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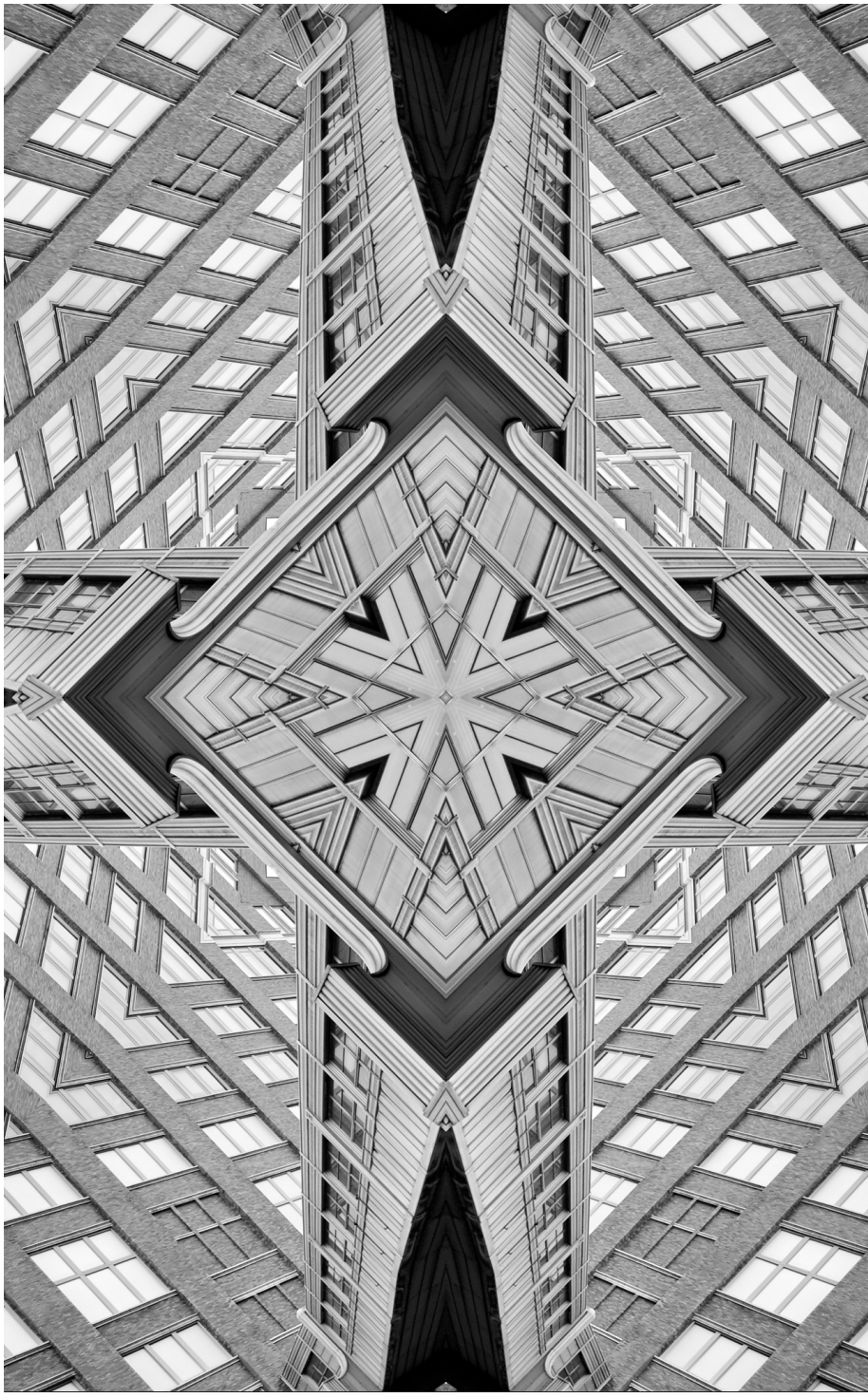

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Global Approaches to Vehicle Electrification and Their Lessons for India

Rumi Aijaz

Abstract

Emissions from fossil fuel-powered motor vehicles adversely affect air quality and contribute to global warming. The manufacture and use of electric vehicles (EVs) is among the ways by which this challenge can be mitigated. This brief evaluates the best practices adopted by countries in the forefront of EV adoption, and outlines the lessons India can draw from them to inform its own EVs strategy. It finds that in addition to strengthening institutional capabilities, India should embark on the manufacture of new EV models, develop battery supply chains, build charging infrastructure, provide purchase incentives for low-income communities and non-financial incentives for EV owners, and make the necessary spatial planning interventions.

