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WORKING PAPER

THE CASE FOR A ZERO EMISSION VEHICLE OBLIGATION IN INDIA

DEEPAK RAJAGOPAL*,# AND NARAYAN GOPINATHAN*

* UCLA Institute of the Environment and Sustainability, rdeepak@ioes.ucla.edu
# India Energy & Climate Center (IECC), UC Berkeley
Energy Markets and Policy Group, Lawrence Berkeley National Laboratory

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ABSTRACT

Public policies to replace fossil-fuel based internal combustion engine vehicle (ICE) with zero emission vehicle (ZEV) technologies such as battery electric vehicles (BEV) and hydrogen fuel cell vehicles (FCEV) are fast becoming commonplace worldwide. The two main types of policies being employed to help ZEVs overcome market failures and barriers to their adoption are subsidies and obligations on automakers to meet annual targets for ZEV sales. India currently has multiple types of subsidies for ZEVs, most notably through the FAME policy and the National Green Hydrogen mission as well as a large rebate on sales tax for ZEVs in addition to rebates on income tax and subsidies at the state government level. However, while India has declared ambitious goals for ZEV adoption by 2030, no binding obligations on automakers exist without which suggest there is no real cost to not achieving those national goals. Here we discuss how binding ZEV obligations on automakers might complement a purely subsidy-based approach and help India achieve its goals and to ZEV adoption. Beyond that it can help bring certainty for investors and a scale to production that can help drive down cost of ZEVs and the need for subsidies. We do not recommend any specific target level for ZEV, nor do we suggest a specific timeline for phasing out internal combustion engine vehicles. We simply provide theoretical reasons as well as arguments based on actual experience from around the world with respect to adoption of renewable energy, specifically, solar and wind, biofuels and BEVs, which reveals that when these technologies have seen rapid growth, one finds that binding obligations on producers of fossil fuels or automobiles have been used alongside subsidies. Furthermore, India has a history of using obligations for clean technology to improve energy security and reduce emissions of air pollution and greenhouse gases. Given this context, and since subsidies are costly, an obligation for sales of ZEVs could be a policy that can lead to greater effort and commitments from OEMs to drive down the cost of ZEVs and make them more attractive to consumers. To help auto OEMs meet these obligations, a suite of complementary policies such obligations on large commercial fleets such as ridesharing and taxi fleets and freight operators to procure ZEVs, obligations on fossil fuel companies to invest in charging or Hydrogen fueling infrastructure, and directing more subsidies for creation of a robust charging and fueling infrastructure are also recommended.

EXECUTIVE SUMMARY

Zero emission vehicles (ZEVs)# such as battery electric vehicles and hydrogen fuel electric vehicles (FCEVs) have now emerged as the key technologies to simultaneously reduce oil consumption and imports, greenhouse gas emissions and air pollution from transportation. Many governments worldwide have adopted aggressive timelines for ZEV adoption or phase outs of sales of internal combustion engines (ICE) vehicles while many major global automakers have made voluntary commitments to stop production of ICEVs and transition to ZEVs over the next decade or two. For example, the European Union has legislated an end to the sale of cars and vans that emit CO2 by the year 2035.[1] Similarly, a group of six leading automakers – Ford, GM, Mercedes-Benz, Volvo, Jaguar Land Rover and BYD – has made a pledge to end the sale of combustion vehicles by 2035 "in leading markets" and in 2040 globally.[2]

The Government of India (GoI) also has declared ambitious targets for ZEV adoption - 30% of private car sales, 70% of commercial car sales, and 80% of two and three-wheeler sales by 2030.[3] In support of these targets, multiple forms of subsidies and incentives are being provided by both at the central and state government levels. The largest subsidy in terms of total budget outlay is the GoI's ₹10,000 Crore (~ USD 1.25 Billion) Faster Adoption and Manufacturing of Hybrid and Electric Vehicles Phase II (FAME II) which was adopted in 2019. When compared to ZEV policies worldwide, FAME II is unique and innovative in that it prioritizes public transit buses and 2- and 3- wheelers. This is well justified from equity perspective given these three modes of transport are used primarily by the lower-and middle-income households. Consequently, EVs in these segments have seen an increase in sales but FAME is scheduled to end in 2024.

On the other hand, three other segments - light duty vehicles (passenger cars and sports utility vehicles whose sales are growing at a rapid pace), private buses (which account for over 75% of the bus fleet), and the commercial medium- and heavy-duty

ZEV simply refers to vehicles with zero tail-pipe emissions and not zero lifecycle emissions which is a more complete measure of the overall environmental footprint of a technology. Lifecycle emissions refers to emissions associated with everything from production of raw materials used in making of vehicle components and energy for driving through management of vehicle post its useful life.

1 European Commission. Zero emission vehicles: first 'Fit for 55' deal will end the sale of new CO2 emitting cars in Europe by 2035. 28 October 2022. https://ec.europa.eu/commission/presscorner/detail/en/IP_22_6462

2 Caleb Miller. Six Major Automakers Agree to End Gas Car Sales by 2040. Car and Driver. Nov 10, 2021. https://www.caranddriver.com/news/a38213848/automakers-pledge-end-gas-sales-2040/

3 India's Electric Mobility Transformation. NITI Aayog and Rocky Mountain Institute.

vehicles together account for the vast majority of oil consumption and pollution from road vehicles today. For ZEVs in these segments, the main form of support is the rebate on the goods and services tax (GST) - 5% for ZEV compared to 28% for ICE, which is effectively a rebate of ₹2 Lakhs or more (or approx. 15% of the retail price or more) per ZEV. The foregone GST together with the foregone central excise and state value-added taxes from avoided petrol and diesel use together amount to a substantial total subsidy for ZEVs. But despite these subsidies, ZEVs are priced higher than ICE, and consequently ZEV adoption in the LDV segment is low (with electric vehicles making up only 1.1% of LDV sales),[4] and practically non-existent in the market for private buses and commercial trucks. Even with respect to buses, the total subsidy under FAME II for buses can at most replace only about 3% of the state-owned public transit bus fleet and less than 1% of the India's bus fleet. Therefore, if India is to achieve its own stated ZEV goals and achieve meaningful reductions in oil consumption, oil imports and GHG emissions, there is a need for strengthening the policies for ZEV adoption in these segments while continuing to increase adoption in the public transit fleet, 2- and 3-wheelers where it is slow.

