Role of fuel efficiency norms in accelerating sales of electric vehicles in India

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India's passenger car segment is one of the world's fastest growing automotive market segments. India surpassed Japan in 2022 to become the world's third-largest passenger vehicle market after China and the United States.[1] Sales surged to 3.9 million passenger cars in fiscal year (FY) 2022–23, up 27% from the previous year, marking a formidable recovery from the economic slowdown of FY 2019–20 and from the COVID-19 pandemic and its aftereffects in FY 2020–21.[2] The automotive industry in India—which includes manufacturing of both automobiles and components—has grown because of strengths in areas that include casting, forging, and precision machining. The availability of skilled workers at lower wages compared with other vehicle-manufacturing countries also means automakers can produce cars at lower costs.

India aims to boost the adoption of battery electric vehicles (BEVs) in part by setting a national goal of 30% of all vehicle sales in 2030 being BEVs. Corporate average fuel economy (CAFE) standards can help achieve this goal by encouraging manufacturers to produce and sell more BEVs to meet fleet-wide emission targets. CAFE standards also encourage manufacturers to continue improving technology in internal combustion engine vehicles (ICEVs) to reduce emissions. This briefing examines how automotive manufacturing has evolved in India, the impact of India's current CAFE standards, a case study of emission standards in Europe, and the potential for the next phase of CAFE standards in India to increase BEV sales to 30% of all vehicles.

GROWTH OF INDIA'S AUTOMOTIVE INDUSTRY

Foreign investment was vital in developing India's automotive industry. The evolution of foreign direct investment (FDI) unfolded in distinct phases, reflecting the country's economic policies and industrial landscape. From 1950 to 1980, the automotive sector experienced slow growth due to limited market size and stringent regulatory measures

1 "India Surpasses Japan to Become 3rd Largest Auto Market Globally," *ET Auto*, January 6, 2023, https://auto.economictimes.indiatimes.com/news/industry/india-surpasses-japan-to-become-3rd-largest-auto-market-globally/96786895.

2 The fiscal year begins April 1 and ends March 31; "Domestic Sales Trends," Society of Indian Automobile Manufacturers, accessed June 10, 2024, https://www.siam.in/statistics.aspx?mpgid=8&pgidtrail=14.

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that limited the percentage of equity a foreign company could invest. However, the landscape began to shift in the early 1980s with the first wave of substantial foreign investment in automotive assembly plants. Maruti Udyog Limited (MUL), a government initiative in partnership with Suzuki Motor Corporation, symbolized this transition. Concurrently, the government's Phased Manufacturing Programme (PMP) incentivized locally produced components, fostering joint ventures and technology transfers with foreign automakers.

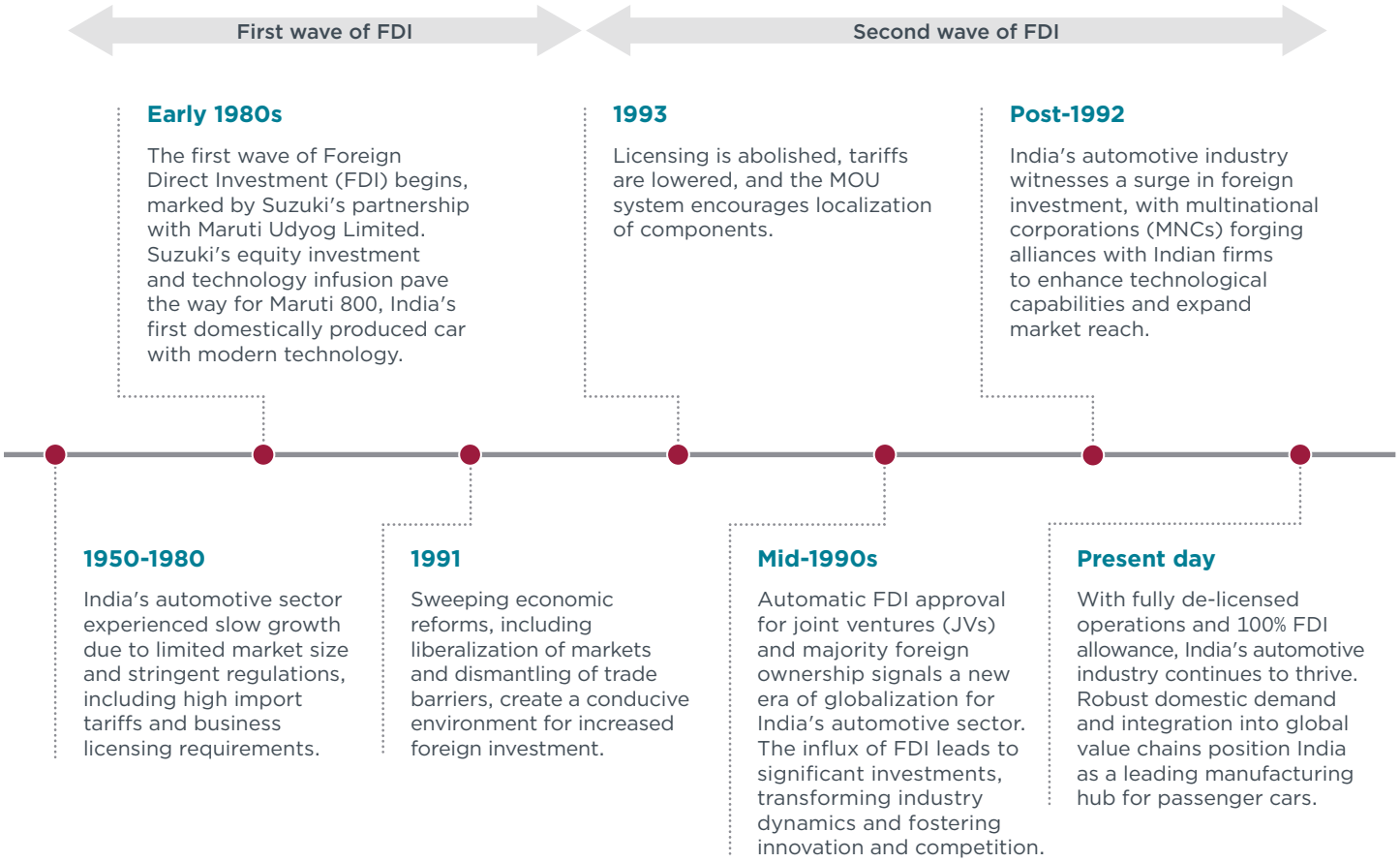
A turning point came in 1991 with economic reforms that liberalized markets and dismantled trade barriers. The launch of a new automobile policy in 1993 facilitated more participation from global assemblers, attracted foreign automakers, and laid the groundwork for the second wave of FDI. The policy shift brought a surge of investments from multinational corporations and transformed industry dynamics. The post-1992 period brought a flurry of activity, with Indian firms forging alliances with international players to enhance technological capabilities and expand market reach. Finally, in 1997, automatic FDI approval of joint ventures with a 51% majority share for the foreign partner was allowed.[3]

