The Global Economic Transformation Before and After the Advent of Electric Vehicles: A Review and Future Perspective

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OPEN ACCESS

Manuscript ID:
ASH-2025-13019032

Volume: 13

Issue: 1

Month: July

Year: 2025

P-ISSN: 2321-788X

E-ISSN: 2582-0397

Received: 15.05.2025

Accepted: 20.06.2025

Published Online: 01.07.2025

Citation:
Prakash, R., and Kursith. "The Global Economic Transformation Before and After the Advent of Electric Vehicles: A Review and Future Perspective." *Shanlax International Journal of Arts, Science and Humanities*, vol. 13, no. 1, 2025, pp. 52–59.

DOI:
https://doi.org/10.34293/sijash.v13i1.9032

Abstract
Economically, ecologically, and in terms of technology the automobile industry is changing as a result of the global switch from internal combustion engine (ICE) to electric vehicle (EV) vehicles. This article looks at how the EV landscape changed before and after significant industrial transformations, with an emphasis on employment consequences, policy frameworks, raw material dependencies, and supply chain disruptions. Through an analysis of data from academic literature, policy reports, and international energy organizations, the study identifies important patterns like the rise in EV adoption, the strategic significance of vital minerals, and the reorganization of global manufacturing hubs. Additionally, the difficulties in developing batteries, the ecological effects of widespread EV use, and the socioeconomic ramifications for autoworkers are all examined. A balanced and inclusive transformation that synchronizes technology innovation with sustainable practices and fair labor tactics is vital, according to the research. This report gives stakeholders, manufacturers, and politicians important information about how to handle the challenges posed by the EV revolution for autoworkers.

Keywords: Electric Vehicles (EVs), Economic Transformation, Energy Transition, Industry Restructuring, Geopolitical Realignment

Introduction

The advent of electric vehicles not only helps reduce the carbon footprint, greenhouse gas (GHG) and protect the planet (Hartmann and Özdemir) (Amoroso and Cappuccino), but also changes individual spending patterns (Sun and Zhou) and national revenue structures (Wang et al.). For countries that rely heavily on fossil fuel income, the rise of EVs could mark the beginning of economic decline. The history of controlling world economy by controlling petroleum production is going to change.

The shift away from internal combustion engine (ICE) cars toward electric vehicles (EVs) is a massive economic transformation during the 21st century. Driven by environmental issues, technological innovation, and supportive policy, EVs have expanded from niche products to mass market alternatives, with world sales of over 10 million units in 2022 (Global EV Outlook 2023 – Analysis - IEA, n.d.). This shift has profound impacts on energy markets, industrial strategy, and working patterns.

This review synthesizes current literature on the economic effects of EVs, comparing pre-and post-adoption and projecting future trends. We consider major impacted industries, such as oil and gas, automotive production, and

renewable energy, and socio-economic issues like job loss and resource security.

Research Objectives

- To examine the worldwide economy's widespread adoption of electric automobiles.
- To evaluate how the oil, energy, automotive, and rare earth element industries are affected by electric vehicles.
- To evaluate the economic shift in EV adoption brought about by regional differences.

Research Questions

- What were the key characteristics f the global economy in relation to transpiration and energy consumption before the risk of electric vehicles?
- How the adoption of electric vehicles demand in fossil fuels changes and how the oil- producing countries

Methodology

This study uses a qualitative review-based approach to analyze the economic transformation induced by the transition from conventional internal combustion engine (ICE) vehicles to electric vehicles (EVs). The study is a secondary data collected from a broad array of peer-reviewed and credible literature, including international energy agency reports, policy briefs, industrial whitepapers, and academic journal articles from 2009 to 2025.

Systematic review of the literature was utilized to search, sift, and synthesize the relevant publications using keywords such as "Electric Vehicles," "EV supply chain," "employment shifts," "automotive restructuring," "oil demand," and "geopolitical impact." Online academic databases such as Scopus, ScienceDirect, JSTOR, IEEE Xplore, and Google Scholar were the major sources of information.

