https://www.iea.org/reports/global-ev-outlook-2025/electric-vehicle-charging

By treating transport decarbonisation as both a systemic and an equity-related challenge, this section sets the context for the analysis that follows. It explains why transition pathways differ across APEC economies and why flexibility, sequencing, and sensitivity to local conditions are essential when considering EV and FCV options.

1.3 Science Diplomacy as a Governing Lens

Transport decarbonisation is occurring in a period of growing uncertainty. Energy markets are volatile, technologies are evolving rapidly, and geopolitical conditions are changing. In this environment, policy pathways rarely follow linear or predictable trajectories. Instead, they are shaped by external shocks, shifting constraints, and changing priorities, which affect the choices that remain available over time. Addressing these conditions requires approaches that can manage uncertainty while sustaining cooperation across diverse economies.

Science diplomacy offers a useful governing lens for this task. It uses scientific knowledge, collaborative research, and scientific institutions to support informed decision-making while maintaining constructive international relationships. Operating at the boundary between science and policy, science diplomacy helps build trust, manage shared risks, and address collective challenges such as climate change, energy security, and environmental sustainability.

Rather than seeking agreement through prescriptive solutions, science diplomacy emphasises dialogue, evidence-informed judgement, and mutual learning. It recognises that scientific understanding evolves and that uncertainty is inherent in complex system transitions. Science is therefore treated not as a source of final answers, but as a tool to improve understanding, clarify trade-offs, and inform choices without closing off future options. This approach is particularly relevant in APEC, where differences in development stage, energy systems, and institutional capacity limit the effectiveness of uniform policy models.

Applied to transport decarbonisation, science diplomacy supports engagement among economies with different priorities and constraints. It encourages cooperation on standards, data, and research, while allowing flexibility in how economies sequence and implement transition measures. By framing EV and FCV transitions as shared challenges that require context-sensitive responses, science diplomacy helps sustain constructive dialogue even when economy-specific pathways differ.

1.4 Intended Audience and Use of the Report

This report is intended as an analytical and strategic resource to support informed discussion and decision-making across diverse APEC contexts. Its purpose is to clarify how different factors interact to shape transition pathways and to support reflection on options, sequencing, and trade-offs.

The primary audiences include policymakers and regulators, energy and transport agencies, industry and infrastructure planners, and regional cooperation and dialogue platforms. Although these stakeholders operate at different points in the decision-making system, all face the challenge of managing uncertainty, competing objectives, and long-term commitments in transport and energy transitions.

The structure of the report reflects this purpose. Chapter 2 presents the analytical framework used throughout the report, including concepts related to informed decision-making, system pressures, and timing. Chapter 3 places EV and FCV transitions within broader global and regional developments, such as technology trends, supply chains, and geopolitical conditions. Subsequent chapters examine the barriers and enablers that influence transition pathways, followed by economy positioning and scenario-based exploration. The final chapter synthesises key insights and proposes questions to guide future dialogue.

The report can be used in several ways. It can inform strategy discussions within economies by helping decision-makers identify relevant constraints, enablers, and sequencing issues. It can support regional peer learning by providing a shared analytical vocabulary without implying convergence on a single model. It can also be used for scenario exploration and stress-testing, particularly where economies wish to assess how different options perform under varying future conditions.

By clarifying options rather than prescribing actions, the report aims to strengthen the quality of deliberation within APEC. It supports decision-making that is context-sensitive, adaptive, and aligned with broader development objectives, while remaining responsive to uncertainty and change over time.

2. Framework for Informed Decision-making

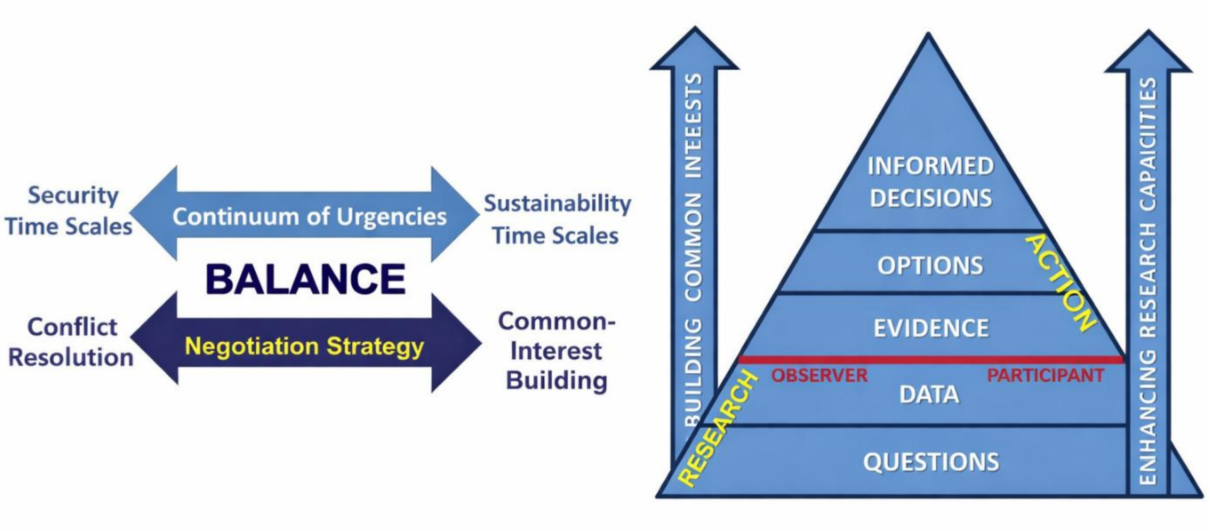

Figure 1. Informed decision-making across a continuum of urgencies.

2.1 Informed Decision-making Under Uncertainty

Decisions on transport decarbonisation increasingly need to be made under conditions of uncertainty, where technological performance, costs, supply chains, and external risks evolve unevenly and often unpredictably. In such environments, conventional linear planning approaches are limited, as they tend to assume stable trajectories and clearly defined end states that may not hold in the face of rapid innovation, geopolitical disruption, climate impacts, or shifting societal expectations.

In this report, informed decision-making is understood as a process that integrates evidence, systems awareness, and judgment across multiple time horizons. Rather than seeking to identify a single optimal pathway in advance, it focuses on improving the quality of choices made at different stages of transition by clarifying constraints, trade-offs, and implications for future flexibility. As illustrated in Figure 2, informed decisions span short-term security and long-term sustainability time scales. They are supported by an iterative process in which questions, evidence, options, and judgment are revisited.

A central feature of this approach is attention to path dependency and lock-in. Investments in vehicle technologies, infrastructure, and regulatory systems often involve long asset lifetimes and high sunk costs. Once established, these systems can be difficult and costly to reverse. Decisions taken to address short-term pressures, such as energy security or fiscal constraints, may therefore have long-term consequences for emissions outcomes, industrial competitiveness, and social equity. Recognising these dynamics is essential for avoiding suboptimal outcomes that arise not from poor intentions, but from constrained choices over time.

Informed decision-making also requires explicit engagement with uncertainty. Rather than treating uncertainty as a temporary lack of information to be resolved before action, this framework treats it as a persistent feature of system transitions. The objective is not to eliminate uncertainty, but to manage it by preserving optionality, sequencing actions carefully, and aligning near-term measures with credible long-term directions. This perspective underpins the analytical structure used throughout the report.

2.2 Continuum of Urgencies: Balancing Security and Sustainability

Decisions on EV and FCV transitions are shaped by a continuum of urgencies that span short-term pressures and long-term objectives. At one end of this continuum are immediate considerations, such as energy security, affordability, supply chain reliability, and economic stability. At the other end are longer-term goals related to emissions reduction, system resilience, technological competitiveness, and intergenerational equity. These concerns coexist and interact, rather than appearing sequentially or independently.

In practice, tensions often arise where short-term imperatives appear to conflict with longer-term sustainability goals. Measures taken to address near-term risks, such as reliance on established fossil-based infrastructure or delayed investment in new systems, may provide immediate stability but increase long-term transition costs. Conversely, aggressive long-term commitments made without regard to current system constraints can generate resistance, implementation bottlenecks, or unintended social impacts. The continuum of urgencies provides a structured way to examine how these pressures interact and how trade-offs are managed.

Within this framework, transport decarbonisation decisions are not evaluated solely on their emissions outcomes, but on how they perform across multiple dimensions of concern. These include reliability of energy supply, fiscal and institutional capacity, infrastructure readiness, workforce implications, and distributional effects. The relative weight of these factors differs across economies and over time, reflecting variations in development stage, energy mix, and exposure to external risks.