FDI spurred increased output and productivity in the automotive sector. The number of car models—which had been static, with only two models offered in FY 1982–83—expanded to eight in FY 1994–95 and 28 in FY 2001–02. The component industry also surged, tripling revenue from FY 1992–93 to FY 2001–02, primarily due to FDI. Joint ventures, notably MUL and Suzuki JV, facilitated the infusion of global technology. In many ways, the automobile industry has been shaped by the Indian government's policies. Figure 1 highlights the evolution of the Indian automotive industry with foreign investment.

3 J. Ramachandran et al., "India Entry Strategy of Auto Majors," Indian Institute of Management Bangalore, October 2011, https://tejas.iimb.ac.in/articles/91.php.

Figure 1

Evolution of major policies in the automotive sector



Source: Smita Miglani, "The Growth of the Indian Automobile Industry: Analysis of the Roles of Government Policy and Other Enabling Factors," in *Innovation, Economic Development, and Intellectual Property in India and China: Comparing Six Economic Sectors*, ed. Kung-Chung Liu and Uday S. Racherla (Springer, 2019), 439–63, https://doi.org/10.1007/978-981-13-8102-7_19.

TRANSPORT DEMAND IN INDIA

Though FDI spurred growth in India's automobile industry, expanded transport demand was at the heart of the boom. Rising middle-class incomes and a large youth population will further increase demand. A study by the Council on Energy, Environment and Water (CEEW) estimated that demand for motorized transport in India will double from 4,000 billion passenger kilometers (pkm) in 2020 to 8,000 billion pkm in 2050. This trend is also seen in passenger vehicle sales in India which increased from 30.7 lakh in 2022 to 39 lakh in 2023. The burgeoning number of vehicles and related growth in travel will substantially increase road transport emissions without norms to improve vehicle fuel efficiency.

EMISSIONS FROM ROAD TRANSPORT IN INDIA

Road transport contributes about 90% of the CO_2 emissions in India's transportation sector.[4] While climate policies are expected to slow emissions growth in the United States and Europe, emissions are projected to increase in China, the Asia-Pacific region, India, and Africa as travel demand grows. Emissions from road transport in India are expected to triple between 2020 and 2050. As a result, India could become the world's third-largest CO_2 emitter by 2050.[5] Efficiency and emissions improvements combined with zero-emission vehicle deployments are key strategies for reducing transport sector CO_2 emissions.[6] Further, research by the International Council on Clean Transportation (ICCT) finds that to align with the well-below 2 °C pathway by 2050 under the Paris Agreement, India will need to achieve 100% zero-emission vehicle sales in all vehicle segments no later than 2045.[7]

ELECTRIC MOBILITY AS A DECARBONIZING AGENT

In 2013, the Ministry of Heavy Industries introduced the National Electric Mobility Mission Plan (NEMMP) to promote the manufacturing and adoption of electric vehicles (EVs) in India. As part of this, in 2015, the Ministry introduced the national demand incentive scheme, Faster Adoption and Manufacturing of Electric Vehicles (FAME).[8]

Another step was the Ministry of Power's establishment of CAFE standards for passenger cars in 2015. Passenger cars are responsible for about 20%–25% of road transport emissions in India. CAFE standards are measured in petrol-equivalent liters per 100 km for fuel consumption in vehicles, with consideration given to the weight of the vehicle model. Weight plays a significant role in fuel consumption; smaller cars typically consume less fuel than larger cars and SUVs. Compliance with CAFE standards is assessed at the corporate fleet level rather than on a per-vehicle basis at the time of certification. Each manufacturer's compliance is evaluated annually by computing average fuel consumption weighed against the sales of each make and model during the fiscal year. This gives the government an avenue to steer vehicle technology at the manufacturing level. Therefore, CAFE norms or fuel efficiency norms will play a vital role in shifting from polluting vehicles to zero-emission vehicles.