In this context, and since the GoI is in the planning stages for the next phase of ZEV policies beyond FAME II, this report develops the case for a binding ZEV Obligation (ZEVO) on original equipment manufacturers (OEM) of automobiles. A ZEV Obligation (ZEVO) is a policy under which a government (national or state/provincial) requires automakers to ensure that a certain share of their sales within the jurisdiction be comprised of ZEVs. In some parts of the world, ZEVO has been used with great success to develop the ZEV market in markets such as California and China.[5] [6] We lay out arguments as to why ZEVO needs to become the primary instrument to drive ZEV adoption with the various types of subsidies (such as GST rebates, income tax credit for interest payments on ZEV financing), serving to mitigate any increase in cost to automakers and consumers rather than relying solely on subsidies as is the case today. We suggest that future subsidies especially for heavy-duty vehicles, which indeed require targeted subsidies, but generally subsidies to all vehicle segments be provided in alongside binding ZEV obligations. We provide some innovative additional strategies to reduce both compliance costs and subsidies.

The responsibility of ZEVO compliance should fall auto OEMs, who would be obligated to sell a stipulated share or number of ZEVs each year or pay penalties for non-compliance (more details in the report). Under ZEVO, when consumers are unwilling to pay more for ZEV (relative to ICE), OEMs will be compelled to innovate and better market ZEVs to customers.

4 Surajeet Das Gupta. EV penetration: At 1.1%, India is far behind Asian average of 17.3%. Business Standard. 17 May 2023. https://www.business-standard.com/economy/news/ev-penetration-at-1-1-india-is-far-behind-asian-average-of-17-3-123051701196_1.html.

5 Shikha Rokadiya and Zifei Yang. Overview of global zero-emission vehicle mandate programs. International Council on Clean Transportation. April 2019.

6 Simon Sharpe. Five Times Faster. Chapter 23: From Oil to Electric Vehicles.

The suite of options they could pursue – i) reducing cost of production by making bigger investments which bring economies of scale and learning-by-doing (which happens with scale for new technologies);[7] ii) reducing the margin they make on ZEV; iii) purchase credits from firms that have sold more ZEVs than they are obligated to or simply pay the penalties and then either absorb these costs or pass them on to ICE customers which will raise ICE prices and makes ZEVs more attractive.

The ZEVO thus acts as an implicit tax on ICE industry and an implicit subsidy for the ZEV industry. But unlike a subsidy whose impact on public finances is direct and transparent, the effect of a ZEVO will be indirect and less tangible affecting tax revenues through its impact on cost to production and consumption, which has own advantages and disadvantages from political and economic perspectives. ZEVOs can accomplish the goals of subsidizing ZEVs and taxing polluting technologies with less direct burden on public finances relative to subsidies. But given that there exist various types of subsidies for ZEVs and that more might be needed (especially for trucks and for charging infrastructure), the added burden of ZEVO on automakers is not likely to be burdensome and can be mitigated through complimentary strategies (more below). At the same time, a binding ZEVO with penalties for non-compliance will provide clarity and certainty about GoI's intentions and encourage the private sector to undertake larger investments that can bring scale and reduce cost of production. Targets that are not binding and attract no serious penalty will tend to be interpreted by industry as not warranting major commitments to transition away from ICE thereby keeping ZEVs costlier than ICE and dependent on subsidies which is unsustainable.

As such, ZEVO is more equitable than subsidies but any remaining concerns about their impact on vehicle prices can be mitigated easily. For instance, if policymakers are concerned that the ZEVO would make it harder for poor people to purchase their first car, they could choose to exempt the cheapest segments of the car market from the obligation. Furthermore, the poor are disproportionately affected by air pollution and climate change, and so any steps to alleviate these burdens will disproportionately benefit them. As ZEV technology improves and cost curves come down. ZEV obligations can be set at any level according to the policymakers' discretion, and so these could be aligned with the targets India has already adopted. The most ambitious ones set increasing targets for ZEV market share for each year until reaching 100%, which would essentially constitute a phaseout of the sales of combustion vehicles for the specified class of vehicles.

Policymakers can adopt complementary steps to assist the ICE industry with compliance and reduce the political opposition from the OEMs. One strategy is to complement ZEVO on OEMs with obligations on owners or operators of large commercial fleets of cars (such

7 Chandan Bhardwaj, Jonn Axsen, and David McColllum. How to design a zero-emissions vehicle mandate? Simulating impacts on sales, GHG emissions and cost-effectiveness using the Automaker-Consumer Model (AUM). Transport Policy. March 2022. https://www.sciencedirect.com/science/article/pii/S0967070X21003656

as Uber or Olacabs) and trucks (such as freight service providers) to procure a fixed share of ZEVs. Since commercial vehicles are used more intensively than private vehicles can realize quicker financial payback and lead to greater reduction in oil use and pollution per vehicle. An obligation on such fleets can help OEMs target ZEV sales to this segment. An example of such a policy is the California Clean Miles Standard, which requires rideshare companies that operate in California to increase the share of passenger-miles traveled using zero-emissions means.[8]

A second complementary policy is to enact a low-carbon fuel standard (LCFS), which would require that transportation fuel in India decrease its carbon intensity over time. This would discourage the use of petrol and diesel, and encourage the use of biofuels, hydrogen, and electricity. Under an LCFS, those who sell fossil fuels would have to purchase LCFS credits, which could be sold by anyone who sells a low-carbon transportation fuel, such as electricity, hydrogen, or biofuels.[9] This would be an extra stream of revenue for those vendors, thus providing an extra incentive to induce investment in the low-carbon transportation industrial ecosystem. In California, the low-carbon fuel standard policy has a provision for "fixed guideway" systems such as electric rail based public transit systems to sell LCFS credits.[10] Since the Indian rail network is almost entirely electric, this can be an additional source of revenue for urban metro systems, which are undergoing rapid development in India, as well as for Indian Railways, which will face budgetary constraints as the country shifts away from the use of coal which currently constitutes the rail network's biggest source of revenue.[11]

A third complementary strategy could be an obligation on oil marketing companies to make available charging or fueling infrastructure for ZEVs. This is akin to the obligation on regulated and government-owned power distribution companies to procure renewable energy from solar and wind power projects through the policy of renewable purchase obligations (RPOs).[12]

A fourth strategy is to provide greater subsidies for the creation of robust charging infrastructure, which is currently lacking in India and poses a major barrier to ZEV adoption.[13] A number of surveys of potential ZEV adopters suggests a good battery charging or H2 refueling infrastructure increases the willingness to adopt ZEVs and this is especially true for commercial adopters for whom the fuel cost savings accrue fast given the higher vehicle usage.

