

Electric Vehicles And Energy Sector Transformation In India: An Analytical Study

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(Received-15-July2025/Revised-30-July2025/ Accepted-10-August2025/ Published-30August2025)

Abstract

The energy sector in India is highly diverse, drawing on coal, natural gas, oil, hydro, lignite, nuclear power, wind, solar, agricultural residue, and domestic waste. By 2020, India had emerged as a global leader in renewable energy, ranking fourth in wind power, fifth in solar power, and fourth in overall installed renewable capacity.¹ In parallel, India has progressed toward its climate commitments under the Paris Agreement (2015) and witnessed a rapid rise in the adoption of electric vehicles (EVs). Recent government policies, including targeted incentives, infrastructure-development initiatives, and regulatory reforms, have significantly reshaped the landscape of both the EV sector and the broader energy ecosystem. This study critically examines the interrelationship between electric vehicle policies and India's evolving energy sector. Further, it mainly focused on regulatory framework and challenges to address the effective sustainable mobility in the energy sector. It has found that the energy sector has transformed from the nuclear power to solar power, natural gas. There are many challenges to dealt with this fast development of energy sector particularly in the regulatory and legal framework.

Keywords: Energy and Power Sector; Electric Vehicles; Government Policies.

1. Introduction

Nowadays, buying electric vehicles is fascinating, and people are excited to purchase electric cars. Electric Vehicles (EVs) offer remarkable acceleration, convenient home fuelling, reduced fuel and maintenance expenses, as well as less noise and vibration compared to internal combustion vehicles. In India, retail sales of Electric Vehicles (EVs) reached 390,399 units in the first half of the calendar year 2022, indicating a 333 % growth compared to the previous year when 90,102 units were sold in 2021.² It is the third-largest producer and second-largest consumer of electricity in the world. As of January 2022, India has installed a power capacity of 395.07 GW.³ The Indian Government has implemented policies focused on "Power for All." This study specifically examines the government's policies aimed at achieving targets for electric vehicles (EVs), including 70 % coverage of commercial

vehicles, 30 % coverage of private vehicles, and 80 % coverage of two- and three-wheelers by 2030.

In terms of pollution, greenhouse-gas emissions, and fuel efficiency, EVs are appealing. They present intriguing strategies to address some of the negative consequences of transportation while maintaining the mobility that people greatly value. It is a fact that use of electric vehicles began in the 19th century. However, the number of electric cars (EVs) declined as internal combustion vehicles (ICVs) improved, gasoline became more affordable, and long-distance travel became more common during the “first era” of EVs in the late 19th century. With increasing concerns about environmental issues and rising oil prices, the second era of electric vehicles began in the 1960s, but there were limited advancements in electric batteries. The contemporary “third era” of electric vehicles is largely propelled by rising concerns over greenhouse-gas (GHG) emissions and other environmental pollutants, coupled with significant technological progress, especially in advanced battery technologies. Further, from a socio-environmental perspective, this study highlights two major concerns associated with mobility and energy use: vehicle-exhaust emissions and climate change. These issues are discussed throughout the paper in the context of India’s transition toward electric vehicles and the broader environmental goals under national and international frameworks.

2. International Legal Framework And Electric Vehicles

By 2030, it is anticipated that India’s large-scale adoption of EVs will increase overall electricity consumption to 69.6 terawatt-hours, generating an additional USD 11 billion in income for power providers.⁴ This transformation brought about by EVs will also reduce emissions by 40–50 % and help the nation achieve its carbon-emission reduction objectives. This study provides an overview of the EV landscape in the country and the prospective regulatory environment that will emerge, as the EV sector is crucial to boosting India’s power industry.

Supported by the National Electric Mobility Mission Plan (NEMMP) of 2013 and the Faster Adoption and Manufacturing of Hybrid & Electric Vehicles (FAME) Program of 2015, the proportion of electric vehicles (EVs) in the Indian transportation industry is increasing. The NEMMP aims to promote hybrid and electric vehicles in India to achieve national fuel security and plans to sell 6–7 million hybrid and electric vehicles annually starting from 2020. FAME, on the other hand, focuses on technological research, demand generation, pilot projects, and charging infrastructure to support the establishment of a market and manufacturing ecosystem for hybrid/electric cars.