CAFE STANDARDS IN INDIA

In 2015, the Indian government established CAFE standards for passenger cars, with CAFE 1 targets for FY 2017–18 and CAFE 2 targets for FY 2022–23 onward. Manufacturers must provide certified CO_2 emission values as established by vehicle certification agencies such as the International Centre for Automotive Technology (ICAT) and Automotive Research Association of India (ARAI). At the end of each year, the status of each manufacturer's compliance is determined and reported based on a formula outlined in the notification, which includes parameters such as CO_2 emissions and vehicle curb weight.[9]

4 Megha Kumar et al., *Decarbonizing India's Road Transport: A Meta-Analysis of Road Transport Emission Models* (International Council on Clean Transportation, 2022), https://theicct.org/publication/decarbonizing-india-road-transport-may22/.

5 International Council on Clean Transportion, *Vision 2050: A Strategy to Decarbonize The Global Transport Sector by Mid-Century* (2020), https://theicct.org/publication/vision-2050-a-strategy-to-decarbonize-the-global-transport-sector-by-mid-century/.

6 International Council on Clean Transportation, *Vision 2050*.

7 Arijit Sen and Joshua Miller, *Vision 2050: Update on the Global Zero-Emission Vehicle Transition in 2023* (International Council on Clean Transportation, 2023), https://theicct.org/publication/vision-2050-global-zev-update-sept23/.

8 Ministry of Heavy Industries & Public Enterprises, "National Electric Mobility Mission Plan," press release, March 2015, https://pib.gov.in/newsite/PrintRelease.aspx?relid=116719.

9 Curb weight is weight of the vehicle considering all standard equipment and consumable items. Fuel types include gasoline, diesel, liquid petroleum gas, compressed natural gas, and electricity.

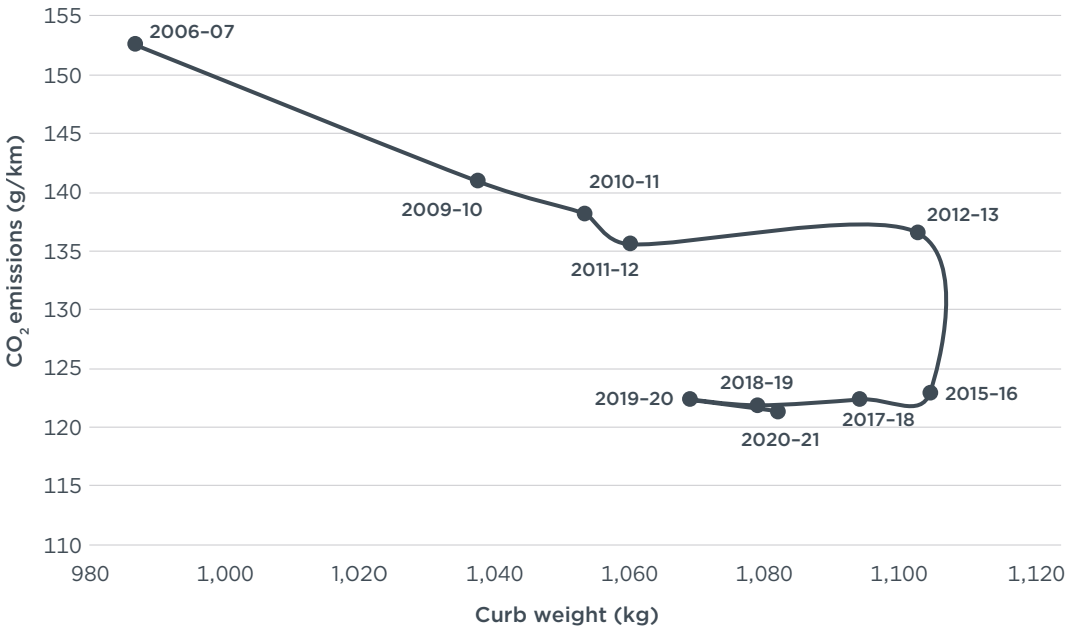
To streamline compliance costs and encourage innovation, the regulation incorporates flexibility mechanisms. These include "super credits" that reward manufacturers for producing and selling EVs by granting them additional emission credits, which can offset emissions from conventional vehicles in a fleet. Under this system, BEVs receive a super credit of 3, meaning that a BEV counts as three vehicles when calculating fleet-average CO_2 emissions. Plug-in hybrid vehicles (PHEVs) receive 2.5 credits and strong hybrid vehicles (HEVs) receive 2 credits. Super credits have played a pivotal role in incentivizing the production and sales of new technologies such as EVs and hybrids. Tata and MG gained major market share in the EV market in 2023 and have planned investments for increasing capacity.[10] Similarly, other manufacturers also plan to invest in EVs to meet their future fuel consumption targets.