8 California Air Resources Board. Clean Miles Standard. https://ww2.arb.ca.gov/our-work/programs/clean-miles-standard

9 Low-Carbon Fuel Standard. California Air Resources Board. https://ww2.arb.ca.gov/our-work/programs/low-carbon-fuel-standard/about

10 BART Low carbon fuel standard policy. https://www.bart.gov/sites/default/files/docs/BART%20LCFS%20Policy_2017_adopted.pdf

11 Yuthika Bhargava. Coal is railways' cash cow – why India's climate goals post risk for transporter. The Print. 21 June 2023. https://theprint.in/india/governance/coal-is-railways-cash-cow-why-indias-climate-goals-pose-risk-for-transporter/1634060/

12 Renewable Purchase Obligation. Ministry of New and Renewable Energy, Government of India. https://rpo.gov.in/Home/Objective

13 Accelerating transport electrification in India by 2030. JMK Research & Analytics.

India has a history of using obligations on corporations to achieve social and environmental progress. The government of India has set a Renewable Purchase Obligation (RPO) to require electricity distribution companies to purchase renewable energy as a share of their electricity consumption and this proving successful.[14] Likewise, emissions norms have been successfully used to vehicle tail pipe emissions. A ZEV obligation would therefore not be unprecedented from a political economic standpoint and provide an enormous fillip for ZEVs. In conclusion, ZEVOs can help India achieve its ambitious targets for reduction in both oil use and emissions faster and at a lower cost to both the taxpayer and poorer households and the logical next addition to the clean energy and climate policy ecosystem in India.

14 Ministry of New and Renewable Energy. Renewable Purchase Obligation. https://rpo.gov.in/Home/Objective

1. INTRODUCTION

India, like most nations, remains heavily reliant on imported petroleum for transport. This contributes to the impacts of air pollution in India. India is the world's second most polluted country. Fine particulate pollution reduces the life expectancy of the average Indian by 5.3 years, compared to what it would be if the WHO guidelines for air quality were met. For residents of India's capital, air pollution shortens lifespans by 11.9 years.[15] India's petroleum reliance also contributes to its greenhouse gas emissions. One of the world's largest emitters, it was rated as highly insufficient by the Climate Action Tracker. As the impacts of global warming become more severe, the need to reduce emissions is clear.[16] In addition to the environmental impacts, this also contributes to macroeconomic concerns, and geostrategic risks. For this reason, many nations are developing strategies to reduce their reliance on petroleum. As a consequence, public policies to replace fossil-fuel based internal combustion engine vehicles (ICE) with zero emission vehicle (ZEV) technologies such as battery electric vehicles (BEV) and hydrogen fuel cell electric vehicles (FCEV) are now fast becoming commonplace worldwide. With pollution pricing still generally politically unpopular worldwide, the primary approach to help ZEVs overcome market failures and barriers to their adoption is different forms of subsidies. India is no exception and has adopted policies such as FAME and National Green Hydrogen mission which are both based on subsidizing BEVs and Hydrogen. The aim of this work is to discuss the rationale for adoption of ZEV obligations both in the context of India and more generally. By ZEV obligation (ZEVO) we refer to a regulation that requires obligated parties, in this case automakers[17], to produce or sell either a fixed number or a fixed share of ZEVs each year. The term obligation itself refers to a broad category of regulations ranging from more to less prescriptive, which we discuss later. We do not discuss the optimal stringency of a ZEVO for India here but instead focus only on the theoretical and empirical rationale for adopting such a regulation.

While policies supporting ZEVs have been in place for more than two decades in some places, such efforts have intensified in the last few years due to breakthroughs in battery technology and a rapid rise in interest in Hydrogen as an alternative form energy storage because of its superior energy density and relatively limited need for scarce minerals and metals. Global battery prices have declined at such a rate that BEVs are projected

15 India - Air quality life index. https://aqli.epic.uchicago.edu/country-spotlight/india/

16 India - Climate Action Tracker. https://climateactiontracker.org/countries/india/

17 In principle, the statutory incidence of any policy could be either on producers or consumers in a market. In the case of vehicle obligations, the point of regulation has been automakers as the number of firms to be regulated will be in the tens as opposed to millions if the point of regulation is consumers or retailers who may be in the thousands. On the other hand, in the case of a public health regulation such as vaccine obligation it is logical to apply them on consumers as opposed to vaccine makers.

to reach upfront cost parity with ICEVs in some segments in select markets by 2025[18] which reduces the cost of mandating such technologies. These developments in turn are attracting bigger investments that are unleashing a mutually reinforcing cycle of increasing scale and cost reduction.[19] A similar pattern of policy-driven increase in adoption has been documented in the case of solar photovoltaic systems. This virtuous cycle of learning by doing has proven effective at scaling up markets for many clean technologies.

18 Nic Lutsey and Michael Nicholas. Update on Electric Vehicle Costs in the United States through 2030. International Council on Clean Transportation. April 2, 2019. https://theicct.org/publications/update-US-2030-electric-vehicle-cost

19 Argus Media. Large lithium battery plants to dominate capacity. 28 March 2019. https://www.argusmedia.com/en/news/1874627-large-lithium-battery-plants-to-dominate-capacity

2. CURRENT POLICIES FOR ZEVS IN INDIA

India has a long history of using obligations and similar policies to foster a shift towards clean technology to reduce emissions of air pollution and greenhouse gases. In the power sector, Renewable Purchase Obligations that require power distribution companies to procure a given share of renewables are playing a role in the growth of solar and wind power. In the auto sector, India has enacted aggressive standards on tailpipe emissions through the Bharat Stage norms, and for energy efficiency through the Corporate Average Fuel Economy (CAFE) norms, which are both instances of obligations on the auto industry. In fact, the Phased Manufacturing Program (PMP) under the Faster Adoption of Manufacturing of Hybrid and Electric Vehicles Scheme (FAME) already requires domestic vehicle makers to meet mandatory targets for domestic content in their products. These policies do not directly obligation a shift to electric vehicles: the CAFE standards obligation a reduction but not an elimination of tailpipe emissions and had no penalty until 2022; while the PMP mandated a share of domestic content for vehicles that obtained subsidies through FAME. These policies are recent examples of the Indian government using obligations to shift the country's automotive market towards cleaner technologies to meet environmental, economic, and geostrategic goals.