Inclusion was on the basis of the applicability to EV-driven economic and industrial change, recency (ideally since 2010), and empirical or policy significance. Exclusion was on the basis of anecdotal evidence, opinion articles, and fact-less pieces.

The data recorded were then thematically classified into pre-EV and post-EV economic conditions, focusing especially on five main dimensions: (1) Oil and energy markets, (2) Automotive industry restructuring, (3) Labor and job shifts, (4) Geopolitical shifts, and (5) Emerging opportunities for technology and policy.

This approach gives a clear understanding of the topic and allows tracing of trends, tendencies, and emerging themes at the global level.

The Pre-EV Economic Landscape

Oil Dependency and Geopolitics

Prior to the mass adoption of electric vehicles (EVs), the world economy was heavily dependent on oil, particularly in transportation, which accounted for more than 50% of global oil consumption (BP, n.d.). The dependence on oil fuels strengthened the geopolitical influence of major oil-exporting nations such as Saudi Arabia and Russia, whose economic and political power was closely tied to hydrocarbon revenues. The volatility of oil markets also increased global economic uncertainty, as changes in crude oil prices directly affected inflation rates, trade balances, and energy security policy in developed and developing countries alike.

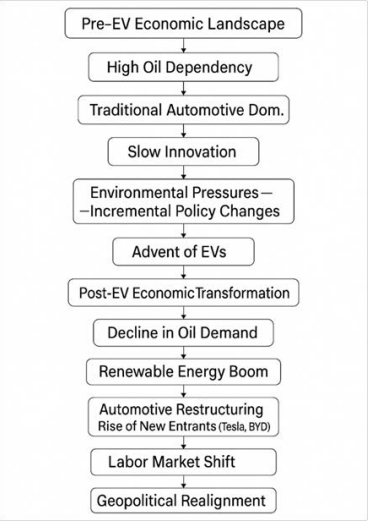

Figure 1 EV Economic Landscape

Therefore, nations with a lack of indigenous oil supplies were often subject to vulnerabilities to supply disruptions and price volatility, demonstrating the strategic importance of energy diversification in long-term economic policies. Thus, the dominance of fossil fuels in transport not only affected international affairs but also stressed the

utmost imperative for alternative energies to mitigate system risks associated with oil dependence.

Automotive Industry Structure

Before the introduction of electric vehicles (EVs), the global automotive sector was dominated by traditional car makers such as Toyota, Ford, and Volkswagen, which had developed vast manufacturing structures and accumulated brand loyalty over decades (Chagas). Supply chains within this industry were primarily focused on internal combustion engine (ICE) vehicles and were dominated by high reliance on mechanical parts, including transmissions, exhaust systems, and fuel injection systems. This foundation base presented formidable barriers to innovation because manufacturers tended to focus on incremental improvements in fuel efficiency—often prompted by regulatory pressures—rather than adopting revolutionary change towards sustainable mobility (Three Revolutions: Steering Automated, Shared, and Electric Vehicles to a Better Future | SpringerLink, n.d.). Environmental factors were secondary to cost and performance considerations, and therefore the introduction of alternative powertrains was slow in spite of escalating climate-related concerns. Vertical integration of the industry and reliance on long-standing supplier networks further entrenched resistance to change and slowed the shift towards electrification (Bohnsack et al.). However, escalating emissions controls, particularly within the European Union and China, began compelling incremental re-examination of long-term strategic approaches, thereby setting the stage for the disruptive introduction of EVs (Kim et al., n.d.).