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Introduction

Across the globe, air quality is deteriorating rapidly as a result of multiple factors such as the extensive use of fossil fuels in industry and transport, and the burning of solid waste and crop residue—all of them generating harmful pollutants that affect air quality. Inferior air quality leads to health risks and reduced life expectancy. The World Health Organization (WHO) has noted that exposure to air pollution is highest in low- and middle-income countries, and causes some 7 million premature deaths globally every year.[1] Air pollution also damages food crops and trees, contaminates soil and surface water bodies, and contributes to the lowering of the Earth's temperature. Countries, international organisations, and communities are actively working to find solutions to air pollution. Although these efforts have had some impact, much of the world continues to battle the multitude repercussions of worsening air quality.

This brief describes some of the initiatives being undertaken by countries to promote the electrification of motor vehicles. There is enough evidence that pollutants emitted by conventional (i.e. fossil fuel-powered) motor vehicles contribute significantly to global emissions, and shifting to electric vehicles (EVs) can help improve air quality. The European Environment Agency (EEA), for instance, has observed that greenhouse gas emissions of EVs are about 17-30 percent lower than those of conventional vehicles.[2] As global population increases and the demand for mobility grows in parallel, it has become more urgent to control the problem of motor vehicle emissions. The electrification of transport reduces oil demand and greenhouse gas emissions, and helps achieve better health outcomes. At the same time, implementing vehicle electrification programmes increases demand for electricity and certain minerals used to manufacture batteries and other components. This entails other issues on their own, and will need to be dealt with accordingly.

The question is whether India can benefit by adopting certain measures that other countries have taken to promote EVs. In 2015, the government of India implemented the scheme called Faster Adoption and Manufacturing of Electric and Hybrid Vehicles (FAME). The programme is now in its second phase, but the transition from conventional to EVs has been slower than targeted. Conventional vehicles still dominate Indian roads, and targets for cleaner air remain distant for many cities, some of them among the top regions across the world with the worst levels of air pollution.

Tracking the Progress of India's EV Sector

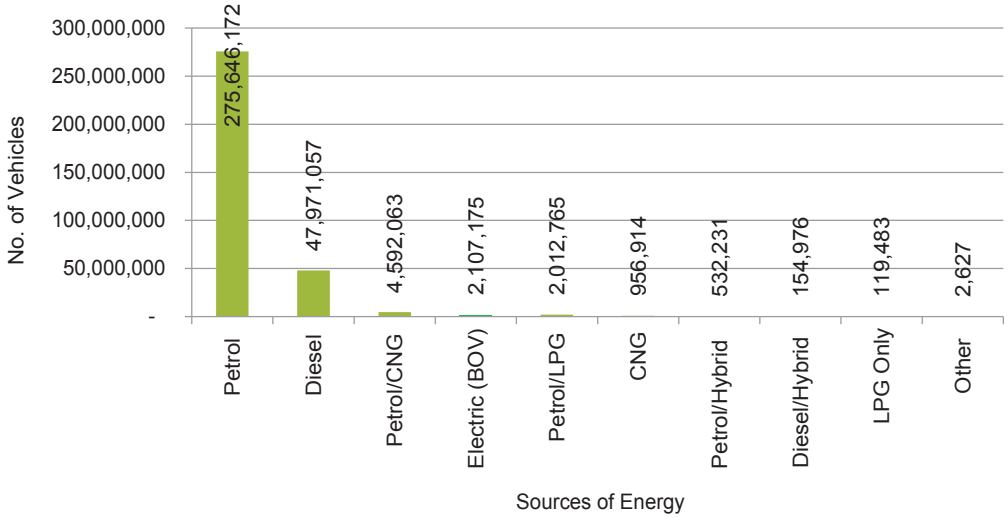
India launched the National Mission for Electric Mobility (NMEM) in 2012—a roadmap for the planned development of the country's EV sector. Its strategic components included demand creation, strengthening the manufacturing ecosystem, providing charging infrastructure, supporting research and development (R&D), and building public awareness.[3] In pursuit of these goals, the government introduced FAME a few years later.[4] Some of the measures undertaken since then include the following: earmarking INR 100 billion for FAME Phase - II;[5] creating a dedicated EV portal, e-AMRIT, which provides information on types of EVs available along with costs, financing and insurance options, and government incentives; offering incentives to EV manufacturers and buyers; reducing the cost of EVs and their components; and seeking engagements with the private sector. Most Indian states and union territories (UTs) have also set their own targets for EV sales and emissions reduction, and formulated EV policies to meet specific needs.