These programmes were designed with the aim of ensuring that electric vehicles constitute 40 % of annual vehicle sales in India by 2030. However, the country currently has a limited number of charging stations, which has restricted EV utilisation. Due to the low density of charging infrastructure, private players remain hesitant to invest in setting up and operating such stations, as the expected return on investment is presently low.

At the end of FY 2016–17, India recorded annual sales of approximately 25,000 electric vehicles. According to the Society of Manufacturers of Electric Vehicles, about 92 % of all EVs sold were two-wheelers, while electric automobiles and four-wheelers accounted for less than 8 % of total sales. According to a survey, during the fiscal year 2016-17, Gujarat sold 4,330 EVs, West Bengal 2,846, Uttar Pradesh 2,467, and Rajasthan 2,388.⁵ While India has made significant strides in electric mobility, the absence of a coherent regulatory framework linking the EV sector with the power sector remains the single largest barrier to mass adoption. This paper argues that India needs an integrated, cross-sectoral regulatory strategy to ensure a smooth transition to sustainable electric mobility. One debate revolves around whether charging stations should utilise any form of renewable energy. The power output from renewable resources is significantly lower in both quantity and consistency compared to non-renewable resources. As a result, there is significant room for fluctuations in the electricity supply to charging stations, which could hinder widespread EV adoption. It is crucial to determine what incentives could be provided to the renewable-energy sector to avoid such issues or ensure the use of renewable energy partially for charging stations. Examples of such incentives include capital subsidies for solar-powered charging stations, viability-gap funding, concessional land allotment, time-of-day tariff benefits, accelerated depreciation for renewable-energy assets, and tradable carbon or RPO credits for stations using renewable sources. Another challenge is that the current electrical-distribution-system infrastructure is inadequate to meet the extensive energy requirements of EVs. To support EVs on a large scale, grid infrastructure needs to be upgraded and expanded to handle the increased demand. Considering the additional strain that charging such cars would place on the power system, the introduction of EVs would create new demand for electricity. This would have additional implications for the already burdened assets in the electricity industry.

2.1 The Stockholm Conference 1972 and The Paris Agreement 2015

India has played a pivotal role in shaping the global discourse on environmental protection and sustainable development. A landmark moment occurred in 1972 when the then Prime Minister, Indira Gandhi, addressed the United Nations Conference on the Human

Environment in Stockholm.⁶ In her influential speech, she emphasized that environmental degradation and poverty are deeply interconnected, asserting that the protection of nature cannot be isolated from the struggle against economic inequality. Her intervention brought global attention to the developmental concerns of newly independent and economically vulnerable nations, reinforcing that environmental justice must accommodate the differing socio-economic realities of developed and developing countries. This ideological foundation laid during the Stockholm Conference not only influenced India's domestic environmental policy framework but also shaped its evolving engagement with subsequent international climate agreements, including the Paris Agreement of 2015.

This led to the introduction of many environmental laws in India. From the Stockholm conference in 1972 to the Paris Agreement in 2015, India has faced the challenge of dealing with energy and environmental issues. Indira Gandhi emphasised the underlying conflict between the demands on industrialised and poor nations. While poverty alleviation should be the top priority in under-developed nations, protecting the human environment must be given the highest priority in rich countries. Unrelenting poverty has been one of India's biggest problems since it gained independence from British rule. Even after seventy years of independence, 20 % of its population still lives in poverty.⁷ However, India's stand on greenhouse-gas (GHG) emissions could be found through the initiatives after the Paris Agreement in environmental protection through legislation.