Environmental and Regulatory Pressures

The developing scientific consensus regarding climate change and human-induced causes, especially those associated with transportation emissions, has compelled governments around the world to adopt stricter regulatory regimes to limit car emissions (Pachauri et al.). Central regulations like the European Union's Euro 6 emissions standards and the United States' Corporate Average Fuel Economy (CAFE) regulations required radical reductions in nitrogen oxides (NOx), particulate matter (PM), and carbon dioxide (CO) emissions, thus forcing automobile firms to adopt cleaner technology (Schipper & Fulton). At the same time, early policy incentives—like tax credits for hybrid cars (e.g., Toyota Prius) and subsidies for biofuels (e.g., ethanol blends)—were introduced to drive a shift away from conventional internal combustion engine (ICE) cars (Gallagher & Muehlegger, 2011). These, however, only managed incremental progress, considering that the automotive industry was reluctant to adopt battery electric vehicles (BEVs) in full measure due to technological limitations, high costs, and consumer fears about driving ranges (Sovacool and Hirsh). The limited uptake of electric vehicles (EVs) at this time also reflected inadequate infrastructure for charging and a firm grip by fossil-fuel lobby on energy policymaking (Stokes, 2020). Despite this, the regulatory foundations laid during this period—coupled with the Paris Agreement (2015)—laid the ground for the eventual explosive uptake of EVs across the 2020s (Global EV Outlook 2022 – Analysis - IEA, n.d.).

The Post-EV Economic Transformation

Oil Demand Decline and Changing Energy Markets

The arrival of electric vehicles (EVs) is bound to transform global energy markets significantly, primarily through a drastic cut in oil consumption. Bloomberg NEF (2023) estimates that EV adoption would eliminate as much as 8 million barrels of oil per day by 2040 (Electric Vehicle Outlook 2023 | Bloomberg Professional Services, n.d.). This projected decrease presents strong economic challenges to oil-dependent nations, particularly those with minimal economic diversification. Saudi Arabia, for example, is one of the Middle Eastern oil-exporting nations that are working intensively to develop strategic strategies to offset these vulnerabilities. Saudi Vision 2030 is a notable example of such a strategy, which seeks to decrease the kingdom's over-reliance on oil revenues through investments in tourism, infrastructure, and renewable energy (transformation' et al.).

As such, the transition to electrification of transport leads to the rise in electricity consumption, thus opening up new avenues for the expansion

of renewable energy firms. Solar and wind energy firms, in particular, stand to benefit from the transition because of the increase in their share of the world energy mix and decreasing levelized costs (World Energy Transitions Outlook 1-5C Pathway 2022 Edition, n.d.). Integration of the electric vehicle (EV) and renewable energies represents a paradigm shift towards a cleaner, decentralized energy system that undermines the historic hegemony of fossil fuels in world geopolitics and trade dynamics.

Automotive Industry Restructuring

The global automotive industry is undergoing a significant transformation as it transitions from internal combustion engine (ICE) cars to electric vehicles (EVs). Traditional car companies face significant challenges, largely due to the high research and development (R&D) costs associated with this changeover (Koelmel et al.). The transition entails significant investment in emerging technologies, manufacturing processes, and adjustments in supply chains, thus exerting economic strain on established companies (Ren).

Conversely, new entrants like Tesla, BYD, and Rivian are employing their adaptability and technology-driven strategies to gain a competitive edge. These companies prefer to adopt vertically integrated systems, producing important components like batteries and electronics controls in-house. Not only does this reduce their production costs but also increases their margins and supply chain resilience (Rachinger and Müller).

The shift to electric vehicles (EVs) has seen the auto supply chain realign with greater emphasis on batteries, rare earth metals—like lithium, cobalt, and nickel—and semiconductors. The demand for these critical materials is on the rise, with projections indicating robust growth in the next few years to meet the needs of EV production (Rehman et al.). Additionally, the reliance on semiconductors has seen countries encouraging local production to reduce reliance on overseas suppliers (Koelmel et al.).

This transition also has challenges and opportunities. Established manufacturers have to contend with complexities of retooling assembly lines and sourcing essential materials, while new players can leverage their technology expertise and flexible operations. The changing scenario emphasizes strategic investments in collaborations to remain competitive in the emerging EV industry (Rachinger and Müller).