By 2030, the government of India aims to achieve 30% sales penetration of electric vehicles for private cars, 70% sales penetration for commercial vehicles, and 80% sales penetration for 2- and 3-wheelers.[20] The principal approach to promote ZEVs currently involves targets and ambitions that are not yet binding on any party but which are backed by subsidies. In 2013, the GOI approved the FAME I program, which ran from 2015 to 2019, and spent ₹359 crore to subsidize the manufacture and purchase of 280,000 vehicles. GOI has calculated that the FAME I program has saved 50 million liters of fuel.[21] In 2019, the Cabinet of India approved the outlay of 10,000 crore (100 billion) rupees on the FAME II program, which subsidizes deployment of electric vehicles on the roads of India. The expenditure was designed to occur over the course of three years, from 2019 to 2022. This program aims to subsidize the purchase of 7,000 electric buses, 500,000 electric 3-wheelers, 55,000 electric passenger cars (4-wheelers), and one million electric scooters/motorcycles.[22]

20 Mirnal Tripathi. How realistic are India's 2030 fleet electrification targets? Down to Earth. https://www.downtoearth.org.in/blog/energy/how-realistic-are-india-s-2030-fleet-electrification-targets--88853

21 https://fame2.heavyindustries.gov.in/content/english/15_1_FAMEI.aspx

22 https://fame2.heavyindustries.gov.in/content/english/1_1_AboutUs.aspx

Under Fame II, the Government of India has tasked its state-owned oil companies to set up 7,432 electric vehicle charging stations, supported by a subsidy transfer of ₹800 crore.[23] Lack of charging infrastructure is a major barrier to electromobility in India, and for that reason India will need to drastically increase its availability of charging stations.[24] The FAME scheme is coming to a close in 2024,[25] but there are other incentives available in India for electric vehicles.

The sale of electric vehicles is subject to a reduced tax burden, as the Goods and Services Tax (GST) on the sale of EVs is only 5% compared to 28% for petrol and diesel vehicles. Furthermore, under section 80EEEB of the Income Tax Act, there are tax rebates for loan repayments of up to ₹1.5 lakh if the loan is made to purchase an electric vehicle.[26] The Production Linked Incentive (PLI) Scheme has been developed to promote the domestic manufacture of electric vehicles and their batteries.[27] Under the PLI, eligible companies receive direct payment from the GOI on incremental sales over the base year 2019-20, for a 4-6 year period.[28] India has some of the highest automobile taxes in the world. In addition to road taxes, there are heavy import duties on imported vehicles. In addition to these policies developed by the Government of India, many Indian states have developed complementary policies to accelerate the deployment of zero-emission vehicles, and these policies are described in Table 1 in the Appendix. Those policies do not constitute ZEV obligations, but they set the stage for a ZEV obligation to be implemented as a logical next step.

23 Twesh Mishra. The Economic Times. Centre gives Rs 800 crore for setting up over 7000 charging stations under FAME II. March 28, 2023. https://economictimes.indiatimes.com/industry/renewables/centre-gives-rs-800-crore-to-oil-companies-for-setting-up-over-7000-charging-stations-under-fame-ii/articleshow/99040128.cms

24 Raghav Bharadwaj. EV Infrastructure in India: What to expect by 2030. https://bolt.earth/blog/indian-ev-charging-infrastructure-by-2030

25 Govt to cut FAME-II subsidy on electric 2-wheelers from June. The Economic Times. 23 May, 2023. https://economictimes.indiatimes.com/industry/renewables/govt-cuts-fame-ii-subsidy-on-electric-2-wheelers-from-june/articleshow/100427250.cms?

26 https://navi.com/blog/section-80eeb-of-income-tax-act/

27 Govt to cut FAME-II subsidy on electric 2-wheelers from June. The Economic Times. 23 May, 2023. https://economictimes.indiatimes.com/industry/renewables/govt-cuts-fame-ii-subsidy-on-electric-2-wheelers-from-june/articleshow/100427250.cms?

28 Naina Bhardwaj. What are Production-Linked Incentive Schemes and How Will They Improve India's Manufacturing Capacity? https://www.india-briefing.com/news/what-are-production-linked-incentive-schemes-and-how-will-they-build-up-indias-manufacturing-capacity-23538.html/

3. RATIONALE FOR ZEV OBLIGATIONS

Given the high burden of air pollution in India, the increasingly clear impacts of global warming, and the macroeconomic and geostrategic reasons to reduce reliance on oil imports, it is clear that additional policies to increase the ZEV market share are warranted. Subsidies can move the market in certain directions, by providing incentives, but they cannot guarantee that any given target for ZEV penetration will be achieved. Conversely, obligations require targets for ZEV penetration to be met, regardless of cost to industry. India has set its targets for EV penetration of 30% of private car sales, 70% of commercial vehicle sales, and 80% of two- and three-wheeler sales, however, these are not binding on the industry or government to ensure these targets are realized. The subsidies provided by FAME have expanded the ZEV market in India but they have not yet come close to achieving the targets. With the cessation of FAME subsidies and the cost of relying on subsidies, the case for ZEV obligations needs a careful consideration if India is to achieve the targets it has set for reducing reliance on oil for transportation and also reducing GHG emissions from transportation, and increasing the competitiveness of the automotive manufacturing industry. Here we present different plausible justifications for ZEV obligations.