CAFE standards also permit off-cycle credits, which are limited additional credits for CO_2-reducing technologies that are not fully captured by standardized testing procedures. These credits apply to features such as start-stop technology, tire pressure monitoring systems (TPMS), regenerative braking, and 6-speed transmissions.

Figure 2 shows fleet-average CO_2 emissions, adjusted by credits, and curb weight in India.[11] During the decade from FY 2009–10 to FY 2019–20, CO_2 emissions decreased by 1.4% annually while average vehicle weight increased by 0.5%. The sharpest drop in emissions occurred from FY 2012–13 to FY 2015–16 (3.4% annually), coinciding with a minimal rise in vehicle weight (0.2% annually). Since FY 2015–16, average vehicle weight has declined, reaching 1,068 kg by FY 2019–20 but slightly rising to 1,081 kg in FY 2020–21, mainly due to the reduced market share of diesel vehicles. CO_2 emissions remained relatively stable in FY 2018–19 and FY 2019–20 but decreased by 0.8% in FY 2020–21.

Figure 2

Historical fleet-average CO_2 performance, adjusted by credits, and curb weight



10 "Tata dominates EV sales with 73 percent market share in 2023," *Autocar India*, January 4, 2024, https://www.autocarindia.com/industry/tata-dominates-ev-sales-with-73-percent-market-share-in-2023-430226#:~:text=MG%20Motor%20India%20and%20Mahindra,second%20and%20third%20places%2C%20respectively.

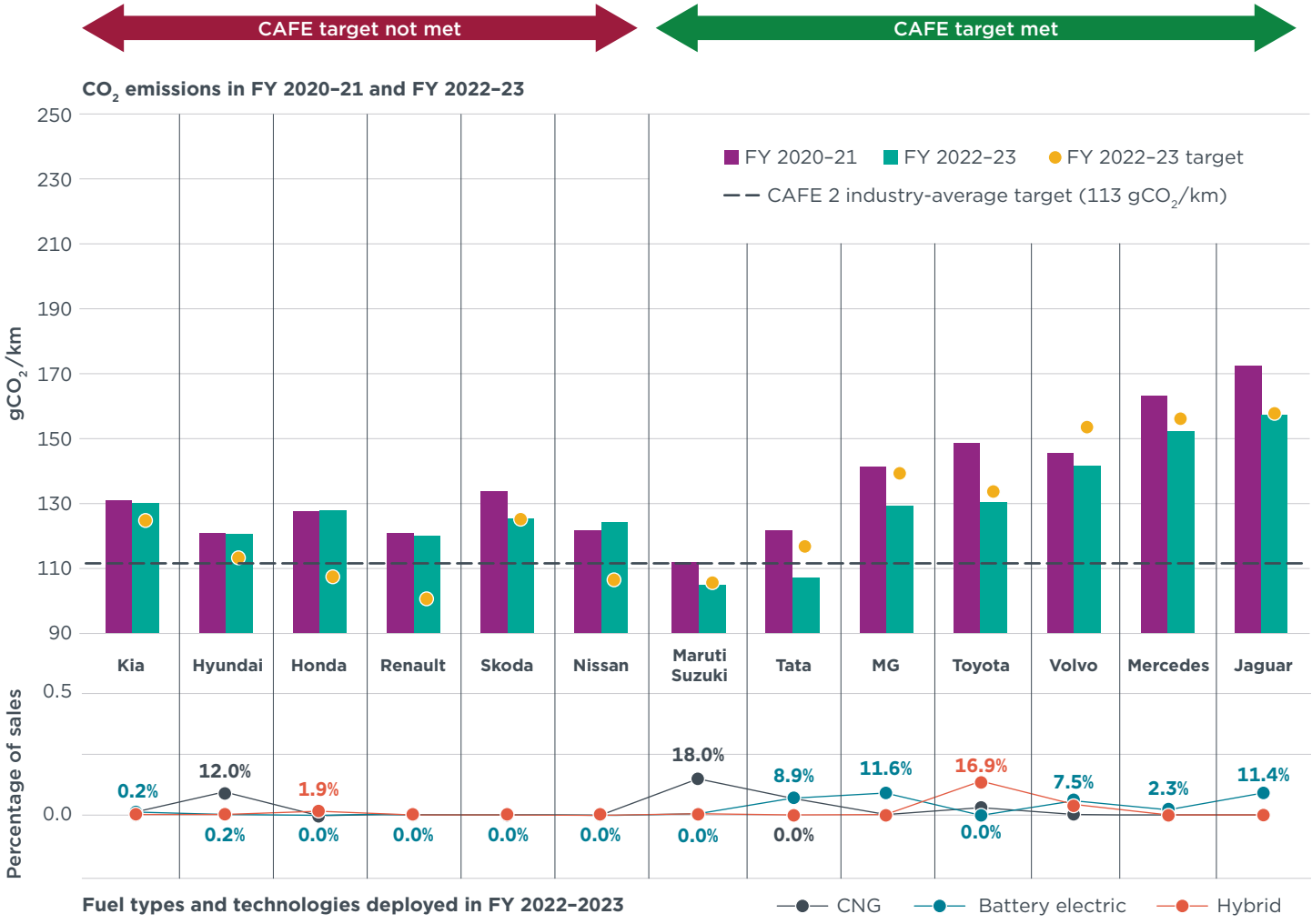
11 Ashok Deo and John German, *Fuel Consumption from New Passenger Cars in India: Manufacturers' Performance in Fiscal Year 2020–21* (International Council on Clean Transportation, 2021), https://theicct.org/publication/fuel-consumption-from-new-passenger-cars-in-india-manufacturers-performance-in-fiscal-year-2020-21/.