Employment and Labor Market Shifts

The global transition from internal combustion engine (ICE) vehicles to electric vehicles (EVs) is radically changing work patterns in the automobile sector. Electric vehicles have fewer mechanical parts, leading to fewer traditional manufacturing jobs, such as those related to engine and transmission assembly (International Labour Organization, 2022). In Thailand, for instance, roughly 816 of the 2,500 vehicle component firms that trade in traditional components are facing redundancy issues due to the use of EVs, thus necessitating massive reskilling programs for workers (International Labour Organization).

Conversely, the new EV sector is generating new employment opportunities, particularly in battery manufacturing and supply chains. In a study by the Upjohn Institute, up to 310,000 workers will be needed in the United States' lithium-ion battery supply chain by 2030, including manufacturing, distribution, and associated inputs (Upjohn Institute).

In order to address the evolving skill requirements, governments and industry stakeholders are investing in employee development programs. The European Union, for example, has a target of retraining or upskilling 800,000 employees to 2025 to address the needs of the EV industry (Charette).

Similarly, major automobile manufacturers are investing a significant amount of resources in employee training programs that will allow them to transition to EV production. However, the transformation raises concerns about the quality and fairness of jobs. Evidence indicates that some of the new jobs linked to electric vehicles, particularly in battery manufacturing, can offer lower pay and worse working conditions compared to traditional auto jobs (Friedman). This calls for the implementation of policies that ensure a just transition, safeguard workers' rights, and encourage equitable employment opportunities across the transforming auto industry.

Geopolitical Realignment

The fast growth of electric vehicle (EV) markets has induced profound geopolitical changes, particularly in the context of critical battery supply chains. China currently possesses approximately 70% of global battery production capacity, with control of the whole value chain from raw material processing, with 60–70% of global refining and processing capacity of lithium, to cell production, with nearly 77% of global production IEA (International Energy Agency) (Global EV Outlook 2023 – Analysis - IEA, n.d.). This power concentration has led to new strategic dependencies, hence reconfiguring world trade patterns.

In response to recent challenges, Western economies have taken strategic industrial policies to reduce their over-reliance on supply chains that are based in China. The United States, through the Inflation Reduction Act of 2022, spent about USD 369 billion on supporting clean energy technology with tight local sourcing and manufacturing requirements (White House) (McKinsey and Company). As a complement, the European Union passed the Critical Raw Materials Act of 2023, which mandates a minimum of 10% of the EU's critical minerals be locally supplied by 2030, and large-scale investments in local battery gigafactories of €6 billion (European Commission).

The effects of these proactive measures have been the formation of competing technological blocs. While China enjoys a competitive advantage with its vertically integrated companies like Contemporary Amperex Technology Co. Limited (CATL), with over 36% of the worldwide electric vehicle (EV) battery market share (Benchmark Mineral Intelligence), Western nations are applying policymaking incentives to rebuild their own strong manufacturing structures. The escalating trade tensions are evident through China's imposition of export controls on graphite (Ministry of Commerce).

Future Prospects and Challenges

The future growth of electric vehicles (EVs) is a very promising one; however, it is also with very challenging factors that need immediate and ongoing attention from policymakers, business players, and researchers in the globe.

Although this study gives an overview of the economic transformation induced by electric vehicles (EVs), there are some areas yet to be explored by researchers. Region-based empirical studies are much needed to quantify the net employment impacts and skill change concerns involved with EV introductions. Likewise, long-term environmental studies of EVs—especially in battery disposal, raw material extraction, and recycling—are to be conducted in a more scientific manner. Adoption pattern studies in the Global South on infrastructural readiness and policy limitations are also limited. Cross-country comparisons of government policies such as subsidies, tax credits, and local content sourcing requirements can be useful to policymakers as well. Future studies can also be triggered further by multi-disciplinary models integrating economics, energy systems, and transportation planning to understand the scalability and sustainability of EV transitions around the world.

