UMD-GMU Boot Camp Policy Brief

Understanding the Fine Print: Electric Vehicles' Potential Impact on Air Pollution and Climate in India

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Key Messages for Policymakers

- The potential impact of electric vehicles (EVs) on air pollutants and greenhouse gas emissions is misunderstood, because most studies of the problem fail to include manufacturing emissions in their analyses.
- EV manufacturing, especially nickel and cobalt refining for battery cathode production, can significantly increase sulfur dioxide (SO_2) pollution.
- The electricity used to propel EVs is also a significant source of SO_2 pollution.
- Urgent action is needed to address both of these gaps. Collaborative interagency initiatives should implement stronger pollution control measures for power plants in the first place and critical mineral extraction and refining in the second.

Policy Context: The Promise Of EVs as an Engine of Manufacturing Growth

EVs have great promise to decarbonize the transport sector, particularly road transport, while also improving air quality. They also represent a lucrative economic opportunity. Many segments of EV supply chains, from metal and mineral extraction upstream to vehicle assembly and maintenance services downstream, are not yet mature in many parts of the world. Although China has established a dominant market position in most of these segments, other countries are trying to break its grip by raising custom duties and imposing domestic content requirements[2,3].

India has certainly done so with the Aatmanirbhar Bharat (Make in India) initiative. It advances ambitious targets for EV adoption and manufacturing with the aim of reducing transport emissions while simultaneously developing an indigenous supply chain. In 2024, the government implemented the initiative through the PM E-DRIVE scheme (PM Electric Drive Revolution in Innovative Vehicle Enhancement).[4]

Research Design: EV Manufacturing and Grid Emissions Remain Under Studied

Most studies of the environmental impacts of EVs focus only on reductions in 'tailpipe' emissions from fuel combustion and ignore the impacts of manufacturing and electricity consumption. To address these gaps, we estimate emissions at the state level for manufacturing using the life cycle assessment model GREET (Greenhouse gases, Regulated Emissions, and Energy use in Technologies); and for tailpipes using the integrated assessment model GAINS (Greenhouse Gas and Air Pollution Interactions and Synergies) for China and India. To better represent regional conditions, we modified GREET to incorporate China- and India-specific electricity mixes, and identified location-specific emission factors for key manufacturing processes. We modified GAINS to include state-level emission factors for fuel production and combustion as well as electricity generation. We focused only on the passenger cars segment, and evaluated changes in emissions due to EV transitions using two main scenarios, the 'Base Case' reflecting the existing policy commitments, and a more ambitious 'EV Case'. We developed additional scenarios that incorporate policies to reduce emissions from EV manufacturing and operation.[5]

Research Findings: Without Pollution Controls, EV Manufacturing and Use Can Worsen Air Pollution

We find that EV manufacturing causes substantial SO_2 emissions. These emissions come predominantly from the processes used to extract and refine the nickel ore used to make NMC (Nickel Manganese Cobalt) cathodes for EV batteries. If India were to pursue its EV targets with NMC batteries produced entirely domestically, we estimate that its SO_2 emissions would increase by 80%v. (See figure 1.) Moreover, this increase would not impact the country uniformly, but rather be concentrated in regions that are either rich in nickel ores, or where nickel ore refining facilities are being set up. To avoid these hotspots, the government should impose strict SO_2 end-of-pipe controls in nickel and cobalt refining industries. The adoption of alternative cathode chemistries, like Lithium Iron Phosphate (LFP), could also bring the emissions down substantially.[5]