As of February 2023, there were over 2 million registered EVs[6] and 5,151 charging stations across the country.[7] However, accounting for over 95 percent of the sales are electric two- and three-wheelers; in the four-wheeler segment, EVs sales remain small. The imperative is to increase the electrification of four-wheelers (i.e., cars, buses, trucks), as they comprise a significant number of vehicles plying city roads and generate high amounts of pollutants.[8]

Under FAME II, 1,716 electric buses have been deployed in various Indian states at the time of writing this brief.[9] Only recently, in 2020, have leading automakers begun manufacturing electric trucks.[10] In all, there are 64 registered original equipment manufacturers (OEMs)[11] and 249 EV models[12] available across vehicle segments, the majority of which are in the two- and three-wheeler categories. Charging stations are mostly in cities, although a growing number are also being installed along crucial highways. Some stations have been set up in partnership with private companies.

Figure 1 shows various energy sources in use for powering motor vehicles in India—i.e., petrol, diesel, CNG, battery, and LPG. In February 2023, there were 275.64 million petrol-powered vehicles, accounting for 83 percent of India's total registered vehicles, while diesel vehicles numbered another 47.97 million. Meanwhile, the number of registered EVs was a mere 2.10 million.[13] The difference is stark: petrol-driven motor vehicles are about 130 times as many as EVs.

Figure 1: Registered No. of Motor Vehicles in India, by Energy Source (2023)



Source: Ministry of Road Transport and Highways.[14]

(Note: The 'Other' category includes vehicles driven by solar power, ethanol, LNG, methanol, and fuel cell hydrogen.)

The challenge for the government is apparent as the shift from conventional to electric vehicles has been slow. In 2021, the share of EVs in total vehicle sales was only 1.1 percent.[15] An earlier study by this author highlighted the following reasons for slow EV penetration in India:[16]

- Low level of public awareness
- Paucity of models in the four-wheeler category
- High price of EVs and batteries
- Need to import raw materials for batteries

- Low battery capacity offering limited driving range
- Vehicle safety concerns
- Insufficient number of public charging stations
- Time taken to charge EVs
- Reluctance of lenders to finance EVs due to risks involved, such as difficulty in recovery of dues.

As India works on its EV agenda, it will be useful to assess global practices that have met with success and can be used in India as well to improve EV penetration in the country.

Global Best Practices

The following paragraphs will discuss a number of examples of how other countries have achieved their targets in the various components of vehicle electrification.

Sales targets

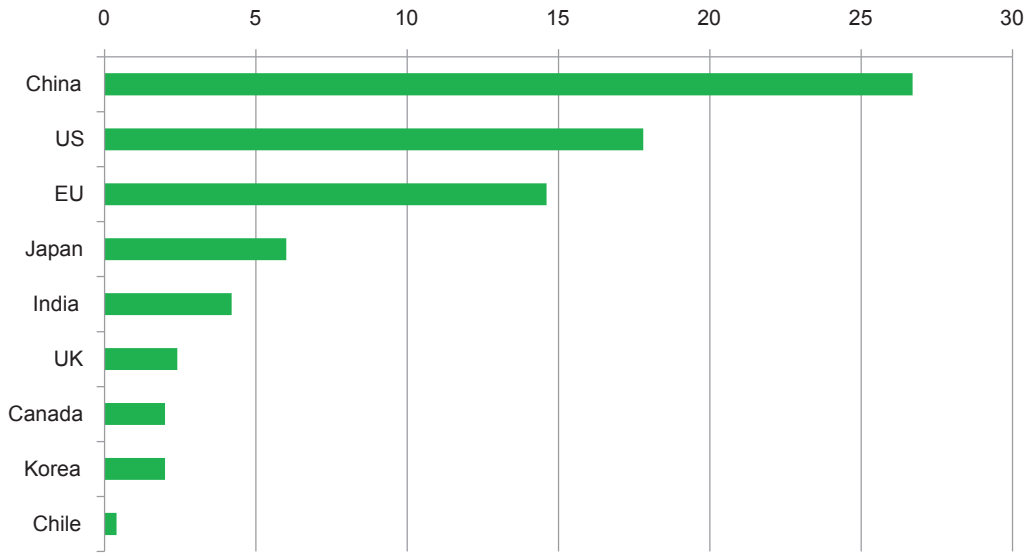
China, where EV sales were the world's highest in 2021 (see Figure 2), is aiming to have 20 million EVs, or 20-percent market share (i.e. new car sales) for EVs, by 2025. The United States, for its part, is targeting 50-percent share by 2030 and is focusing on improving associated technologies and domestic industries. Many US states, including Washington, California, New York, and Massachusetts have set targets for ending sales of petrol vehicles.