The continuum of urgencies also highlights why transition pathways evolve rather than follow predetermined trajectories. As conditions change, the balance between security-oriented and sustainability-oriented priorities may shift. Periods of stability may allow greater emphasis on long-term transformation, while periods of stress may require measures that prioritise resilience and continuity. By situating EV and FCV decisions along this continuum, the framework enables a more transparent assessment of why certain options become more or less viable at different moments.

Together, informed decision-making under uncertainty and the continuum of urgencies provide the foundation for the analytical approach used in this report. They set the basis for examining how pressures accumulate, how constraints emerge, and how choices can be sequenced in ways that maintain flexibility while advancing transport decarbonisation objectives.

2.3 Common-Interest Inflection Points

Within complex system transitions, pressures do not accumulate smoothly or predictably. Instead, they tend to converge at specific moments when constraints tighten, options narrow, and the consequences of decisions become more pronounced. In this report, these moments are referred to as *inflection points*. Inflection points are not singular events, nor do they determine outcomes on their own. Rather, they represent thresholds at which existing arrangements become increasingly difficult to sustain, and where decisions carry heightened and often irreversible implications for future pathways.

Inflection points are best understood as common-interest challenges. Although they may manifest differently across economies, they often arise from shared structural pressures that cut across borders and sectors. Addressing them effectively therefore benefits from coordinated understanding and, where possible, collective responses. In the context of EV and FCV transitions, several categories of common-interest inflection points are particularly relevant.

One category relates to climate and environmental thresholds. The increasing frequency and severity of extreme weather events can disrupt energy and transportation systems, expose vulnerabilities in infrastructure, and strain institutional capacity. These pressures can accelerate the need for transition while simultaneously reducing the margin for error in implementation. Another category concerns demographic and labour dynamics, including population ageing, workforce shortages, and skill mismatches, which affect the ability to deploy, operate, and maintain new technologies at scale.

Urbanisation and land-use pressures constitute a further set of inflection points. Rapid urban growth, high-density development, and constrained space can limit the feasibility of certain infrastructure solutions, particularly for charging and refuelling systems. Grid expansion and system stress form another critical category. As electricity demand rises due to transport electrification, delays in grid reinforcement or renewable integration can create bottlenecks that slow deployment or undermine emissions benefits.

These inflection points do not occur in isolation. They often intersect, amplifying their effects and increasing the urgency of decision-making. Recognising inflection points as part of a broader pattern of system pressure allows policymakers to anticipate where choices may become constrained and to act before options are foreclosed. This forward-looking perspective is central to the analytical approach adopted in this report.

2.4 Before–During–After Decision Cycles

To navigate inflection points effectively, this report adopts a temporal framing that distinguishes between *before*, *during*, and *after* phases of decision-making. This structure reflects the observation that the nature of decisions, available options, and acceptable trade-offs change as pressures intensify and then stabilise.

The *before* phase focuses on preparedness. During this phase, pressures are emerging but have not yet reached critical levels. Decisions made here typically involve planning, capacity building, pilot projects, and early infrastructure investments. The objective is to expand future options, reduce exposure to foreseeable risks, and build institutional and technical readiness without committing prematurely to rigid pathways.

The *during* phase corresponds to periods of heightened stress, where inflection points become visible and immediate responses are required. Constraints may tighten rapidly due to external shocks, such as energy supply disruptions, rapid demand growth, or climate-related events. In this phase, decision space is often narrower, and trade-offs become more acute. Measures adopted during this period tend to prioritise system stability, continuity of services, and risk management. Decisions made under these conditions are particularly consequential, as they can lock systems into trajectories that persist long after the immediate pressure has passed.

The *after* phase focuses on consolidation and adjustment. As pressures ease or stabilise, there is an opportunity to assess the effects of earlier decisions, address unintended consequences, and recalibrate strategies. This phase is critical for correcting course, embedding lessons learned, and re-expanding optionality where possible. It also provides a window for aligning short-term responses with longer-term objectives, including emissions reduction and system resilience.

Applied across EV and FCV transition pathways, the before–during–after cycle provides a consistent lens for analysing how decisions evolve over time. It helps distinguish actions that are appropriate as preparatory measures from those suited to crisis response or longer-term system integration. By embedding temporal awareness into the analytical framework, the report supports decision-making that is responsive to changing conditions while remaining attentive to long-term consequences.

2.5 Why the Report Uses Options, Not Prescriptions

In contexts characterised by uncertainty, diversity, and long asset lifetimes, prescriptive policy guidance carries inherent risks. Fixed recommendations can commit economies to pathways that may prove suboptimal as technologies evolve, costs change, or external conditions shift. They can also obscure differences in local context, including variations in energy systems, institutional capacity, fiscal space, and development priorities across APEC economies.

The use of options rather than prescriptions reflects an effort to manage these risks. An options-based approach recognises that multiple pathways may be viable at any given time, but that their suitability depends on conditions that vary across economies and over time. By outlining a range of plausible actions instead of a single preferred course, this approach preserves flexibility and allows economies to adapt sequencing and emphasis as circumstances change.

Options are presented in this report as explicitly conditional. Their relevance depends on factors such as infrastructure readiness, grid capacity, technological ecosystem maturity, workforce skills, and exposure to external risks. Measures that are appropriate as preparatory steps in one economy may be ineffective or counterproductive in another, or may only become viable at a later stage. Timing is therefore as important as choice. Actions that expand future decision space in earlier phases may differ from those required to stabilise systems during periods of stress or to consolidate gains after pressures ease.

An options-based approach also supports learning and comparison without implying convergence on a single model. By examining how similar challenges are addressed under different conditions, economies can draw insights from peers facing comparable constraints while retaining autonomy over economy-specific strategies. This is particularly important in APEC, where diversity is a defining characteristic rather than an exception.

By privileging evidence-informed judgement over prescription, the framework adopted in this report seeks to reduce the risk of lock-in while supporting strategic flexibility across short-term and long-term horizons. It provides a structured basis for navigating inflection points and sequencing decisions in ways that remain responsive to uncertainty, resilient to disruption, and aligned with broader development objectives.

3. Global and Regional Context for EV and FCV Transitions

3.1 Technology Maturity and Cost Trajectories

Global technology maturity and cost trajectories shape the outer boundaries of EV and FCV transition pathways for all APEC economies. These dynamics are largely determined by cumulative global investment, manufacturing scale, and learning effects, rather than by individual economy-specific policy choices. As a result, economies face a shared technological landscape, even though their capacity to respond to it varies.

EV technologies have reached a stage of commercial maturity in multiple market segments. Declining battery costs, improvements in energy density, and standardisation of vehicle platforms have driven rapid scaling in global EV production and deployment. Learning-by-doing effects have been reinforced by high-volume manufacturing, particularly in the production of battery cells, power electronics, and electric drivetrains. These trends have reduced upfront costs and improved performance, but they have also increased dependence on global supply chains and exposed economies to price volatility and trade disruptions.

In contrast, FCV technologies are still in an early stage of development. While technical performance has improved in areas such as durability, refuelling speed, and efficiency, costs remain high, and deployment remains limited. Progress in FCV technologies is closely tied to advances in hydrogen production, storage, transport, and refuelling infrastructure. As these enabling systems evolve unevenly across regions, FCV cost trajectories remain uncertain and sensitive to external factors such as energy prices, infrastructure investment cycles, and standards development.

Importantly, technology maturity does not translate directly into system readiness. Even where EV technologies are commercially viable, scaling deployment can be constrained by grid capacity, land availability, workforce skills, and institutional coordination. Similarly, FCV technologies may be technically viable for specific applications, but system-level requirements can delay or limit broader adoption. These mismatches between technology readiness and system capacity represent a persistent feature of the global transition landscape.

Illustrative recent developments underline this non-linearity. The average cost of a lithium-ion battery pack fell to USD139 per kilowatt-hour in 2023, with leading manufacturers achieving a cost of around USD123 per kilowatt-hour. Projections in some markets suggest that costs could decline toward, or even below, USD100 per kilowatt-hour by the late 2020s, as manufacturing scale and learning effects continue.[6] These trends have been driven in part by the rapid expansion of global cell production capacity, with China holding more than three-quarters of global battery manufacturing and downstream integration.[7] In contrast to established energy sources, low-carbon hydrogen continues to face significant cost premiums. Green hydrogen production costs currently average between USD4 and USD6 per kg, whereas fossil-based alternatives remain significantly cheaper at USD1 to USD2 per kg.[8] This price gap is driven by high production expenses, limited electrolyzer deployment and existing infrastructure constraints, as well as a high sensitivity to electricity price volatility. As of 2023, the vast majority of global hydrogen production remained fossil-based, with renewable green hydrogen

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[6] Bloomberg NEF. Battery Price Survey 2023. London: BloombergNEF, 2023.

[7] IEA. Global EV Outlook 2023. Paris: IEA, 2023.