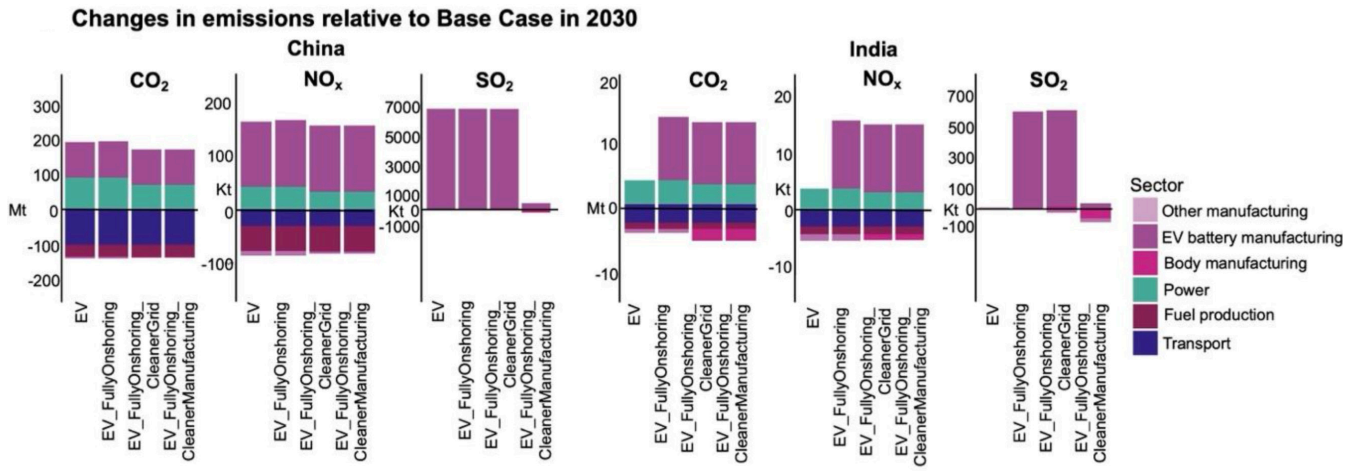

Figure 1: Changes in CO_2 and air pollutant emissions (NO_2 and SO_2) taking into account the entire stock of conventional and electric vehicles in China and India for the year 2030. Source: Sharma et al.[v]

The electricity used to charge EV batteries is also a potential source of environmental risk. Although EVs eliminate tailpipe emissions, their overall emissions are eliminated only when the electricity used to charge them is entirely clean. When fossil fuels like coal are used on the grid, emissions reductions are less impressive. Coal use also produces local air pollution, which remains an urgent issue for India. When comparing India with China, our models find that electricity-related SO_2 emissions are about fourteen times higher in India because air pollution control measures are not enforced as rigorously[5].

Insights for EV Policy

The overall emissions from the EV transition are determined by technological and non-technological factors that go beyond transport sector. If the entire EV supply chain is created in India and no new pollution controls are imposed, new air pollution hotspots will emerge, negatively affecting human health. In addition, if the grid is not cleaned up, carbon emissions from EVs will continue to fuel climate change. Hence, it is crucial that emissions impact assessments of EVs are not limited to tailpipe emissions, and instead consider the entire supply chain and EV use.

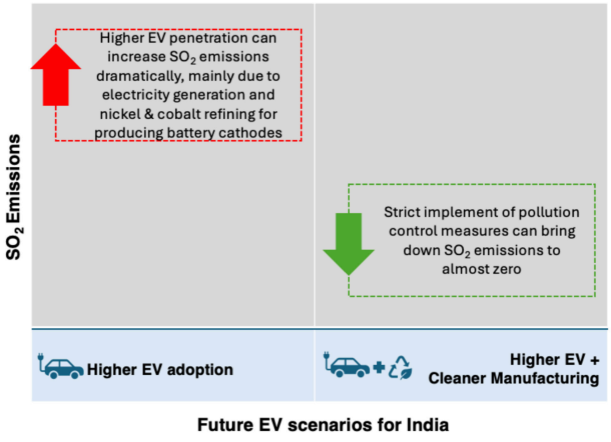

Figure 2: Key insights on SO_2 emission impacts of EV transitions, and processes that need particular attention to bring down the emissions. Adapted from Sharma et al.(2024)[5].

As the first priority, Ministry of Power (MoP) & Centre Electricity Authority (CEA) (leading emission controls for electricity sector), with the Ministry of Environment, Forest, and Climate Change (MoEFCC) (leading climate commitments), Ministry of Mines (leading mining efforts), and Central Pollution Control Board (CPCB) (enforcing pollution control measures) should collaboratively work to implement pollution control measures in electricity generation. In the medium- and long-term, MoEFCC and CPCBs needs to actively work with the Ministry of Heavy Industries (MHI) (spearheading PM EDRIVE) to introduce regulations to check industrial SO2 emissions.

Ancillary Material

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Competing Interests

The author declares no competing financial or non-financial interests.