The Paris Agreement set international climate-policy goals to “achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century” and “hold the increase in the global average temperature to well below 2 Degree Celsius above pre-industrial levels and pursue efforts to limit the temperature increase to 1.5 Degree Celsius above pre-industrial levels.” There is a strong and growing consensus that the electricity industry is crucial for the decarbonisation of the economy. The production of electricity needs to transition to low-carbon technologies, employing various technical approaches (both centralised and decentralised), and a shift from direct combustion of fossil fuels to more energy-efficient power uses must take place. The specifics of this “low-carbon electrification” will vary depending on each country's terrain, resources, revenue, and existing infrastructure. According to the International Energy Agency (IEA)'s 2-degree-compatible scenario (2DS), electricity consumption is projected to increase by 79 % between now and 2050, with its share in the final energy mix rising from 18 % to 28 %. In

this scenario, the demand for electricity in transportation would also increase significantly, accounting for over 7 % of total electricity demand by 2050.⁸

The opening of the Paris Agreement for signing by each nation was one of the tangible accomplishments of COP21.⁹ Some terms of the Paris Agreement justified why developing countries like India were eager to join. Firstly, there was no longer a clear distinction between developed and developing countries. All nations pledged to make the greatest efforts possible to combat climate change. Secondly, for the first time, all nations are required to regularly publish their greenhouse-gas (GHG) emissions and implementation efforts for international evaluation. In six areas (reduction of GHG emissions, adaptation, financing, technology transfer, capacity building, and transparency), all signatories made legally enforceable promises to contribute through Nationally Determined Contributions (NDCs) and undertake domestic initiatives to achieve them. The NDCs must be presented every five years, with the expectation that they will progress from the previous submission. The United Nations Framework Convention on Climate Change (UNFCCC) imposed obligations on wealthier countries, while developing countries made voluntary contributions. The Paris Agreement extended the current objective of securing USD 100 billion in annual support from affluent nations from 2020 through 2025, with a higher objective to be decided after 2025. Climate change poses serious risks to India, particularly in vital economic sectors and resources such as agriculture and water. The issue is exacerbated by widespread poverty and a significant portion of the population relying on climate-vulnerable industries. Over 72 % of the world's GHG emissions come from the top ten polluting nations, with India ranking third globally. More than 75 % of India's GHG emissions stem from the country's energy sector.¹⁰

3. Judicial Pronouncements

Judicial decisions in India have played an increasingly important role in shaping environmental governance and influencing policy reforms relevant to the energy sector and the transition towards electric mobility. Courts and tribunals have repeatedly intervened where legislative or executive action has been inadequate, thereby indirectly strengthening the regulatory environment in which EV adoption must occur.

In *Rajat Kapoor, Advocate v. Union of India* (2017), the Delhi High Court issued notice to the Union and Delhi Governments seeking clarification on mandatory insurance for electric two-wheelers under Section 146 of the Motor Vehicles Act, 1988. Although primarily a motor-vehicle compliance issue, the case reflects a larger regulatory gap: as EV technology expands faster than legislation, courts are often required to address basic questions of safety, liability,

and compliance. Such gaps hinder the smooth integration of EVs into India's transportation system.¹¹

Similarly, in *Sunil Dahiya v. Union of India*, App. No. 315 of 2016 (Principal Bench of the National Green Tribunal (NGT) Jan. 17, 2018), the NGT directed the Ministry of Environment, Forest and Climate Change (MoEFCC) to strictly follow environmental-approval protocols for thermal-power plants. This decision is significant for EV adoption because thermal energy still contributes the majority of India's electricity supply, meaning that weak oversight of coal-based plants undermines the environmental benefits expected from EVs. Judicial insistence on rigorous environmental scrutiny therefore contributes to a cleaner energy mixan essential precondition for meaningful decarbonisation of transport.¹²

In *Ridhima Pandey v. Union of India* (2017), the NGT emphasised the obligation of the Central Pollution Control Board to take proactive, science-based measures to address climate change. This case underscores a broader institutional problem: environmental regulators have struggled to keep pace with rising emissions and emerging scientific evidence. For EV policy, this judicial insistence on climate-responsive regulation reinforces the need for a coordinated national framework addressing both transportation emissions and energy-sector externalities.¹³

The *M.C. Mehta v. Union of India* (2015) order of the Supreme Court of India, imposing an Environment Compensation Charge on commercial diesel vehicles entering Delhi, further illustrates how judicial intervention can push governments toward cleaner transport alternatives when policy measures lag. Coupled with the NGT's ban on older diesel and petrol vehicles later upheld by the Court, the judiciary has effectively compelled transitions away from highly polluting internal-combustion engines. The Delhi High Court's ruling in *Association of Radio Taxis v. Union of India* (2015), prohibiting the operation of diesel taxis in the capital, similarly highlights the judiciary's role in enforcing environmental priorities over commercial convenience. The judgment reiterates that economic growth cannot override the constitutional mandate to protect the environmenta principle that aligns with India's long-term shift toward low-emission mobility.¹⁴