[8] IEA. Global Hydrogen Review 2023. Paris: IEA, 2023.

accounting for less than 0.1% of the total output. Together, these developments illustrate how cost signals can diverge sharply across technologies and over time, reinforcing the need to treat cost trajectories as evolving global conditions rather than stable planning assumptions.

Cost trajectories for both EVs and FCVs are also non-linear. Short-term cost reductions may be interrupted by supply-chain bottlenecks, commodity price spikes, or geopolitical tensions. Conversely, step-changes in manufacturing scale or innovation can unexpectedly accelerate cost declines. For APEC economies, these dynamics underscore the importance of understanding technology trends as evolving global conditions rather than as fixed inputs to economy-level planning.

3.2 Supply Chains, Strategic Resources, and Manufacturing Ecosystems

The global EV–FCV transition is underpinned by highly concentrated and interdependent supply chains. These supply chains span critical minerals, component manufacturing, vehicle assembly, and supporting infrastructure, all of which operate across multiple jurisdictions. For APEC economies, this creates both opportunities for participation and vulnerabilities to external disruption.

Critical minerals such as lithium, nickel, cobalt, and rare earth elements are essential inputs for batteries, electric motors, fuel cells, and power electronics. While reserves of these materials are geographically distributed, processing and refining capacity is significantly more concentrated. This structural concentration exposes economies to risks arising from export controls, trade restrictions, logistical disruptions, and price volatility. Similar patterns exist in the production of key components, including battery cells, fuel cell stacks, and semiconductors.

Resource endowments within the APEC region further highlight this interdependence. Indonesia approved a 2025 nickel mining quota of 298.5 million wet metric tons, consolidating its position as the world's largest producer, with more than half of global nickel production concentrated in the economy.[9] Australia, meanwhile, supplies nearly half of global lithium, with exports forecast to rise from USD5.2 billion in FY2025 to USD8.2 billion by FY2030, driven by strong mine output.[10] However, the presence of reserves does not imply control over value chains. Processing, refining, and component manufacturing capacity remains far more concentrated than upstream extraction, with China accounting for 78% of global battery pre-treatment capacity and 89% of black mass refining capacity, alongside its dominance in the interregional trade of battery minerals.[11] As a result, economies with resource endowments remain embedded within global production networks, while economies without such resources remain dependent on stable access to international markets. These patterns reinforce the structural nature of supply-chain interdependence rather than offering a basis for self-sufficiency or optimisation

Manufacturing ecosystems for EVs and FCVs have evolved through cumulative investment and clustering effects. Economies with established industrial bases benefit from agglomeration,

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[9] Valor International. "How Indonesia Became the World's Nickel Powerhouse." July, 2025. https://valorinternational.globo.com/business/news/2025/07/09/how-indonesia-became-the-worlds-nickel-powerhouse.ghtml

[10] Export Finance Australia. "Australia—Higher Lithium Exports Supported by Strong Mine Output." May 2025. https://www.exportfinance.gov.au/resources/world-risk-developments/2025/may/australia-higher-lithium-exports-supported-by-strong-mine-output

[11] U.S. Energy Information Administration. "China Dominates Global Trade of Battery Minerals." May, 2025. https://www.eia.gov/todayinenergy/detail.php?id=65305

skilled labour pools, supplier networks, and integrated logistics. At the same time, the capital intensity of these ecosystems creates barriers to entry and increases the cost of rapid reconfiguration. As a result, manufacturing capacity tends to reinforce existing advantages while limiting the speed at which production can be diversified geographically.

Intellectual property regimes, standards, and licensing arrangements further shape access to technology and markets. Control over proprietary designs, software, and manufacturing processes can influence who captures value along the supply chain and how quickly technologies diffuse. These factors interact with economy-level industrial policies and regional trade arrangements, affecting investment decisions and cross-border collaboration.

From a regional perspective, EV–FCV supply chains highlight the limits of full self-sufficiency. Even economies with strong manufacturing capabilities remain dependent on external inputs, markets, or technologies. Conversely, economies with resource endowments or niche capabilities are often integrated into broader regional or global value chains rather than operating independently. This interdependence makes coordination, transparency, and risk management increasingly important at the regional level.

For the purposes of this report, supply chains and manufacturing ecosystems are treated as structural conditions rather than as objects of optimisation. They shape the constraints and opportunities faced by all economies, but they do not determine specific transition pathways on their own. How individual economies engage with these structures is examined later, when economy positioning and scenario-based options are considered.

3.3 Standards, Safety, Testing, and Certification Trends

Standards, safety frameworks, and certification regimes play a critical role in shaping the deployment and cross-border diffusion of EV and FCV technologies. These regimes influence market access, interoperability, consumer confidence, and investment risk, and they operate largely beyond the control of individual economies. As such, they form an important part of the shared external environment for EV–FCV transitions across APEC.

For EVs, standards govern charging interfaces, communication protocols, battery safety, vehicle performance, and end-of-life management. While some degree of convergence has emerged around charging connectors and safety requirements, significant fragmentation remains across regions and manufacturers. Differences in technical specifications, certification processes, and testing requirements can increase costs, delay deployment, and limit interoperability, particularly for cross-border transport and regional supply chains.

FCVs face an even more complex standards landscape. Hydrogen refuelling involves high-pressure systems, stringent safety requirements, and precise fuel quality specifications. International standards covering hydrogen purity, storage, refuelling protocols, and station design are still evolving, and their adoption varies across jurisdictions. Limited testing and certification capacity in some regions further constrains deployment, as components and systems often require validation in specialised facilities located beyond borders.

Beyond technical specifications, regulatory and institutional capacity play a decisive role in how standards are implemented. Certification timelines, approval processes, and enforcement practices vary significantly, impacting project costs and investment certainty. Inconsistent or unclear regulatory frameworks can discourage private-sector participation, while overly rigid frameworks may struggle to keep pace with technological change.

At the regional level, standards and certification trends highlight a tension between innovation and harmonisation. Rapid technological evolution can outpace formal standard-setting processes, while fragmented standards can inhibit scale and increase systemic risk. For APEC economies, these dynamics underscore the importance of understanding standards not merely as technical details, but as structural factors that shape market integration, safety outcomes, and the pace of transition.

3.4 Global Trade, Investment Patterns, and Systemic Vulnerabilities

EV-FCV transitions are unfolding within a broader global economic context characterised by shifting trade patterns, evolving industrial policy, and heightened exposure to systemic risks. Trade and investment flows influence where technologies are produced, how quickly they scale, and the resilience of supply chains to disruptions. These forces affect all APEC economies, regardless of their individual transition strategies.

Global trade in vehicles, components, and critical materials has expanded rapidly alongside the growth of EV markets. At the same time, trade flows have become increasingly sensitive to policy interventions, including tariffs, subsidies, local input requirements, and environmental regulations. Measures designed to support domestic industries or accelerate decarbonisation can also introduce uncertainty, increase costs, or trigger retaliatory responses, affecting regional and global markets.

Investment patterns highlight the capital-intensive requirements of both EV and FCV ecosystems. Developing these sectors demands significant upfront funding for manufacturing facilities, grid enhancements, charging networks, and hydrogen infrastructure. To support global transport electrification alone, system upgrades and infrastructure scaling will require more than USD500 billion by 2030.[12] These financial flows are frequently concentrated within a few dominant economies, which strengthens existing production hubs but also increases global exposure to financial and geopolitical shocks. Consequently, factors such as access to finance, the cost of capital, and overall investor confidence serve as the primary drivers of where and how quickly new capacity expands.

Systemic vulnerabilities arise from the interaction of trade, investment, and external shocks. Supply-chain disruptions, commodity price volatility, exchange rate fluctuations, and geopolitical tensions can impact technology costs and deployment timelines. Climate-related events can damage infrastructure and disrupt logistics, while macroeconomic downturns can constrain public and private investment. These risks are not evenly distributed, but they form part of the shared backdrop against which all economies must plan.

From a regional perspective, these dynamics highlight the limits of isolated approaches to EV–FCV transitions. Trade and investment conditions are shaped by global forces that extend beyond borders, and vulnerabilities in one part of the system can propagate across regions. Understanding these systemic conditions is therefore essential for informed decision-making, even though responses to them will necessarily differ by economy.

In this report, global trade, investment patterns, and systemic vulnerabilities are treated as contextual forces rather than as levers for optimisation. They define the external environment within which economies operate, setting constraints and shaping risks, but they do not predetermine specific transition pathways. How economies navigate these conditions is addressed later through economy positioning and scenario-based analysis.

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[12] IEA. *Global EV Outlook 2023*. Paris: IEA, 2023.