According to economic theory, if emissions are the only unpriced externality, then the most cost-effective approach to address it, i.e., the approach of least cost to achieve a given level of emission reduction, is emission pricing, which can be done explicitly through emission taxes or implicitly through tradable emissions permits. This has the effect of providing an incentive to conserve energy or switch to lower-emissions sources of energy, by increasing costs for anyone who uses fossil fuel energy. The revenue could be allocated to subsidies for zero-emissions vehicles or other low-emissions technologies, which would further the incentive for a switch. Under emission pricing the cost is borne by polluters, which are in many cases ordinary consumers who drive combustion-powered vehicles. As one would expect, pollution pricing is generally politically unpopular, and for that reason, subsidies are the most widely used policy. However, the cost of subsidies falls on the taxpayer, and subsidies provide no direct incentive for polluters to reduce emissions. Furthermore, emissions are not the only unpriced externality. There are many market failures including network effects of charging infrastructure, energy security and geopolitical risks associated with petroleum reliance, and the market power of oil companies. For these reasons, policies beyond carbon pricing are warranted to reduce the reliance of transportation on petroleum.[29]

29 Sonia Yeh and Daniel Sperling. Low carbon fuel policy and analysis. Energy Policy. May 2013. https://www.sciencedirect.com/science/article/pii/S0301421513000141

For those reasons, another strategy is to require increased shares of low-carbon technologies such as renewable energy and zero-emissions vehicles. Focused on the transportation sector, this paper will focus on ZEV obligations.

An obligation is effectively both an implicit tax on dirty technology and an implicit subsidy to clean technology. Under an obligation, the obligated party will be required to procure the clean technology and sell it at a price equal to lower than dirty technology for consumers to prefer them over the dirty alternative. This under-recovery of cost will either be absorbed by the firm selling the dirty technology or passed through to consumers of the dirty technology. Absent innovation, obligations can raise costs and lower consumption just like a tax. However, obligations reduce uncertainty and provide clarity for investment planning across the value chain, because in the presence of a ZEV obligation, investors have confidence that their product will have a market. For this reason, obligations can foster innovation, and thus have a virtuous effect of reducing costs of cleantech adoption.[30] Moreover, obligations for clean technologies have proven more politically durable than carbon pricing or subsidy policies, because the cost of obligations on the citizenry and public finances is intangible and therefore tends to generate less political resistance relative to taxes. In theory, emissions intensity standards or fuel economy standard targets each be designed such that these are stringent enough to not be satisfied simply by blending low carbon fuels such as biofuels or raising the efficiency of internal combustion engines and require automakers to sell ZEVs to achieve compliance. A theoretical argument in favor of such instruments is that these are in general technology-neutral but given that there already exist subsidies and targets for ZEVs, they hold no major advantage to a ZEV obligation.

ZEV obligations do not penalize anyone for operating an existing combustion vehicle, making it more politically palatable. However, even if they have lower total cost of operation than fossil fuel vehicles, ZEVs tend to be costlier upfront which increases the resistance of automakers to ZEV obligations. When an obligation is paired with subsidies, then ZEVs can achieve parity in terms of upfront cost as well thus reducing the cost on automakers. Thus far India has promoted EV use with subsidies through the FAME program, which will end in 2024. An obligation would guarantee a ZEV market without putting pressure on public finance. In his book “Five Times Faster”, Simon Sharpe described the ZEV obligation as the “policy that is proving more effective than any other” in increasing ZEV market share, because they increase ZEV production in the most direct manner possible, by forcing each manufacturer to increase its share of ZEVs in its vehicle fleet.[31] Manufacturers can accomplish this by cross-subsidizing ZEVs – they raise the price of combustion powered vehicles and use the profit to subsidize ZEVs. Thus, an obligation can function like a subsidy without the burden on public finances.

30 Jonn Axsen, Scott Hardman, Alan Jenn. What do we know about Zero-Emission Vehicle Obligations? Environmental Science and Technology, 2022.

31 Simon Sharpe. Five Times Faster. Chapter 23: From Oil to Electric Vehicles.

ZEV obligations, also known as ZEV mandates, have been instrumental in fostering the development of the market for battery-electric vehicles. The California Air Resources Board issued the first ZEV mandate in 1990, but it had to walk that back because ZEV technology was not mature at that time. However, they continued in their determination to mandate a share of zero-emission vehicles, and they did later impose binding ZEV obligations.[32] At a federal level, the US has subsidies and tax credits for ZEVs, but has never implemented a ZEV obligation. The state of California has adopted a ZEV obligation and several other states have chosen to align with their standards. Several states including California also have provided purchase incentives for ZEVs.[33] The California ZEV obligation has existed in various forms since 1990, and though proving causality is difficult, it fostered technological innovation and development. When the obligation was first issued, it led to increased R&D activity and patent filings.[34]

The country with the world's highest ZEV market share is Norway. It has implemented obligations, incentives, and other policies to increase the ZEV market share. It has implemented many policies that restrict the use of cars, and exempted ZEVs from them, to create an incentive for ZEV use.[35] Norway's BEV policies would not have worked without advances in BEV technology abroad, which were induced in part by the ZEV obligation in California.[36]

The world's largest market for ZEVs is China, which has used ZEV mandates to increase the ZEV market share. The country has used obligations and subsidies to increase its market share for new energy vehicles (NEVs), which include plug-in hybrid, battery electric, and hydrogen fuel cell vehicles. By the end of 2020, China had put 4.92 million NEVs on the road and these accounted for more than 50% of the global total.[37] It has increased its NEV market share to almost 20% in 2022, and up to 35% in 2023, with full electric vehicles making up 24% of the country's auto sales.[38] China's NEV mandate policy is a based off of California's ZEV mandate policy, and specifies annual percentage targets for NEV credits.[39]

India, with a low per capita income, has taken action to subsidize zero emission vehicles, with its National Electric Mobility Mission Plan and FAME policies, but it has not implemented a ZEV obligation.[40]

32 Virginia McConnell, Benjamin Leard, and Fred Kardos. California's Evolving Zero Emission Vehicle Program: Pulling New Technology into the Market. Resources from the Future. November 2019.

33 US State Clean Vehicle Policies and Incentives. Center for Climate and Energy Solutions. https://www.c2es.org/document/us-state-clean-vehicle-policies-and-incentives/

34 Scott Hardman, et al. Driving the Market for Plug-in Vehicles: Understanding ZEV Obligations. UC Davis International EV Policy Council.

35 Norway EV policy. https://elbil.no/english/norwegian-ev-policy/

36 Erik Figenbaum. Perspectives on Norway's supercharged electric vehicle policy. Environmental Innovation and Social Transitions. https://www.sciencedirect.com/science/article/pii/S2210422416301162

37 China's New Energy Vehicle Industrial Development Plan for 2021 to 2035. ICCT Policy Update. June 2021.

38 Jose Pontes. 35% Plugin Vehicle Market share in China. https://cleantechnica.com/2023/07/05/35-plugin-vehicle-market-share-in-china-china-ev-sales-report-2/

39 CHINA'S NEW ENERGY VEHICLE OBLIGATION POLICY. ICCT Policy Update. January 2018.

40 Pankaj Goyal. The Times of India. EV policies in India. https://timesofindia.indiatimes.com/blogs/voices/ev-policies-in-india/

If it implements a ZEV obligation, then it can increase its ZEV market share just like the aforementioned countries have done. The graphs in Figure 1 show the increasing market shares of battery electric vehicles in various markets along with the policy interventions.