CAFE STANDARDS AND EV ADOPTION

CAFE 1 regulations lacked stringency, limiting manufacturers' adoption of fuel-efficient technologies in passenger cars. However, the heightened stringency of CAFE 2—requiring a 13% reduction in fleet-average emissions—compelled manufacturers to explore diverse technologies to meet CAFE targets. Among these, compressed natural gas (CNG), battery electric, and hybrid technologies were employed across fleets to achieve compliance.

Figure 3 compares the CO_2 performance of major manufacturers between FY 2020–21 and FY 2022–23, a critical juncture for manufacturers to strategize product portfolios to align with CAFE 2 targets of 113 gCO_2/km. Manufacturers that refrained from adopting any technology failed to meet CAFE 2 targets, as did those that relied solely on CNG fuel. However, hybrid vehicle technology aided some manufacturers to meet targets. By leveraging EVs, manufacturers Tata and MG comfortably met CAFE 2 targets with ample margins. This underscores the potential of EVs to serve as the primary solution for meeting future, more stringent fuel consumption targets.

Figure 3
CAFE performance of manufacturers



CASE STUDY OF THE EUROPEAN UNION

The European passenger car market shares similarities with India's regarding fuel mix, but historically, Indian cars have been smaller, lighter, and less powerful than their European counterparts. Both regions set fleet-average CO_2 emissions targets at 130 grams of CO_2 per kilometer in the first phase of their fuel efficiency standards, reflecting comparable conditions. However, Europe's fleet-average CO_2 emissions have substantially decreased over time, despite larger, heavier, more powerful vehicles.

Prior to the implementation of standards, there was a noticeable downward trend in CO_2 emissions in Europe, with an average decline of 1.9 g/km annually between 2000 and 2007, as seen in Figure 4. The introduction of CO_2 standards in 2008 marked a shift as manufacturers exceeded expectations and surpassed the required annual reduction rate of 3.6 g/km to meet the 2015 target of 130 g/km. Average CO_2 emissions decreased by 4.9 g/km per year during this period. Following the achievement of the 2015 targets, and in the absence of regulations until 2020, there was an uptick, with average CO_2 emissions rising by 0.7 g/km annually.[12]

The European Union (EU) implemented its Phase 2 target of 95 gCO_2/km in 2021. European manufacturers intensified their efforts to meet that new standard, resulting in a drop in fleet-average CO_2 emissions from 122 gCO_2/km in 2019 to 97 gCO_2/km in 2020 (Figure 4). Furthermore, the EU has adopted more stringent standards for 2025 and 2030, aiming for reductions of 15% and 55%, respectively.

EU norms have also given super credits for ZEVs when calculating the average specific CO_2 emissions: Each new passenger car emitting less than 50 g CO_2/km was counted as 2 passenger cars in 2020, 1.67 passenger cars in 2021, 1.33 passenger cars in 2022, and 1 passenger car from 2023 onward.[13] This counting method applied to the year of registration from 2020 to 2022, with a cap of 7.5 g CO_2/km over this period for each manufacturer.

Concurrently, EV sales in the EU rose from an average of 3% of new sales in 2019 to 20% in 2021. This shift positioned the EU as a global leader in EV share of new sales in 2021, demonstrating the synergy between stringent fuel efficiency targets and the promotion of EVs in the market.

12 Jan Dornoff, CO_2 *Emission Standards for New Passenger Cars and Vans in the European Union* (International Council on Clean Transportation, 2023), https://theicct.org/publication/eu-co2-standards-cars-vans-may23/.

13 Regulation (EU) 2019/631 of the European Parliament and of the Council of 17 April 2019 setting CO2 emission performance standards for new passenger cars and for new light commercial vehicles, and repealing regulations (EC) No 443/2009 and (EU) No 510/2011, OJ L 111, 13–53 (2019), http://data.europa.eu/eli/reg/2019/631/oj/eng.