4. Internal Barriers Affecting Transition Pathways

Internal barriers are economy-level constraints that arise from domestic institutions, infrastructure, markets, and social conditions. They shape how EV–FCV transition choices are formed, constrained, or delayed within an economy, independent of external shocks. These barriers influence decisions across the continuum of urgencies and determine how much flexibility an economy retains as pressures accumulate over time.

This chapter examines internal barriers as structural conditions, not as policy failures. The aim is to clarify where constraints originate, how they interact, and why they often intensify as systems approach points of stress.

4.1 Governance, Regulatory, and Institutional Barriers

Governance and institutional arrangements strongly influence the pace and coherence of EV–FCV transitions. Fragmented mandates across transport, energy, urban planning, and environmental agencies can result in misaligned objectives and delayed decision-making. In many economies, regulatory frameworks were designed for legacy transport and energy systems and have limited capacity to accommodate new technologies, business models, or cross-sector coordination.

Approval processes for infrastructure deployment, vehicle standards, and grid upgrades are often sequential and siloed. This can increase uncertainty for investors and operators, particularly where responsibilities are divided across economies, within economies, and municipal authorities. Limited data sharing, unclear accountability, and rigid compliance requirements further constrain adaptive responses as technologies and markets evolve.

Institutional capacity also varies across economies. Constraints may include limited technical expertise, insufficient regulatory resources, or weak coordination mechanisms. These factors can slow implementation even where policy intent is clear, narrowing the range of feasible transition choices over time.

4.2 Infrastructure, Land-Use, and System Readiness Barriers

Physical infrastructure and land-use conditions represent binding constraints on EV–FCV deployment. Grid capacity and reliability influence the scale and timing of EV uptake, while hydrogen production, storage, and refuelling infrastructure determine the feasibility of FCV applications. In many cases, infrastructure expansion lags behind vehicle deployment ambitions, creating system stress rather than enabling transition.

Urban form and land availability further shape infrastructure options. High-density cities face challenges in siting charging and refuelling facilities, upgrading distribution networks, and allocating space for depots or logistics hubs. Competing land uses, lengthy permitting processes, and community concerns can delay or restrict infrastructure development, even where demand exists.

Urban planning constraints illustrate how system-level barriers translate into uneven access and distributional effects. In high-density cities, retrofitting existing housing stock, particularly multi-unit residential buildings, for EV charging is complex, costly, and often constrained by ownership structures and building regulations.[13] Residents without access to private parking or

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[13] Garcia Blàzquez, Ester, Roberto Villafáfila-Robles, and Marina Codina Escolar. "Comparison of Charging Infrastructure for Electric Vehicles in Multi-unit Residential Buildings in Spain." In *Ibero-American Congress of Smart Cities*, pp. 359-372. Singapore: Springer Nature Singapore, 2024.

dedicated electrical capacity face limited charging options, even where city-wide charging networks are expanding, slowing down adoption among lower-income households and renters, and further reinforcing the disparities between early adopters with private infrastructure and those reliant on shared or public systems.[14,15] Similar land-use constraints affect depot siting and grid upgrades, where space scarcity and competing urban priorities limit feasible configurations, and grid upgrades can consume more than half of project budgets in dense urban areas.[16]

System readiness also encompasses digital and operational integration. Limited deployment of smart grids, real-time monitoring, and demand-management systems can reduce flexibility and resilience, making it harder to manage peak loads or respond to disruptions as electrification increases.

4.3 Market, Fiscal, and Demand-Side Barriers

Market conditions and fiscal capacity directly affect adoption dynamics. High upfront vehicle costs, limited access to financing, and uncertain residual values can deter consumers and fleet operators. Where demand remains fragmented or volatile, private investment in supporting infrastructure may be delayed or reduced.

Fiscal constraints shape the extent and durability of public support. Subsidies, tax incentives, and infrastructure funding often depend on budgetary cycles and competing priorities. Short-term or unpredictable support can weaken market confidence and slow scale-up, particularly in the initial stages of transition.

Demand-side barriers also include behavioural and informational factors. Limited consumer awareness, concerns about range, reliability, or resale value, and unfamiliarity with newer technologies can suppress uptake even where infrastructure is available. These factors interact with fiscal and market conditions, reinforcing inertia.

Consumer perceptions further illustrate how demand-side barriers interact with system readiness. Concerns related to driving range, charging reliability, battery safety, and resale value persist in many markets, particularly where firsthand experience with EVs remains limited.[17] In some contexts, misinformation or highly visible incidents have amplified risk perceptions beyond observed technical performance, affecting public confidence and political support.[18] These effects are not evenly distributed. Households with limited flexibility in travel patterns, constrained access to information, or higher sensitivity to upfront costs may be more exposed to perceived risks, even where long-term operating costs are lower.[19] Such dynamics can dampen demand and delay scale-up, reinforcing infrastructure underinvestment and slowing learning effects

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[14] Muzir, Nur Ayeesha Qisteena, Md Rayid Hasan Mojumder, Md Hasanuzzaman, and Jeyraj Selvaraj. "Challenges of electric vehicles and their prospects in Malaysia: A comprehensive review." *Sustainability* 14, no. 14 (2022): 8320.

[15] Kang, Hew Jun, and Mohamad Shah Kassim. "Barriers Limiting the Adoption of Electric Vehicles in Malaysia." *Journal of Contemporary Management Studies* 1, no. 2 (2025): 99-111.

[16] IIETA. "Planning of Electric Vehicle Charging Infrastructure: A Review." 2024. https://iieta.org/download/file/fid/174928 .

[17] IEA. Global EV Outlook 2023. Paris: IEA, 2023. https://www.iea.org/reports/global-ev-outlook-2023

[18] National Transportation Safety Board. Battery Safety Risks in Electric Vehicles. Washington, DC: NTSB, 2023. https://www.ntsb.gov

[19] McKinsey & Company. "Resale Value and Consumer Confidence in EVs." McKinsey Automotive Insights, 2023. https://www.mckinsey.com/industries/automotive-and-assembly/our-insights

4.4 Inflection Points

Internal barriers become most consequential at inflection points, when accumulated pressures push systems toward thresholds beyond which options narrow or disappear. These moments are often predictable in nature, even if their precise timing is uncertain.

Key internal inflection dynamics include:

- **Climate shocks,** where intensifying extreme weather and climate variability overwhelm regulatory, service, and infrastructure capacity, forcing reactive responses and diverting attention and resources away from long-term planning and system transformation.
- **Labour shortages and demographic shifts,** from ageing populations, low birth rates, early retirements, and weak workforce replacement lock in low-capacity delivery models and constrain the expansion, operation, and maintenance of energy and transport infrastructure.
- **Population declines,** due to chronic depopulation and out-migration reduce demand density and local revenues, weakening the economic viability of large-scale infrastructure investment and narrowing future transition options even where technology is available.
- **Rapid urbanisation**, population concentration and rural-to-urban migration foreclose land-use options for charging, refuelling, and grid expansion, particularly where planning, permitting, and coordination lag behind growth.
- **Grid stress,** from rising peak demand, intermittent renewable integration, and delayed upgrades compel short-term load management and emergency measures, reducing flexibility in technology choice and limiting long-term system optimisation.
- **Deindustrialisation,** caused by over financialisation, outsourcing, and declining manufacturing competitiveness, erodes domestic production, technical skills, and maintenance capacity, increasing external dependence and reducing the ability to adapt systems under stress.

At these points, internal systems may break down, harden, or become locked into suboptimal pathways. Understanding where and how domestic optionality is lost provides essential context for identifying which capacities must be strengthened earlier, before inflection points are reached. Subsequent chapters examine how internal and external enablers can preserve or expand option space ahead of such moments.

5. External Barriers Affecting Transition Pathways

External barriers are constraints arising beyond the direct control of individual economies. They originate in global and regional markets, supply chains, standards regimes, and geopolitical or macroeconomic conditions. These barriers shape the decision space for EV–FCV transitions by influencing costs, access, timing, and risk exposure across the continuum of urgencies.

This chapter examines external barriers as structural conditions of interdependence, not as temporary disruptions. It focuses on how reliance on global systems creates vulnerabilities that can narrow or foreclose options as pressures accumulate and inflection points are approached.

5.1 Supply Chains, Strategic Resources, and Technology Access Barriers

EV–FCV transitions depend on complex and geographically concentrated supply chains. Critical minerals, component manufacturing, and system integration are often concentrated in a limited number of economies, creating exposure to trade restrictions, export controls, logistical disruptions, and geopolitical tensions. While resource endowments may be widely distributed, processing and refining capacity is typically far more concentrated.

Access to key technologies is also shaped by manufacturing scale, supplier relationships, and contractual arrangements. Economies without established positions in global value chains may face higher costs, longer lead times, or reduced access to advanced components. These dynamics can delay deployment, constrain scale, or force reliance on a narrow set of suppliers, increasing systemic risk.