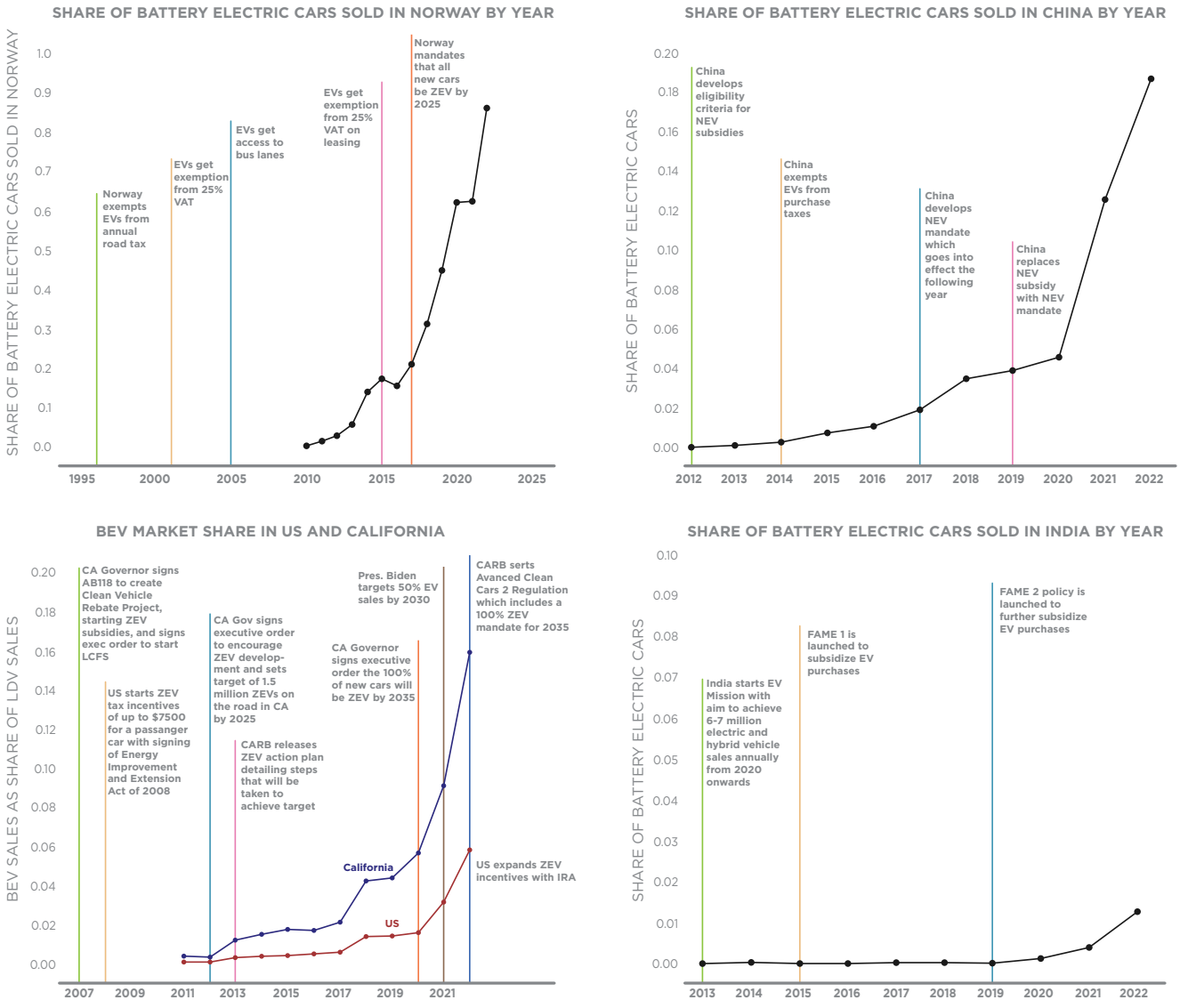

Figure 1: Timeline of policies and growth in battery electric vehicles in Norway, China, the US and California, and India. These data do not include other ZEV technologies such as fuel cell or plug-in hybrid vehicles, which have lower market shares than battery electric vehicles. They focus on the light-duty sector, leaving aside the obligations that California has set for trucks. They show that the ZEV market share is responsive to policy interventions. Note the different y-axes.

Aside from zero-emission vehicles, obligations for other clean technologies have successfully increased their market shares and enabled rapid development of new technologies. For example, renewable energy portfolio standards have led to increased deployment of solar and wind energy in many countries around the world. Germany's 2000 Renewable Energy Law and feed-in tariff stimulated the development of wind energy technology, and enabled Germany to attain a high share of wind energy in its grid. Though the feed-in tariff does not directly obligation a specific market share of renewable energy, it did obligation that consumers purchase renewable energy at a specific price. The country has since passed more binding obligations and targets to increase its renewable energy market penetration, in accordance with its plan for net zero emissions which was published in 2016. In 2017, the feed-in tariff was replaced by a system of auctions for renewable energy.[41] France and Germany are both subject to the same EU policies, such as carbon pricing and renewable energy obligations, but France has not set as many policies that specifically target the development of renewable energy. Despite its low penetration of renewable energy, France has among the lowest per capita emissions of advanced economies due to its reliance on nuclear power.[42] In 2022, though, France did set out a plan to invest €1 billion in renewable energy, increasing renewable installed capacity by ten times. Offshore wind would represent 40% of this capacity.[43] These policies are depicted in the graphs in Figure 2.