Finally, in *Gauri Grover v. NCT of Delhi* (2018), the Court directed municipal bodies to improve solid-waste-management practices, noting the severe health impacts of improper waste disposal and its contribution to methane emissions, a potent greenhouse gas.¹⁵ Although not directly concerned with EVs, the decision reflects a broader judicial logic: environmental degradation must be addressed holistically, and emissions from all sectors

including waste, transport, and power generation affect India's overall climate trajectory. A stronger environmental-governance framework ultimately supports the EV transition by creating an aligned regulatory context for emissions reduction. Conjointly, these cases demonstrate that judicial intervention is not merely remedial but has become an essential component of India's environmental and energy-governance architecture. For the EV sector, this jurisprudence highlights systemic regulatory weaknesses fragmented enforcement, outdated legal definitions, and inadequate pollution control that must be addressed for India to achieve meaningful electrification in the transport and energy sectors.

The NGT has recently intervened by closely scrutinising the Environmental Impact Assessments (EIAs) for some projects. For instance, the NGT heard a challenge from local people disputing the government's clearance of diverting 17.7 hectares (about 44 acres) of forest land for the development of a 130 MW hydropower project in *Paryavaran Sanrakshan Sangharsh Samiti, Lippa v. Union of India* (2016).¹⁶ There are 200 hydropower projects being built currently in that region. The EIA report's inadequate consideration of the cumulative impacts of existing and proposed hydropower projects was questioned. The Tribunal directed the State authorities to place the complete project plan before the local Gram Sabhas, in compliance with the Forest Rights Act, 2006, and required village bodies to negotiate with project developers to mitigate adverse consequences. Similarly, concerns about the "rubber-stamping" of coal-mining approvals where the MoEFCC granted a high volume of clearances without adequate environmental scrutiny highlight major systemic weaknesses in India's environmental-governance framework. These examples are directly relevant to the EV-energy discussion because weak environmental assessment and regulatory oversight in the energy sector undermine India's transition to cleaner mobility. Effective EV policies require an integrated regulatory approach that addresses the environmental impacts of all energy sources, both renewable and non-renewable.

4. Conclusion

India's transition to electric mobility is unfolding within a uniquely complex energy landscape marked by diverse power sources, uneven regulatory capacity, and competing developmental priorities. While it remains difficult to predict the exact trajectory of EV penetration, several trends are evident. India is likely to adopt an evolutionary not disruptive path to large-scale EV adoption, influenced by rising private-vehicle ownership, expanding travel demand, and gradual improvements in technology and infrastructure. Yet, India's strong record of technological adaptation, coupled with its vast domestic market, positions it

to exert substantial influence on global EV innovation, manufacturing, and supply chains. The pace of adoption will depend significantly on declining battery costs, improved charging infrastructure, and targeted public-policy interventions. As subsidies become less decisive over time, market forces particularly fleet electrification, competitive pricing, and private investment will play a larger role. At the same time, international developments, especially China's rapid expansion in BEV production and exports, will shape global-cost curves and accelerate India's own transition.

However, meaningful electrification of India's transport sector cannot occur in isolation from reforms in the energy sector. Weak environmental regulation, inconsistent implementation of the EIA framework, and continued dependence on coal dilute the climate benefits of EVs. Stronger environmental governance, transparent permitting processes, and integration of renewable energy in EV-charging systems are therefore essential preconditions for sustainable mobility. Likewise, policies such as "Make in India," while economically beneficial, must not compromise environmental safeguards or worker protections, as such trade-offs undermine long-term sustainability goals. Finally, India's commitment to its Paris Agreement obligations provides a critical foundation for aligning energy and mobility transitions. Real progress will require a coordinated national strategy that links EV deployment with power-sector reforms, grid modernisation, renewable-energy expansion, and environmental compliance. If India succeeds in strengthening these institutional and regulatory pillars, it can not only accelerate domestic EV adoption but also emerge as a global leader in affordable, low-carbon mobility.

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