5.2 Standards, Intellectual Property, and Regulatory Fragmentation Barriers

Divergent standards, certification regimes, and intellectual property frameworks represent a significant external barrier to EV–FCV deployment. Differences in charging interfaces, safety requirements, hydrogen quality standards, and testing protocols increase compliance costs and complicate cross-border operations. Limited access to accredited testing and certification facilities can further delay market entry.

Intellectual property and licensing arrangements influence who can manufacture, deploy, or adapt technologies. Concentration of proprietary knowledge in specific firms or jurisdictions can restrict diffusion and limit local adaptation. Regulatory fragmentation across regions also creates uncertainty for investors and operators, particularly when standards evolve more rapidly than governance processes.

5.3 External Cost Volatility and Financial Exposure

External cost conditions play a crucial role in shaping the feasibility of the transition. Commodity price volatility affecting energy inputs, critical minerals, and construction materials can significantly alter project economics. Exchange-rate movements, interest-rate fluctuations, and shifts in global financial conditions also impact affordability and access to capital.

Investment in EV–FCV ecosystems is highly capital-intensive and often concentrated in specific regions or firms. This concentration increases exposure to financial shocks, policy reversals, or shifts in investor sentiment. For many economies, such volatility can delay investment decisions, increase financing costs, or reduce the scale of deployment.

5.4 Inflection Points

External barriers become most consequential at **inflection points**, when global or regional pressures cross thresholds that reduce or eliminate future options. These moments are often foreseeable in nature, even if their timing is uncertain.

Key external inflection dynamics include:

- **Supply-chain and processing bottlenecks** arising from geopolitical or trade thresholds and concentrated critical mineral refining, which restrict access to materials, components, and EV–FCV technologies and limit substitution across battery chemistries, fuel-cell systems, and manufacturing platforms once supply routes or contracts are fixed.

- **Commodity and energy price shocks** that trigger abrupt cost increases, distort investment signals, and force premature technology or infrastructure lock-in.
- **Nationalistic and green protectionism**, including tariffs, local-content rules, and border measures, that close off markets, constrain technology access, or fragment global value chains. APEC was founded on the principles of liberalization, facilitation, and economic-technical cooperation which continue to guide regional cooperation.
- **Standards, intellectual property, and regulatory fragmentation** that undermine interoperability, delay deployment, or lock economies into incompatible systems.
- **Brain drains and STEM workforce shortages** arising from global competition for talent, which reduce access to specialised skills needed for EV–FCV deployment, system integration, and maintenance.
- **Breakdown of cross-border coordination** during crises, disrupting logistics, finance, energy flows, or technology transfer.

At these inflection points, economies may lose the ability to diversify suppliers, adjust timing, or switch technologies without incurring high costs. Understanding how external optionality is reduced under such conditions provides essential context for identifying the forms of cooperation and capacity-building needed to preserve flexibility. Subsequent chapters examine internal and external enablers that can expand option space before these thresholds are reached.

6. Internal Enablers Supporting Transition Pathways

Internal enablers are economy-level capacities that preserve, widen, or restore option space for EV–FCV transitions under uncertainty. They do not determine outcomes or control technological breakthroughs. Instead, they shape how well an economy can absorb external change, delay premature lock-in, pivot during stress, and recover after disruption across the continuum of urgencies.

6.1 Institutional Integrity and Coordination

Institutional coherence and coordination are foundational internal enablers. Clear mandates, coordination across transport, energy, urban planning, and environmental agencies, and mechanisms for cross-sector data sharing improve the ability to respond to change without locking in rigid pathways. Adaptive regulatory frameworks that can be updated as technologies evolve reduce the risk of obsolescence and stranded assets.

Integrated planning across power systems, transport networks, and land-use allows economies to anticipate interactions among infrastructure, demand, and environmental constraints. Where planning horizons are aligned and responsibilities are clearly defined, economies retain greater flexibility to adjust timing, scale, and sequencing as external conditions change.

6.2 Industrial and Innovation Capacities

Industrial and innovation capacities determine how effectively economies can absorb technologies that emerge beyond their direct control. Flexible manufacturing systems, modular production lines, and diversified supplier bases allow firms to retool or adapt platforms when new battery chemistries, fuel-cell designs, or power electronics become available.

Domestic research and development capacity, together with mechanisms for technology translation and demonstration, supports learning and localisation without requiring control over invention. Strong links between research institutions, industry, and system operators increase the ability to evaluate new technologies quickly and integrate them where appropriate. These capacities reduce dependence on single-technology pathways and extend the range of feasible responses to external changes.

6.3 Infrastructure and Workforce Capacities

Infrastructure and workforce capacities function as critical enablers of adaptability. Power systems with reserve margins, flexible generation, storage, and digital monitoring can accommodate changing load profiles and technology mixes. Modular charging and refuelling infrastructure, depot-based systems, and interoperable digital platforms reduce the cost of adjustment as demand patterns evolve.

Workforce depth and redeployability are equally important. Broad-based technical skills, continuous training systems, and the ability to retrain workers across related sectors can support maintenance, integration, and system optimisation. These capacities help economies avoid bottlenecks that would otherwise force short-term fixes or constrain future choices.

Workforce capacity also encompasses the scale and timing of reskilling needs as transport and energy systems evolve. Across many economies, significant retraining of technicians, engineers, planners, and system operators is anticipated over the coming decade, alongside concerns about the adequacy of STEM education pipelines and mid-career transition pathways.[20,21] Gaps in electrical engineering, power systems, digital control, hydrogen safety, and maintenance skills can become binding constraints, particularly during periods of rapid deployment or system stress.[22,23] Where skills development is treated as a long-term capacity-building effort rather than a reactive measure, economies are better positioned to preserve optionality, integrate new technologies as they emerge, and avoid reliance on short-term fixes that may lock in suboptimal configurations

6.4 Options and Opportunities

Internal, economy-level enablers preserve option space across the before, during, and after phases of inflection points. Before inflection points, they build readiness and flexibility. During inflection points, they allow adjustment of timing, scale, and configuration under pressure. After inflection points, they support learning and recalibration. Their role is not to eliminate risk, but to avoid premature lock-in and maintain choices over time.

Before inflection points, internal enablers shape early decisions that determine whether future options remain available. In anticipation of climate shocks, coordinated institutions and forward planning enable economies to strengthen system redundancy and prioritise adaptable infrastructure rather than relying on emergency measures. Where labour shortages, ageing workforces, or population decline are emerging, workforce planning and modular infrastructure investment allow economies to delay irreversible commitments and adjust system scale as demand evolves. In rapidly urbanizing contexts, integrated land-use, and infrastructure

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[20] ILO. Skills for a Greener Future: Energy and Transport Workforce Transitions. Geneva: ILO, 2023. https://www.ilo.org/global/publications

[21] OECD. Skills Outlook 2023: Skills for the Green Transition. Paris: OECD, 2023. https://www.oecd.org/education/skills-outlook-2023

[22] IEA. Energy Employment 2023. Paris: IEA, 2023. https://www.iea.org/reports/energy-employment-2023

[23] WEF. Future of Jobs Report 2023. Geneva: WEF, 2023. https://www.weforum.org/reports/future-of-jobs-report-2023

planning preserves space for future charging, refuelling, and grid expansion, preventing the early foreclosure of options. Across these conditions, flexible industrial and innovation capacities enable economies to remain prepared to integrate improvements in battery or fuel-cell technologies when they become available, without prematurely committing to a single platform.

During inflection points, internal enablers determine whether adjustment is possible without crisis-driven lock-in. When climate shocks or grid stress strain infrastructure and services, operational flexibility, digital monitoring, and coordinated governance support decisions to modulate loads, reconfigure operations, or phase deployment rather than resorting to rushed investments. Acute labour shortages and skills gaps heighten the need for choices between redeployment, automation, or prioritising temporary services over long-term structural commitments made under pressure. In dense urban environments, regulatory and institutional flexibility enables the use of interim or shared infrastructure solutions while longer-term configurations are reassessed. Where deindustrialisation has reduced domestic capacity, remaining innovation and system-integration capabilities support informed decisions on sourcing, adaptation, or temporary postponement.

After inflection points, internal enablers shape recovery and recalibration. Post-shock rebuilding following climate events or prolonged grid stress creates decision points around whether to replace assets on a like-for-like basis or to adopt more modular, efficient, or resilient systems. In regions experiencing population decline, recovery planning informs decisions between consolidation, downsizing, or distributed infrastructure models that align with reduced demand. Where deindustrialisation has weakened production and maintenance capacity, skills systems and innovation networks influence whether economies can adapt imported technologies, re-enter selected value-chain segments, or reposition toward system operation and optimisation roles. Improvements in battery or fuel-cell efficiency that emerge over time become actionable only where internal enablers enable learning and integration without requiring a restart of transition efforts.