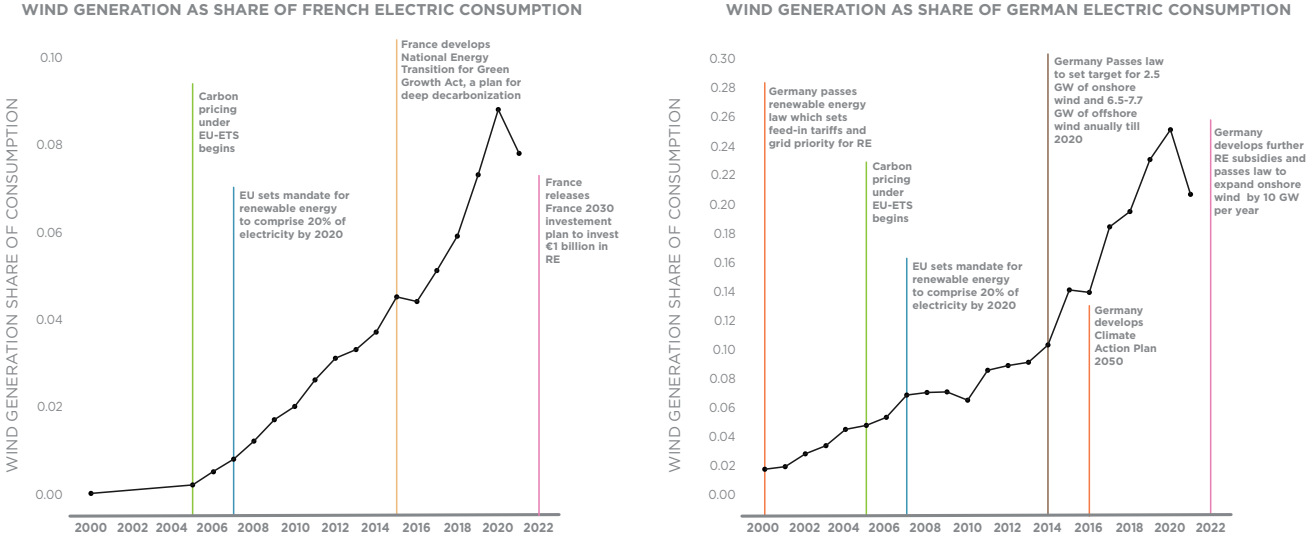

Figure 2: Wind energy generation in France and Germany. Note the different y-axes. These show that Germany's subsidy and obligation policies have increased the market share of wind energy compared to France, which is subject to the same EU policies and trends in technology development.

41 Julian Wettengel. Clean Energy Wire. A (very) brief timeline of Germany's Energiewende. https://www.cleanenergywire.org/factsheets/very-brief-timeline-germanys-energiewende

42 IEA. France executive summary. https://www.iea.org/reports/france-2021/executive-summary

43 IEA. France 2030 investment plan. https://www.iea.org/policies/15025-france-2030-investment-plan-investment-in-renewable-energy-innovation

Similarly, Germany has used policies to foster the development of solar energy technology. Germany was one of the first countries to develop a serious market for photovoltaic solar panels, when it started its feed-in tariff and grid priority for renewable energy as part of its Renewable Energy Law in 2000. In 2014, Germany introduced a new Renewable Energy Law, and introduced an auction system for PV capacity. Carbon pricing under the European Union's emission trading system and the EU obligation also buttressed the market.[44] The German policies to develop the market for solar energy played a key role in enabling the market to develop, and for solar photovoltaic technology to become more cost-effective.[45] In 2006, Germany had more than 60% of the global solar installations, at that time solar technology was immature and needed a policy-driven market in order to scale, regardless of solar resource potential. This enabled the market to develop, and caused large-scale price declines in solar photovoltaic panels.[46]

India has also used obligations to scale up the development of solar energy. The National Solar Mission was established to set the nation's first solar energy targets, and the nation has set larger and more ambitious renewable energy targets since then, and set renewable purchase obligations for electric utilities.[47] In 2022, the Indian government set an ambitious target for 500 GW of renewable energy capacity by the year 2030, including 280 GW of solar power and 140 GW of wind power.[48] These policies are depicted in Figure 3. These policies demonstrate the efficacy of obligations for cleantech market share, and offer a clear path forward for increasing ZEV penetration.

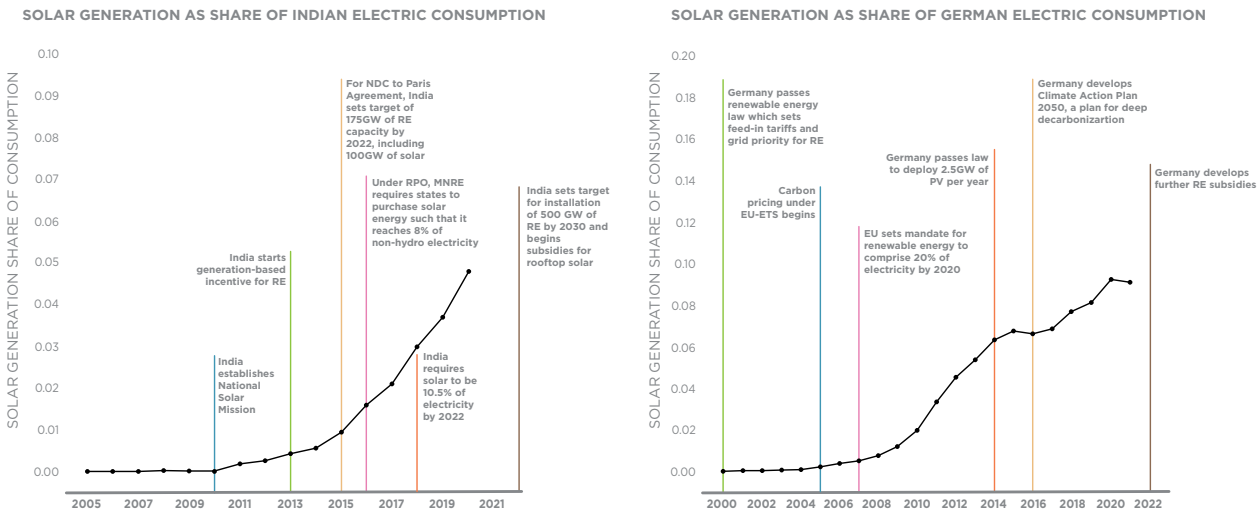

Figure 3: Solar energy generation in India and Germany. Note the different y-axes. These show the policies that have impacted the solar market share in India and Germany.