Figure 4

Comparison of fleet-average CO_2 emissions of new passenger cars in India and the European Union

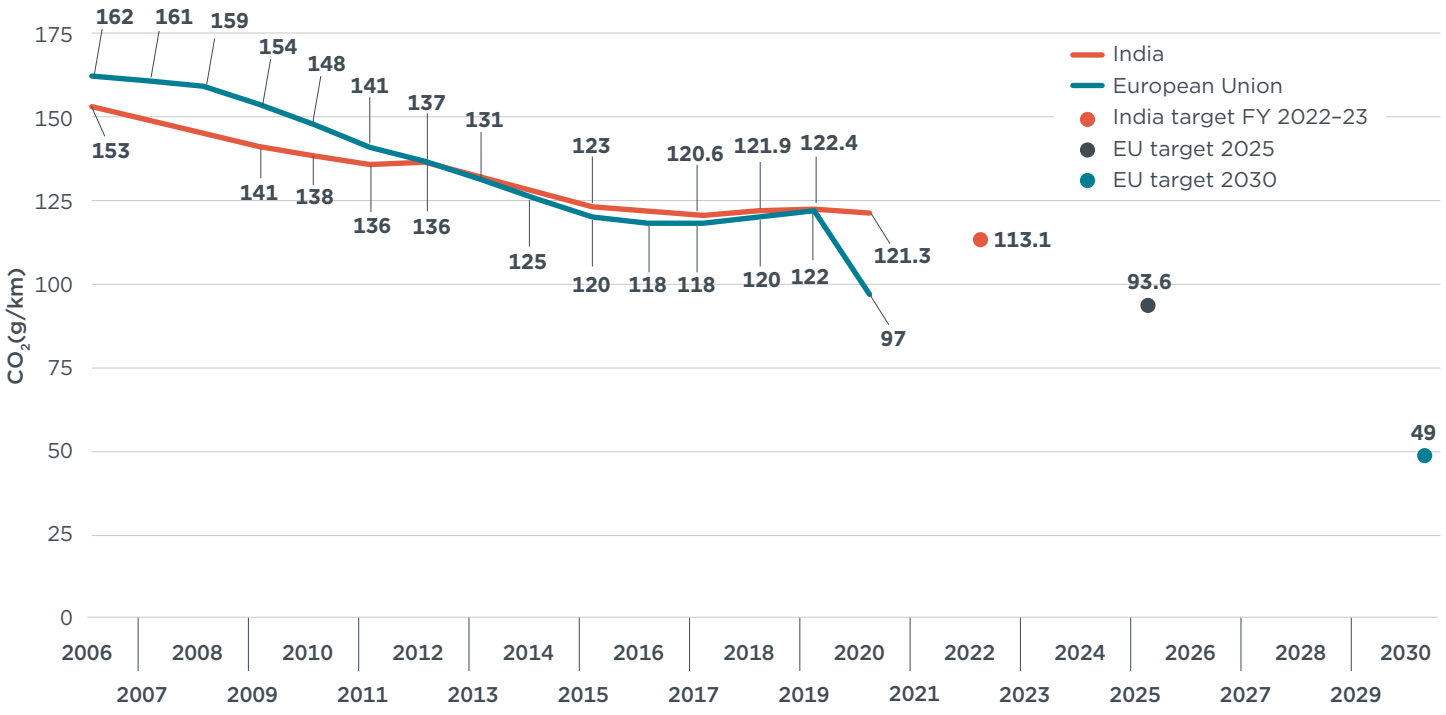


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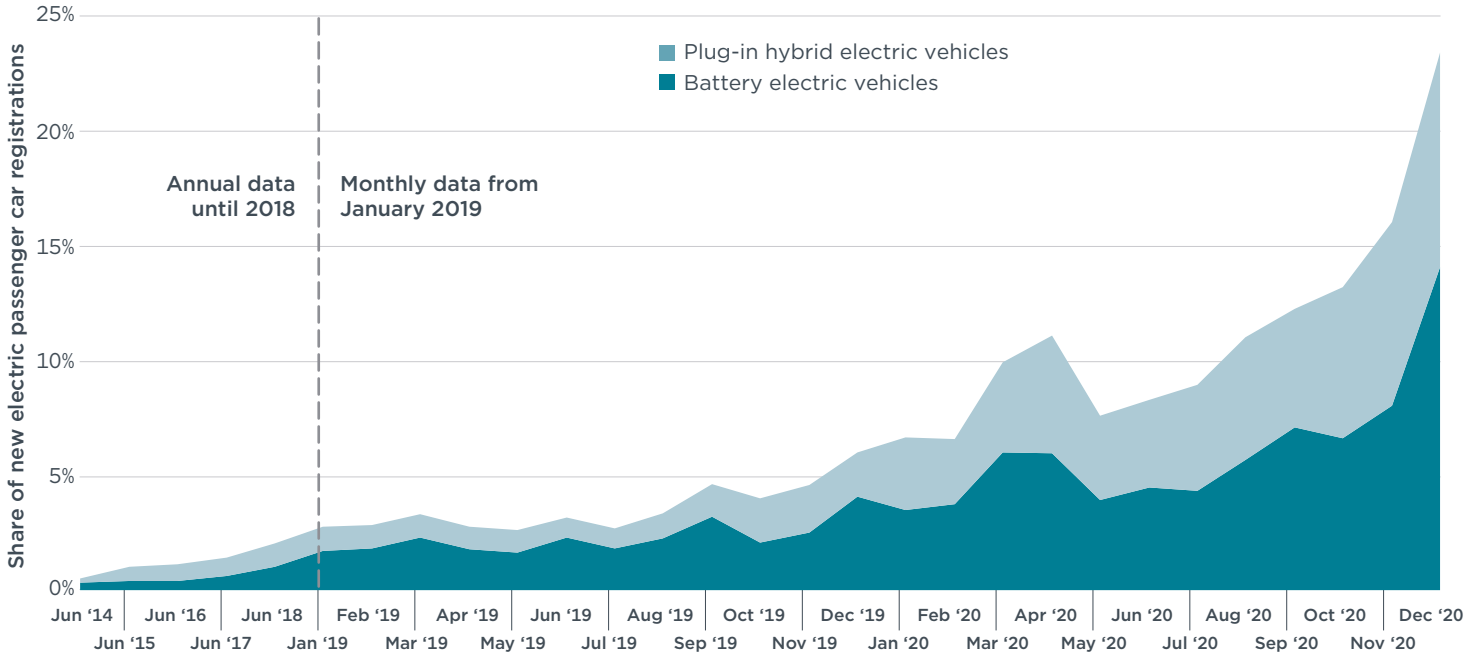
Figure 5, from a 2021 ICCT study, shows the evolution of EV sales in the passenger car segment in the EU.[14] From 2018–2021, the combined share of BEVs and PHEVs in new passenger car registrations rose from 1.4% to 20%, despite fluctuations due to COVID-19. This growth is attributed to stricter CO_2 emission standards, which will transition from 130 g/km in 2019 to 93.6 g/km in 2025 and 49 g/km in 2030 under the New European Drive Cycle's replacement, the more accurate Worldwide harmonized Light vehicles Test Procedure (WLTP).[15]