7. External Enablers Supporting Transition Pathways

External enablers are regional and global conditions and arrangements that preserve, widen, or restore option space for EV–FCV transitions under uncertainty. They do not determine outcomes or control technological breakthroughs. Instead, they shape how well economies can access innovation beyond borders, delay premature lock-in, adjust under stress, and recover after disruption across the continuum of urgencies.

7.1 Trade, Investment, and Regional Integration

Trade and investment arrangements influence whether economies can access vehicles, components, fuels, and infrastructure at scale and at predictable cost. Diversified sourcing, regional production networks, and cross-border investment reduce exposure to single suppliers and improve resilience to disruption.

Regional integration can lower transaction costs, stabilise supply, and extend market access for EV–FCV technologies. Where investment frameworks are transparent and predictable, capital-intensive infrastructure, such as charging networks, hydrogen production, and refuelling systems, becomes more viable. These arrangements do not eliminate risk, but they widen the range of feasible responses when conditions change.

7.2 Technology Access, Standards, and Interoperability

Access to technology is shaped by standards regimes, intellectual property frameworks, and interoperability arrangements. Shared or aligned standards for charging, hydrogen quality, safety, and digital interfaces reduce switching costs and enable cross-border operation. Interoperability enables infrastructure and vehicles to operate seamlessly across jurisdictions, preserving flexibility as systems expand.

Collaborative testing facilities, standards cooperation, and licensing arrangements support diffusion and adaptation of EV–FCV technologies without requiring control over invention. These enablers are particularly important where new battery or fuel-cell technologies emerge unevenly across regions, as they determine whether economies can integrate improvements without rebuilding systems from scratch.

7.3 Financing, Carbon Markets, and Risk-Sharing

Financing conditions shape the timing and scale of EV–FCV transitions. Green finance instruments, concessional funding, blended finance, and carbon-market mechanisms can lower capital costs and extend investment horizons. Risk-sharing arrangements reduce exposure to volatility and policy uncertainty, supporting continuity through economic cycles.

These mechanisms do not direct technology choice. Their role is to keep investment options open by smoothing financing constraints, allowing economies to defer irreversible commitments until uncertainties resolve or technologies mature.

7.4 Options and Opportunities

External enablers shape how economies collectively retain access, interoperability, and flexibility as they approach, experience, and move beyond external inflection points. Their role is not to eliminate supply-chain disruption, price volatility, or protectionist pressures, but to limit the extent to which these forces translate into irreversible lock-in for EV–FCV transition pathways.

Before inflection points, external enablers influence decisions that preserve access and substitution options. Diversified trade and investment links reduce exposure to supply-chain and processing bottlenecks arising from geopolitical thresholds or concentrated critical mineral refining. Shared standards, cooperative testing arrangements, and transparent licensing frameworks help mitigate the risk that standards and intellectual property fragmentation may foreclose future interoperability. Regional education, research, and talent mobility initiatives help mitigate emerging brain drain and STEM shortages, sustaining supply of specialized skills needed for EV–FCV deployment and system integration. In this phase, diplomatic capacity built on shared regional frameworks plays a stabilising role by aligning expectations and maintaining channels for cooperation before pressures intensify.

During inflection points, external enablers determine whether adjustment remains possible under pressure. When commodity and energy price shocks distort investment signals, coordinated financing approaches and risk-sharing mechanisms allow economies to adjust timing and scale rather than commit under duress. In periods of nationalistic or green protectionism, diplomatic coordination and existing regional frameworks help prevent complete market closure or technology exclusion, even when formal trade conditions tighten. Where cross-border coordination weakens during crises, standing platforms for dialogue and information exchange, including those convened by APEC, support minimum continuity in logistics, energy flows, and technology access.

***After inflection points*,** external enablers shape recovery, reintegration, and recalibration. Rebuilding interoperability, restoring trade and investment links, and renewing cooperation influence whether economies can integrate improved batteries, fuel-cell systems, or manufacturing platforms that may have advanced during periods of disruption. Addressing skills gaps exacerbated by brain drain through regional training, mutual recognition, or mobility arrangements supports system restoration and optimisation. APEC's role in this phase lies in re-establishing shared reference points, reducing the costs of reintegration, and preventing long-term technological or regulatory divergence.

8. Economy Positioning and Scenario Foresighting

Chapter 8 supports foresighting by helping economies determine their position within the EV–FCV transition landscape and how they can navigate uncertainty through scenario-based options. It introduces how inflection points, long-term trends, and a common-interest framing informed by science diplomacy can guide scenario development. Rather than offering prescriptions, the chapter emphasises options, comparative foresight, and structured exploration of future choices under evolving conditions.

Building on earlier chapters, Chapter 8 translates the analysis of internal and external inflection points, barriers, and enablers into a framework for economy positioning and scenario pathways. Economies are situated according to ecosystem maturity and energy profiles, with attention to how climate, demographic, urbanisation, and grid pressures shape decision space across before–during–after cycles. Inflection points are treated as moments where choices narrow or lock in, while enablers determine how option space is preserved over time. Scenarios are used not as forecasts, but as foresighting tools to examine how timing, constraints, and available capacities can lead to different transition outcomes across economies.

8.1 EV–FCV Ecosystem Maturity and Energy Profiles

This section provides a concise diagnostic to help economies position themselves within the EV–FCV transition landscape. The purpose is not to rank performance or prescribe trajectories, but to clarify starting conditions that shape which options remain feasible under different inflection pressures. Ecosystem maturity and energy profiles influence exposure to internal and external barriers, the relevance of specific technologies, and the degree of flexibility available across the transition.

Ecosystem maturity is determined by how effectively domestic infrastructure, institutions, industrial capacity, and market development support EV and FCV technologies. Currently, FCVs represent significantly less than 1% of the global vehicle stock, remaining largely limited to pilot projects and specific heavy-duty or fleet applications.[24] Table 1 illustrates diverse policy architectures used by selected economies at different stages of EV–FCV ecosystem development.

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[24] IEA. Global EV Outlook 2025. Paris: IEA, 2025.

Table 1. Examples of EV–FCV Policy Frameworks Across Different Ecosystem Maturity Levels

Aspect	Chile (Emerging ecosystem, Estrategia Nacional de Electromovilidad 2021, Ministry of Energy)	China (Established ecosystem, Dual-Credit Policy, MIIT)	Malaysia (Developing ecosystem, National Automotive Policy 2020, MITI)	United States (Established ecosystem, Former IRA Clean Vehicle Credits)
Core Mechanism	Comprehensive strategy with ambitious zero-emission targets; emphasis on public transport electrification and infrastructure.	Mandate with credits: Manufacturers earn NEV credits based on vehicle performance (e.g., range, efficiency); credits offset fuel consumption deficits or tradable. Applies to passenger cars from large producers (>30,000 units/year).	Incentive-based framework focusing on Next Generation Vehicles (NxGV), Mobility as a Service (MaaS), and Industry 4.0; targets energy-efficient vehicles including EVs.	Former tax credit (up to USD7,500) for qualifying new EVs/FCVs; required North American assembly, critical minerals/battery sourcing.
Credit/Incentive Structure	Tax exemptions (e.g., green tax relief); focus on fleet incentives rather than direct consumer credits.	Variable credits per vehicle (up to 6); higher for longer range/efficiency/FCVs. Surplus credits bankable/tradable.	Tax exemptions (import/excise/sales duties for CBU EVs until end-2025; CKD/local assembly incentives extended variably); green investment allowances.	Split credit (USD3,750 minerals + USD3,750 components); point-of-sale transfer allowed until expiration.
Targets (Recent/Current)	100% zero-emission sales for light/medium vehicles and public transport by 2035; 40% private fleet electric by 2050.	NEV credit ratios: 48% (2026), 58% (2027); purchase tax exemptions halved (capped ~CNY 15,000) 2026–2027.	10,000 public chargers by 2025; 15–20% EV share by 2030; 80% energy-efficient vehicles by 2050 (mid-term review end-2025).	No active federal targets post-2025; previous aimed at adoption growth.
Infrastructure Focus	Public charging network expansion; interurban gaps <100 km by 2025; strong public fleet emphasis (e.g., Santiago buses).	Integrated with domestic grid/renewables; massive public charging expansion.	10,000 chargers by 2025 (partial achievement); incentives for private/home installations.	Former charger credit extended to June 2026.
Manufacturing/Industry	Growing imports/public fleets; emerging local industry support.	Domestic leadership enforced; stricter qualifications for tax benefits.	Attract foreign investment (e.g., ASEAN hub); customized incentives for local assembly/R&D.	Previous supply chain restrictions (expired).
Scope and Applicability	Light/medium vehicles, public transport, machinery; nationwide with regional coordination.	Passenger cars; small-volume exemptions tightened.	Broad automotive sector; NxGV including EVs/hybrids.	New/used clean vehicles (expired Sept. 30, 2025 for acquisition).