In India, EV sales penetration targets for 2030 are: 30 percent for cars; 70 percent for commercial vehicles; 40 percent for buses; and 80 percent for two- and three-wheelers.[17]

Promoting EVs in the medium- and heavy-duty vehicles (M/HDV) category is an important concern of policymakers in many different countries.[18] The most crucial challenges—such as inadequacy of high-power charging facilities and large batteries for M/HDVs—are being addressed through technology advancements. Canada, for example, is aiming at 35-percent sale of zero-emission vehicles (ZEVs) in the M/HDV category by 2030, and is planning to launch a purchase incentive programme to achieve it. It already has a 'Zero Emissions Transit Fund' that allows communities to invest in zero-emission public transit buses and school buses. For its part, Chile's target is to sell only zero-emission M/HDVs by 2045. In the capital, Santiago, public-private partnerships have helped operationalise a fleet of over 800 electric buses.

For the EU, The European Commission has proposed lower emission targets for all new HDVs (trucks and buses) which are to be achieved in a phased manner: 45 percent emissions reduction by 2030, 65 percent reduction by 2035, and 90 percent by 2040.[19] By 2035, the EU is stopping all sales of new petrol and diesel cars. And in China, electric M/HDV sales are largely due to purchase incentives, and a pilot programme that supports R&D.

Figure 2:
Global Share of Electric Light Duty Vehicle (LDV) Sales (2021, in %)



Source: International Energy Agency.[20]

Range of models

Manufacturers of conventional vehicles launch new models frequently to meet diverse customer preferences. The EV sector being nascent, its range of models is still limited and customers tend to purchase conventional vehicles of which they have multiple choices.

Automakers in some countries have begun to address this issue of range. The *Global Electric Vehicle Outlook 2022* report observes that there were five times as many new EV models in 2021 than in 2015.[21] The launch of new electric models, including in the SUV category, has been an important factor in the rise of sales, particularly in China, the US, and Europe.

In India, a number of domestic companies, including Tata Motors and Mahindra Electric, assemble electric car models. Most of these are being bought by taxi operators. Some of the foreign automakers operating in India, such as BMW, Hyundai, Mercedes Benz, MG and Volvo, also manufacture and sell electric four-wheelers. The number of electric two- and three-wheeler models has grown as well.[22]

Battery production and performance

The availability of EV batteries, together with the driving range they offer per charge, and their prices, are important parameters that buyers consider. Countries with abundant reserves of metals such as lithium, nickel, manganese, iron, cobalt and aluminium, and other raw materials required for battery production, are at an advantage. These countries also have the technical expertise to develop high-energy and high-density batteries to provide a long driving range,

Demand for EV batteries is highest in China, the US, and Europe. Lithium iron phosphate batteries are preferred, as they do not need expensive metals such as nickel or cobalt and thus have lower cost; they also have longer life cycles, and carry less risk of malfunction. Indeed, some countries are grappling with rising prices of metals due to growing battery demand, and supply constraints.

States whose EV programmes have performed well are those which give priority to developing battery supply chains[a] through proper policies, planning, investments, financial subsidies, and R&D. Foremost among them is China, which accounts for 76 percent of global EV battery production. Other players in the domain have far smaller global shares: the EU, Japan, South Korea, and the US, each accounts for less than 10 percent.[23]

India has launched two initiatives to address battery requirements: the National Mission for Transformative Mobility and Battery Storage, begun in 2019, to localise production of EVs, EV components and batteries; and the National Programme on Advanced Chemistry Cell Battery Storage, started in 2021 for battery manufacturing.[24] A number of private sector-led initiatives to develop advanced batteries are also underway.

a These comprise multiple stages from mining to raw material processing, and cell production.

In February 2023, lithium reserves—estimated at 5.9 million tonnes—were found for the first time in India in Jammu and Kashmir's Reasi district.[25] Lithium is one of the key materials used to make EV batteries, and its availability within Indian territory will help local manufacturing. However, the environmental impacts of extracting this natural resource need to be assessed. On numerous occasions, resource over-exploitation has exacerbated climate change, and negatively impacted soil quality, water and food availability, biodiversity, and the ecosystem.[26] In India, there is evidence of such irreversible changes in the mountain state of Himachal Pradesh.[27]

Charging infrastructure

For conventional motor vehicles, there are gas stations all over the country but few public facilities are available for battery charging of EVs. Motorists consider this deficiency in making their decision about whether or not to purchase an EV.