14 Sandra Wappelhorst et al., *Europe's CO_2 Emission Performance Standards for New Passenger Cars: Lessons from 2020 and Future Prospects* (International Council on Clean Transportation, 2021), https://theicct.org/publication/europes-co2-emission-performance-standards-for-new-passenger-cars-lessons-from-2020-and-future-prospects/.

15 Jan Dornoff, Victor Valverde Morales, and Uwe Tietge, *On the Way to 'Real-World' CO_2 Values? The European Passenger Car Market after 5 Years of WLTP* (International Council on Clean Transportation, 2024), https://theicct.org/publication/real-world-co2-emission-values-vehicles-europe-jan24/.

Figure 5

Share of EVs in new passenger car sales in the 27 EU Member States and the United Kingdom



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In March 2023, the EU adopted an amendment to its CO_2 standards for light-duty vehicles with a zero-emission target for all cars and vans newly registered from 2035 onward. This was part of the European Commission's Fit-for-55 package, a series of regulations intended to reduce EU greenhouse gas emissions by at least 55% in 2030 compared with 1990 levels. The new standards are meant to ensure the EU can achieve climate neutrality by 2050, as required by the European Climate Law.[16]

FLEXIBILITY MECHANISMS AND THE CARBON MARKET

Flexibility mechanisms in European and U.S. fuel consumption standards provide important avenues for manufacturers to meet regulatory targets while accommodating diverse market conditions and technological advancements. In Europe, flexibility mechanisms such as banking (carrying forward credits from over-compliance to future years), trading (buying and selling credits between manufacturers), and pooling (forming pools to combine emissions of multiple manufacturers) can enable manufacturers to meet CO_2 targets more cost effectively. These mechanisms promote innovation and efficiency improvements while ensuring compliance with stringent regulations.

Similarly, in the United States, flexibility mechanisms like credit banking and trading enable manufacturers to offset excess emissions by purchasing credits from other manufacturers or carrying forward credits from previous compliance periods. This fosters innovation and incentivizes investment in cleaner technologies while maintaining regulatory compliance. Overall, flexibility mechanisms in both the Europe and the United States offer manufacturers the opportunity to navigate evolving market dynamics and regulatory requirements while promoting sustainable practices and driving progress toward emissions reduction goals.