Economy-specific energy profiles also play a decisive role in this transition. The distinction between fossil-fuel producers and non-producers influences local incentives, cost structures, and the strategic emphasis placed on electrification versus hydrogen. Collectively, these factors explain why different economies experience identical technological inflection points in unique ways. Because of these varied starting points and industrial priorities, global transition pathways are unlikely to converge into a single, uniform model.

Established Ecosystems

Established ecosystems, such as those found in China; Japan; United States; are often characterised by high rates of electric vehicle adoption, extensive charging or refuelling networks, and strong industrial and research capabilities. Table 1 highlights that similar levels of ecosystem maturity do not imply convergence in policy approach or governance logic. Instead, established economies may pursue markedly different transition models, shaped by institutional design, political economy, and strategic priorities.

China and the United States exemplify this divergence. Both have large markets, advanced manufacturing, and deep expertise, yet pursue contrasting policy designs. China has moved from subsidies to a mandate-based system of production credits, performance thresholds, and tradable compliance. The US, by contrast, leaned on time-limited fiscal incentives and supply-chain rules before federal support lapsed, leaving a more fragmented, market-mediated landscape. These models show that strong ecosystems can achieve high adoption and industrial strength while following fundamentally different governance logics.

Japan represents a third variant within the established ecosystem category, maintaining long-term strategic support for fuel-cell technologies alongside electrification. Its approach reflects sustained industrial policy alignment and continued investment in hydrogen systems, rather than rapid mass-market deployment.

China's BYD and the United States' Tesla engage in intense global competition, with BYD surpassing Tesla in pure electric vehicle sales in 2025 amid expanding international markets and diverse model offerings (Figure 2). Meanwhile, Japan advances fuel-cell technology through initiatives such as Toyota's ongoing development of the Mirai and next-generation systems, complemented by efforts from Hyundai in broader applications.[25]

Figure 2. Flagship models from established EV/FCV ecosystems (BYD, Tesla, Toyota, Hyundai).

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[25] Nikkei BP. Global EV Overview & Technology Strategy Report 2025. Tokyo: Nikkei, 2025

These established ecosystems retain broad strategic option space but exercise it differently. Their structural advantages support adaptation to technological change and market disruption, yet legacy infrastructure, accumulated compliance systems, and sunk investments also heighten the risk of institutional lock-in, making timing and sequencing of policy adjustments particularly consequential even at advanced stages of transition.

Developing Ecosystems

Developing ecosystems, such as Malaysia; Thailand; Viet Nam; are characterised by moderate adoption levels, expanding infrastructure, and the growth of local assembly capacity and standards development. As illustrated in Table 1, these economies typically rely on incentive-based or facilitative policy frameworks rather than binding mandates, reflecting institutions and markets that are still in transition, with increasing but uneven capacity across sectors. As a result, these economies are particularly sensitive to inflection points involving grid stress, rapid urbanisation, and workforce constraints, and their strategic flexibility depends heavily on the ability to scale incrementally rather than commit early to rigid system configurations.

Consequently, external enablers such as regional cooperation and access to international finance, technology, and standards play a critical role in maintaining options and avoiding premature infrastructure lock-in. These economies often follow selective growth patterns, combining rising electric vehicle adoption with the development of manufacturing hubs and targeted pilot programmes for hydrogen or heavy-vehicle applications. [26] Early-stage ecosystems frequently prioritise niche use cases and pilot deployments to support institutional learning, testing, and capacity building rather than immediate large-scale rollout. [27]

Within these markets, clear segmentation has emerged: battery-electric vehicles dominate light-duty and two-wheeler segments, while fuel-cell applications are typically reserved for heavy-duty or long-distance niches. Taken together, these pathways demonstrate that rapid scaling in some regions can coexist with targeted niche strategies in others, reinforcing the importance of context-specific positioning rather than assumptions of uniform global convergence.

Early Ecosystems

Early ecosystems are characterised by nascent adoption, limited infrastructure, and high dependence on imports for vehicles, components, and fuels, as seen in economies such as Chile; Papua New Guinea; Peru. As reflected in the policy architectures outlined in Table 1, institutional capacity and market depth in these contexts may be constrained, and transition efforts are often fragmented, exploratory, or pilot-based rather than system-wide.

Under such conditions, immediate large-scale deployment may be less feasible or desirable. Instead, economic positioning tends to focus on preserving future option space, managing exposure to external inflection points such as supply-chain disruption or protectionism, and exploring niche or staged applications. Timing, learning, and selective engagement, therefore, become central considerations in shaping transition pathways.

Energy Profile: Fossil-Fuel Producers and Non-Producers

Energy profiles span across ecosystem maturity categories and have a significant influence on transition dynamics. Fossil-fuel–producing economies may face different incentives and trade-

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[26] MOSTI. “Malaysia’s First Mobile Hydrogen Refuelling Station Launched.” May, 2025.

[27] IEA. Global EV Outlook 2025. Paris: IEA, 2025.

offs, including exposure to commodity price volatility, existing energy-sector employment, and potential roles in hydrogen production or export (e.g. Australia; Indonesia; Malaysia). Non-producing economies may prioritise energy security, import reduction, and electrification to reduce external dependence (e.g. Japan; Republic of Korea; Singapore).

This distinction impacts the relevance and timing of EV versus FCV pathways, as well as their interaction with external inflection points, such as protectionism or price shocks, and the strategic value of regional cooperation. Recognising energy profiles alongside ecosystem maturity helps ensure that scenario pathways reflect structural conditions rather than assumed preferences.

8.2 Scenario Pathways and Policy Options

This section develops scenario pathways as a foresighting tool to help economies explore how EV–FCV transitions may unfold under different combinations of inflection points, external pressures, and available option space. The scenarios are not forecasts and do not prescribe actions. Instead, they provide structured ways to examine how choices may differ depending on timing, system maturity, energy profiles, and exposure to internal and external constraints.

Each pathway represents a plausible trajectory, shaped by assumptions about technology evolution, demand patterns, energy systems, and cross-border conditions. Within each pathway, policy options are framed as conditional choices, relevant only where institutional capacity, infrastructure readiness, and external access permit. Before–during–after cycles are applied comparatively to illustrate how similar inflection points can yield different outcomes depending on when they occur and the amount of option space remaining.

Technology Pathways

How do different trajectories of EV and hydrogen technologies shape transition choices under varying ecosystem maturity?

Technology pathways describe how progress in batteries, fuel cells, manufacturing systems, and digital integration influences transition choices. While major breakthroughs, such as higher-density lithium batteries, sodium-ion batteries, or more efficient fuel cells, are largely outside direct policy control, adoption outcomes depend on how technologies are understood, trusted, and integrated. Public concerns over range, charging reliability, and safety significantly impact adoption. Misperceptions, including narratives that EVs are unsafe or prone to fires, shape consumer behaviour, and political acceptance as much as technical performance.

In mature ecosystems, technology pathways favour early absorption combined with system integration and communication. EV platforms evolve in tandem with charging networks, software systems, and safety standards. New battery types, such as sodium-ion batteries, offer lower cost, improved thermal stability, and reduced reliance on critical minerals, although with lower energy density. These characteristics make them suitable for urban use and fleets, helping address range anxiety and safety concerns. Clear standards, transparent safety data, and consistent public communication reduce misinformation and build trust, supporting adoption while managing lock-in risks.

In less mature ecosystems, technology pathways tend to emphasise caution and selectivity. Limited infrastructure, weaker standards enforcement, and supply-chain exposure amplify concerns about range, reliability, and safety. In these contexts, negative narratives, often amplified through social media and online platforms, can slow adoption even when technical risks are low. Reliance on imported technologies and limited public communication capacity may reduce confidence and delay learning. Over time, this can lead to increased dependence on external platforms and constrain future flexibility as global technologies and standards consolidate.

Niche Use-Case Pathways

How do sector-specific technological niches shape transition pathways under constrained deployment conditions?

Niche use-case pathways illustrate how specific technologies dominate different transport segments based on their operational advantages. Battery-electric vehicles are ideally suited for personal transport, urban mobility, and light-duty fleets where travel distances are shorter and charging schedules are predictable. In contrast, fuel-cell vehicles are more effective for heavy lifting, long-haul transport, and high-utilization operations that prioritize energy density and rapid refuelling.

In some strategic pathways, these niches remain stable over time, with electric vehicles dominating passenger transport while hydrogen systems are primarily reserved for freight, heavy-duty vehicles, and industrial logistics. This stability creates parallel systems that necessitate coordinated infrastructure and policy planning to manage distinct energy needs. However, other pathways envision these boundaries shifting as technology improves and costs decline. For example, advanced battery systems may eventually expand into heavier transport segments, or hydrogen could become competitive in broader markets.