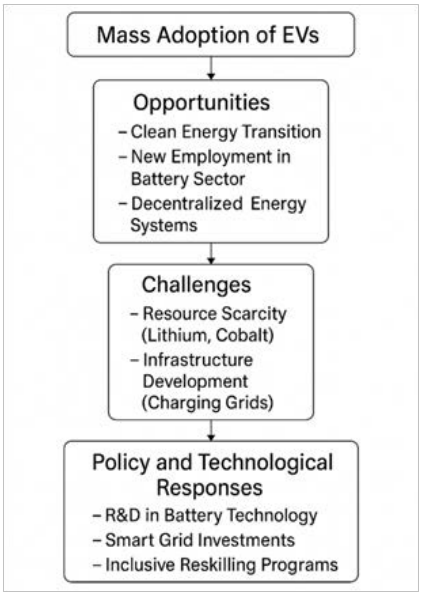

Figure 2 Adoption of EVs

Battery Technology and Scarcity of Resources

The growth of the electric vehicle (EV) market is ultimately decided by the availability of key raw materials such as lithium, cobalt, and nickel. Based on existing estimates, in the absence of substantial improvements in resource efficiency and recycling of batteries, lithium availability can become a bottleneck

by the 2030s (Klemeš et al.). In addition, the high environmental footprint of mining operations adds to the challenges of meeting sustainability goals.

To address these concerns, R&D efforts are shifting focus to newer technologies such as solid-state batteries, which are expected to provide greater energy densities and better safety features and potentially reduce the reliance on rare minerals (Janek and Zeier). Additionally, alternative chemistries such as sodium-ion batteries are on the horizon as potential contenders for grid storage and low-cost electric vehicle models, especially in areas where there is limited availability of rare earth materials (Yabuuchi et al.) .

Grid and Infrastructure Readiness

Mass deployment of electric vehicles (EVs) means the entire charging infrastructure needs to be developed, particularly in rural and semi-urban regions where coverage is now weak. Estimates suggest that investments of more than USD 1 trillion will be required globally by 2040 to build enough charging points and strengthen electricity grids (Bloomberg NEF). The new world has twin issues: fiscal constraints and existing infrastructural shortages.

At the same time, power grids must be upgraded to manage the surge in demand from EVs. Smart grids, with dynamic load management and vehicle-to-grid (V2G) functionality, will be required to prevent grid instability and to optimize energy use (Global EV Outlook 2023 – Analysis - IEA, n.d.) .

Policy and Equity Concerns

Government measures are set to continue playing a pivotal role in the shift towards electric vehicles (EVs). While financial incentives, tax credits, and regulatory mandates have proven effective in driving early adoption, future policies should be designed to ensure fiscal prudence and social fairness (Organisation for Economic Co-operation and Development (OECD)). There is a valid concern that without deliberate action, the benefits of EV adoption could disproportionately accrue to more affluent consumers, marginalizing lower-income consumers. In addition, a fair transition will need to be prioritized to assist displaced workers from the conventional automotive and fossil fuel sectors. Reskilling and upskilling programs, as well as social protection programs, will need to be introduced to make sure that the economic benefits of the EV revolution are shared far and wide (Organisation for Economic Co-operation and Development (OECD).

Conclusion

The global transition away from internal combustion engine (ICE) towards electric vehicles (EVs) is one of the most revolutionary 21st-century economic and environmental shifts. This review has synthesized knowledge from policy briefs, academic, and energy agency literature to understand the transitions in oil dependence, industrial restructuring, labor market relations, and geopolitical arrangements before and after the advent of EVs. The unique contribution of this review is its holistic approach—combining macroeconomic trends, supply chain disruption, and labor market implications—to provide an end-to-end perspective of the global economic impact of the EV revolution. However, this study is constrained by its reliance on secondary data and qualitative synthesis, which could restrict replicability and empirical depth. Furthermore, data availability was skewed towards advanced economies and potentially underestimated Global South accounts. To improve these constraints, future research should include region-specific empirical studies, lifecycle environmental studies, and interdisciplinary modelling approaches. Greater focus on the socio-economic implications in emerging economies and evaluations of the efficacy of public policy will further enrich the literature and inform equitable and sustainable transitions.

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