16 Dornoff, *CO_2 Emission Standards*.

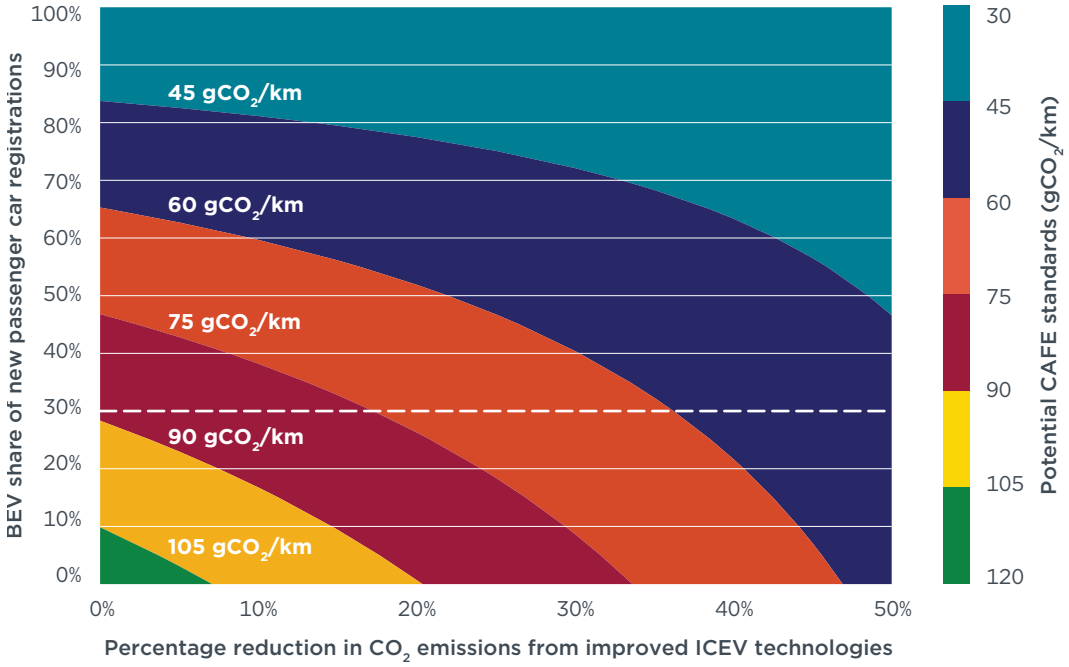
STRINGENT CO_2 STANDARDS AND EVS

India has set a national goal of 30% BEV sales by 2030. CAFE standards could effectively support the adoption of BEVs in passenger car fleets. The Bureau of Energy Efficiency has released a draft proposal of fuel efficiency norms for CAFE 3 for the 5 years between 2027 and 2032 and CAFE 4 for the 5 years between 2032 and 2037.[17] The proposed regulation is based on the WLTP and an industry average unladen vehicle weight of 1,170 kg.

A recent ICCT study also examined the potential effect of different stringency limits toward achieving the 30% BEV goal by 2030. The results are summarized in Figure 6.[18] Achieving a 30% BEV share of the passenger car market is possible with a fleet-average target of 90 gCO_2/km. Manufacturers could meet this standard by making 30% of their fleets BEVs while not making any improvements in their ICEVs. To reach a 30% BEV sales share, along with efficiency improvements of ICEVs, the standard can be even more stringent. The dotted horizontal line in Figure 6 highlights that the 30% BEV sales share, along with ICEV improvements, can meet standards ranging from 75–90 gCO_2/km. The precise range hinges on the percentage decrease in CO_2 emissions in ICEVs by 2030 from improvements in technology. This insight underscores potential sustainable transportation pathways practices in coming years.

Figure 6

Impact on 2030 BEV sales of potential CAFE 3 standards for the passenger car segment



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17 "Inviting comments on the proposal of Future Fuel Efficiency Norms i.e. CAFE-III & CAFE-IV norms," Bureau of Energy Efficiency, accessed on June 10, 2024, https://beeindia.gov.in/sites/default/files/2024-06/Inviting%20Comments%20on%20Proposal%20of%20Future%20CAFE%20-%20III%20and%20IV.pdf.

18 Ashok Deo and John German, *Costs and CO_2 Emissions Reduction Benefits of Potential Phase 3 Fuel Consumption Standards for India's Passenger Vehicles* (International Council on Clean Transportation, 2023), https://theicct.org/publication/ldv-india-co2-emissions-reduction-phase3-jun23/.

THE WAY FORWARD: LONG-TERM FUEL EFFICIENCY ROADMAP, STRINGENT TARGETS, AND WLTP

As the industry is currently implementing CAFE 2 standards, it is imperative to establish a framework for ambitious targets for 2027 and 2032. These targets should be communicated to passenger car manufacturers well in advance so they can devise compliance strategies.

CAFE standards are seen as a key driver toward achieving India's 30% BEV sales goal by 2030. Recent ICCT research explored what level of stringency in upcoming CAFE standards would be required to meet this national goal.[19] The 30% BEV sales share is attainable by a more stringent target of 75–90 gCO_2/km, which would encourage manufacturers to produce and sell more EVs while also improving the efficiency of ICEVs. These standards indicate the potential pathways toward sustainable transportation practices by 2030.

Rapidly declining battery prices are expected to make EVs more affordable across all segments after 2032. In the interim, super credits incorporated into CAFE standards can help boost BEV sales. However, to achieve the 30% BEV national goal, India could consider eliminating super credits for hybrid electric vehicles, reducing super credits for PHEVs, and phasing out all super credits by 2032.

Additionally, as norms tighten, laboratory testing methods could be made more rigorous to deliver accurate measures of fuel efficiency performance. The Bureau of Energy Efficiency's draft proposal aims to narrow the gap between certified emissions and real-world performance by basing CAFE 3 and CAFE 4 standards on WLTP test cycles.

As part of the standards-setting process, India could consider evaluating the potential benefits and impacts of using the WLTP for both fuel efficiency regulations and EV programs. More accurate data for on-road emissions and fuel efficiency could provide consumers with information to guide purchasing decisions, a key factor in speeding the transition to zero-emission vehicles.

19 Deo and German, *Costs and CO_2 Emissions Reduction Benefits*.

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