Economies that view these niches as flexible options rather than fixed choices are better equipped to adjust when technology or cost inflection points occur. By treating these trajectories as foresighting constructs rather than rigid predictions, economies can better examine how timing, resource endowments, and institutional capacity interact to shape transition outcomes under conditions of uncertainty.[28,29]

Energy Mix Pathways

How do energy system trajectories condition EV–FCV transition choices?

Energy mix pathways are shaped by the global direction of climate policy and energy markets. Current discussions in the United Nations Climate Change Conference (UNFCCC) Conference of the Parties (COP) process, following COP30 in Belém in 2025, show continued difficulty in reaching an agreement on a formal fossil fuel phase-out. Final texts avoided binding language on phasing out or down fossil fuels, reflecting opposition from major producers. Instead, voluntary roadmaps for a just transition and strong support for renewable expansion were emphasised. This suggests a gradual phase-down pathway, where renewables grow rapidly due to falling costs and policy support, rather than through mandated fossil fuel bans.

In this context, renewables such as solar and wind are expected to expand faster than fossil fuels, with many scenarios showing fossil fuel demand peaking and declining between 2030 and 2040 for combustion uses. Fossil fuels are likely to persist mainly in non-fuel applications, such as petrochemical feedstocks for plastics and chemicals, where alternatives remain limited. Declining renewable costs improve competitiveness for economies with strong solar or wind resources, allowing lower electricity prices and attracting energy-intensive industries. In contrast, renewable-scarce regions face higher energy costs due to import dependence, carbon pricing, and grid constraints, raising concerns about industrial relocation.

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[28] WEF. Hydrogen for the Energy Transition: Pathways and Priorities. Geneva: WEF, 2023.

[29] OECD. Industrial Policy for the Green Transition. Paris: OECD, 2023

The transition toward clean energy is driving a "renewables pull" effect, where falling solar and wind costs attract energy-intensive manufacturing toward regions with abundant, low-cost electricity.[30,31] This shift allows economies with favorable renewable resources to experience faster electrification and industrial clustering. Conversely, economies that struggle with grid integration, storage, or cost competitiveness risk losing manufacturing capacity and jobs as they face mounting pressure from higher energy expenses and infrastructure constraints.[32]

This reduces the value of fossil fuels while elevating economies rich in renewables or clean technology. While energy security generally improves for former importers, new vulnerabilities emerge around critical minerals and digital systems. Managed carefully, the transition supports a decentralized, multipolar energy order. Hydrogen's role within this trajectory is pivotal and is examined in detail below.

Hydrogen Industry Pathways

What roles can hydrogen industries play under different regional and global conditions?

Hydrogen industry pathways are shaped by an ongoing debate on how limited low-carbon hydrogen should be used. One approach prioritises hydrogen as an energy carrier for transport, power generation, and heating. In this view, industrial use helps build scale, reduce costs, and justify early investment in infrastructure such as pipelines and storage. Large industrial demand is seen as a way to accelerate the development of a broad hydrogen ecosystem.

The alternative approach argues that hydrogen should be directed first to hard-to-abate industrial sectors where it has a direct chemical role. This includes replacing fossil-based hydrogen in ammonia and methanol, using hydrogen in steel production, and supporting refining processes. Other uses, such as synthetic fuels for aviation and shipping, are considered secondary but relevant. This strategy views industrial decarbonization as the primary objective, rather than merely a stepping stone to broader energy use.

Recent expert assessments tend to support the decarbonization-focused approach in the near to medium term. Low-carbon hydrogen remains costly and limited in supply. Using it in applications where more efficient alternatives exist is regarded as inefficient. Industrial uses offer immediate emissions reductions and are considered “no-regrets” options. Broader energy carrier roles for hydrogen are expected to become more viable only after significant cost reductions and scaling, likely after 2030 or 2040.

Grid and Charging Infrastructure Pathways

How do infrastructure deployment choices affect long-term transition flexibility?

Grid and charging infrastructure pathways depend strongly on how power systems respond to variable renewable energy. The rapid growth of solar and wind creates daily and seasonal fluctuations in electricity supply. Infrastructure must therefore manage energy spikes during periods of high generation and shortages during low generation. Grid planning, storage, and digital control systems become critical enablers of EV and hydrogen deployment.

Flexible pathways focus on smart grids, grid supplementation, and demand-side management. Smart charging, dynamic pricing, storage systems, and vehicle-to-grid solutions help absorb

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[30] IEA. World Energy Outlook 2023. Paris: IEA, 2023. https://www.iea.org/reports/world-energy-outlook-2023

[31] International Renewable Energy Agency. World Energy Transitions Outlook 2023. Abu Dhabi: IRENA, 2023. https://www.irena.org/publications/2023/Jun/World-Energy-Transitions-Outlook-2023

[32] OECD. Industrial Policy for the Green Transition. Paris: OECD, 2023. https://www.oecd.org/publications/industrial-policy-for-the-green-transition

excess renewable energy and reduce peak stress. Supplementary measures, such as distributed generation and local storage can improve resilience and reduce the need for costly grid overbuild. These approaches preserve flexibility as demand patterns and technologies evolve.

Rigid or fragmented pathways emerge when infrastructure is deployed without coordination or digital integration. Fixed charging systems, limited storage, and weak interoperability increase congestion and curtail renewable generation. Once large investments are made, correcting these problems becomes expensive and slow. Early choices, therefore, play a decisive role in determining whether infrastructure supports adaptive transitions or constrains future options.

9. Conclusions and Questions for The Future

Transitions toward electric vehicles (EV) and fuel-cell vehicles (FCV) represent a long-term system change rather than a single technology shift. Across APEC economies, transition pathways differ due to ecosystem maturity, energy resource profiles, domestic capacity, external dependence, and the timing of shared inflection points. These differences explain why transition strategies vary and why a single policy approach is not suitable for all economies.

A key conclusion of this report is that many of the most important decisions are not about choosing between electric or fuel-cell vehicles. They are about preserving future options. Choices related to infrastructure design, technical standards, industrial capacity, workforce skills, and public communication have a greater impact on long-term flexibility than vehicle technologies alone. Economies that invest in adaptability, interoperability, and institutional coordination are better prepared to respond to changes in technology, markets, and external conditions.

Timing is critical. Before major pressures arise, economies can focus on preparation, learning, and maintaining options. During periods of stress, decisions taken quickly can create long-term lock-in. After such periods, there are opportunities to adjust systems, apply lessons learned, and align short-term actions with long-term goals. Understanding where an economy stands within these cycles supports better decision-making under uncertainty.

Rather than recommending specific actions, this report ends with guiding questions. These questions are intended to support reflection, dialogue, and scenario exploration among APEC economies. They recognise different domestic circumstances and are offered as a basis for voluntary engagement.

9.1 Guiding Questions

System Readiness, Positioning, and Timing

How prepared is the domestic transport and energy system to manage expected pressures related to grid capacity, urban growth, workforce change, and climate impacts, particularly as these pressures interact and intensify over time?

Do current strategies preserve flexibility to integrate future technological innovations without costly system changes or early lock-in as conditions evolve?

Energy Systems, Competitiveness, and Structural Change

How do domestic energy conditions influence industrial competitiveness and exposure to shifts in production location as renewable energy expands and global energy systems evolve?

How might these dynamics affect long-term economic resilience, employment structures, and exposure to external shocks across different transition pathways?

Institutions, Public Confidence, and Equity

Are governance arrangements, regulatory frameworks, and public communication mechanisms sufficient to maintain safety, trust, and investor confidence throughout the transition, including during periods of uncertainty or system stress?

How are public perceptions of technology risk, safety, and reliability evolving as EV and FCV systems scale, and how might these perceptions influence demand, political feasibility, and investment continuity?

How do distributional factors, such as differences in access to infrastructure, information, or adaptive capacity, shape public confidence across population groups, and how might these differences affect long-term acceptance of transition pathways?

To what extent do institutional arrangements support learning, feedback, and adjustment in public engagement strategies as technologies, costs, and system performance change over time?

9.2 Looking Ahead

The transition to electric and fuel-cell vehicles will develop at different speeds across APEC economies. This reflects global forces that no single economy can control. The main challenge is not to predict outcomes, but to remain prepared for change. By focusing on informed decision-making, system awareness, and preservation of options, economies can advance transport decarbonisation in ways that are resilient, inclusive, and aligned with sustainable development objectives.

APEC plays an important role as a voluntary platform for dialogue and shared learning. It allows economies to exchange experience, build understanding, and strengthen cooperation while respecting economy-specific pathways.