Countries with high EV penetration are those that have prioritised the adequate development of charging infrastructure. Canada, for example, has invested considerable resources to fill gaps in charging infrastructure in public areas. China has nearly 2 million public charging points,[28] and plans to expand both charging and battery swapping networks to meet the requirements of 20 million EVs by 2025. There is special focus on charging facilities in rural areas and along transport corridors. Similarly, the EU is looking to have 3 million publicly accessible charging points by 2030. The European Commission's proposal on Alternative Fuels Infrastructure Regulation (AFIR) requires all member states to meet the target, and will also ensure a coordinated approach to charging network distribution among them.

The US, meanwhile, is targeting interstate highways, rural areas, and disadvantaged communities. Some private buildings in cities such as Beijing, Oslo, and San Francisco also have low-cost EV charging infrastructure. In Bangkok, a mobile app enables EV drivers to find conveniently located charging stations and make a booking for their EV.[29] Many countries are emphasising setting up rapid charging facilities to reduce charging time.

India had about 5,151 public charging stations at the end of 2022. While many more have been sanctioned, the facilities are mostly concentrated in cities though efforts are underway to increase their number along interstate

highways. The battery swapping station network, which eliminates the time taken to recharge, is being expanded at the same time. To attract private investment, the government has allowed the sale of power for EV charging, and offers capital subsidies for establishing charging infrastructure. In states focused on building a reliable charging infrastructure, registration of EVs is increasing.

Private charging facilities, in people's homes and workplaces, are also needed. In many countries, this is the dominant charging source; in the US, for example, 88 percent of EVs draw power from residential charging facilities.[30] Some countries charge lower electricity rates from those setting up home charging facilities. In India, however, setting up charging infrastructure in residential apartments is a difficult task due to administrative hurdles. The process of obtaining permission is tedious and expensive. Experts claim that such problems can be resolved by creating a single window clearance, and issuing directives to housing societies and resident welfare associations (RWAs) to install them.

Incentives

Offering purchase subsidies is a common practice among governments with clear targets on EV penetration. In this arrangement, a certain percentage of the EV price is waived; the waived amount is paid by the government to the vehicle manufacturer. China, for example, began this strategy by offering high purchase subsidies on EVs, which were eventually reduced as sales picked up. The reduction did not affect EV sales, which have indeed continued to grow due to the maturing of the market and availability of charging infrastructure. South Korea, for its part, gives subsidies only on lower-cost EV car models. In Germany, the government and manufacturers together offered a subsidy on EVs. In San Francisco in the US, low-income residents get incentives to buy EVs.[31]

India too, offers purchase subsidy on EVs. It also has incentives for scrapping old conventional vehicles, and waives vehicle road tax and registration fees for EVs. As of February 2023, INR 39.89 billion have been spent by the Indian government to incentivise purchase of EVs.[32]

Some countries provide other incentives, such as exemption from paying toll on highways, bridges, tunnels, and ferries, or parking charges at parking lots; and EVs also get access to bus-only corridors. Paris, San Jose, Liuzhou, and Oslo are only some cities where cost of vehicle maintenance is thus reduced.[33] Chile has proposed a pilot project for the Santiago Metropolitan Area where EVs of urban logistics companies would have access to free charging.

Spatial planning

Planning and development agencies are creating spaces and facilities for the convenience of EV owners. In Beijing, Shanghai, Bergen and London, there are low-emission or emission-free zones, into which only EVs are allowed.[34] Many cities in the EU are creating such zones.

In Delhi, Maharashtra and Tamil Nadu too, there are plans to create dedicated EV lanes and parking spaces. West Bengal is aiming to develop e-mobility cities with green zones and inter-city green routes with rapid chargers at every 25 km.

Conclusion

EV penetration remains uneven across the world. China, the US, and Europe have recorded appreciable progress in this domain. Key contributing factors include technological innovations, domestic manufacturing, prudent financial management, and optimal spatial location of charging infrastructure. In contrast, emerging economies are recording slower growth rates of EV manufacture and use.

In India, both the central and state governments have demonstrated capabilities in developing EV policies. However, it will also be useful to learn and apply certain best practices of other countries in specific components of a sound EVs strategy. This will require collaboration on various fronts, including production of new models and superior batteries, improving supply chains, planned spatial location of charging infrastructure, providing purchase incentives for low-income communities, non-financial incentives for EV owners, demonstration projects, and spatial planning interventions.

Rumi Aijaz *is Senior Fellow at ORF.*

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20, Rouse Avenue Institutional Area,
New Delhi - 110 002, INDIA
Ph. : +91-11-35332000. **Fax :** +91-11-35332005
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Website: www.orfonline.org