44 Julian Wettengel. Clean Energy Wire. A very brief timeline of Germany's energiewende. 15 May, 2020. https://www.cleanenergywire.org/factsheets/very-brief-timeline-germanys-energiewende

45 Gregory Nemet. How Solar Became Cheap.

46 Craig Morris. How Germany helped bring down the cost of PV. Energy Transition. https://energytransition.org/2016/01/how-germany-helped-bring-down-the-cost-of-pv/

47 Jawaharlal Nehru National Solar Mission. India Climate Explorer https://indiaclimateexplorer.org/climate-policies/NSM/overview

48 Zakir Hussein. India gets closer to meeting 2030 renewable energy targets with new transmission plan. https://timesofindia.indiatimes.com/blogs/voices/india-gets-closer-to-meeting-2030-renewable-energy-targets-with-new-transmission-plan/

In Indonesia, increasing the market share of biodiesel made from palm oil is a strategic issue because it can produce palm oil domestically but it is a net importer of petroleum. For that reason, Indonesia mandated biodiesel blending in 2008, and has increased the mandatory blending ratio several times.[49] Fuel subsidies imposed a significant burden on the national budget, until their abolition in 2015, but remain a sensitive political issue.[50] Indonesia has increased its biodiesel blending obligation to 35%, to further displace petroleum use and reduce its import dependency.[51] In the United Kingdom, the Renewable Fuel Transport Obligation (RTFO) is an obligation that requires suppliers of transport fuels to blend their fuels with a percentage of renewable and sustainable sources, including biofuels.[52] These policies are depicted in Figure 4. India also has an ethanol obligation policy, which requires petrol to be blended with 20% ethanol by 2025/26.[53] It is easier for India to regulate its oil market because its oil marketing companies (OMC) are public sector companies; however, it is still possible for it to do the same with auto manufacturers.

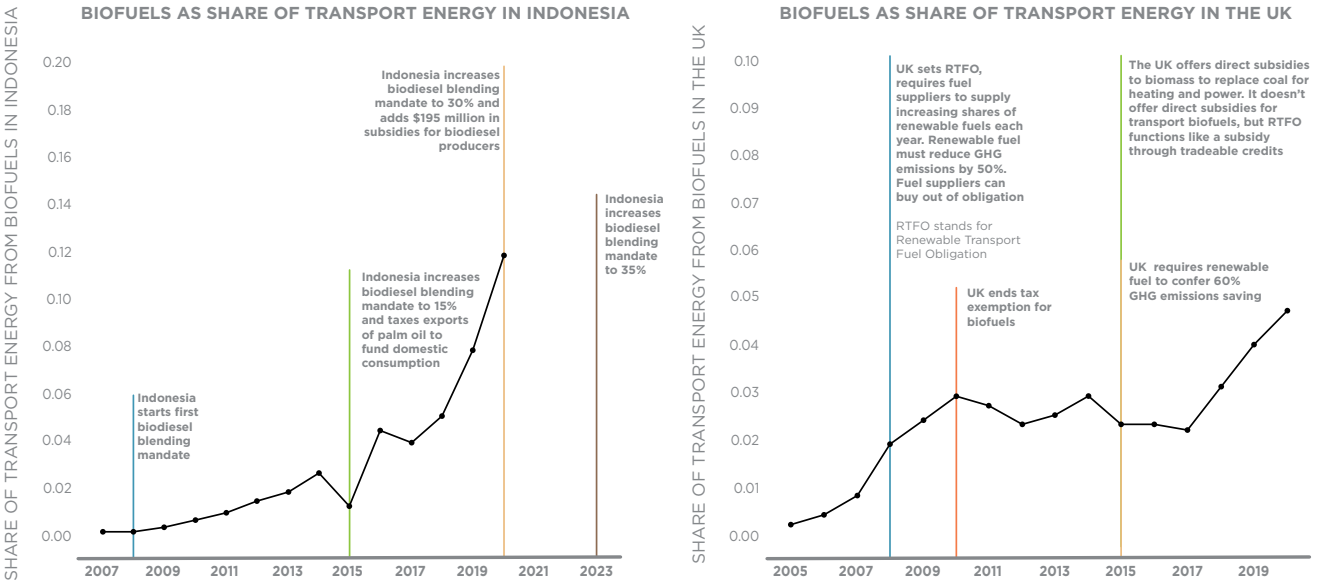

Figure 4: Biofuels as share of transport energy in Indonesia and the United Kingdom. Note the different y-axes. These show the policies that have impacted biofuel market share in the UK and Indonesia.

49 Adil Widrian, et al. Review of Biodiesel Policy in Indonesia. IOP Science. https://iopscience.iop.org/article/10.1088/1755-1315/1034/1/012062

50 Anastasia Kharina, Chris Malins, and Stephanie Searle. Biofuels policy in Indonesia: Overview and Status Report. International Council on Clean Transportation.

51 USDA: Indonesia to implement Biodiesel B35 in February 2023. https://www.fas.usda.gov/data/indonesia-indonesia-implement-biodiesel-b35-february-2023

52 Renewable Transport Fuel Obligation. UK Government. https://www.gov.uk/guidance/renewable-transport-fuels-obligation

53 International Energy Agency. Roadmap for ethanol blending in India 2020-25. https://www.iea.org/policies/17007-roadmap-for-ethanol-blending-in-india-2020-25

Obligations for cleaner automotive technologies have a long history in India. Indian regulations for four-wheeled vehicles follow the European Union regulatory pathways, with a time lag of about five years in major cities and ten years nationwide. Since India has a greater market share of two- and three- wheelers, they develop their own standards for those vehicles. As of 2016, the emission standards for vehicles in India were at Bharat Stage (BS) III or IV levels, and that same year India's Ministry of Road Transport and Highways announced intention to issue BS VI standards, leapfrogging past the level V. This was done to combat rising levels of air pollution in India's cities. These standards focus on criteria pollutants, not greenhouse gas emissions, and incorporate particulate number limits for gasoline and diesel engines. They also require limits for nitrogen oxides (NOx), carbon monoxide, and hydrocarbon emissions for two-wheelers.[54] This year, the European Union issued a ZEV obligation which requires that all new cars will have to be zero-emissions starting in 2035.[55] India's Bureau of Energy Efficiency has also issued fuel economy standards for vehicles to reduce petroleum demand and GHG emissions.[56] In 2015, India set a target to reduce its oil imports by 10% below 2015 levels by 2022, but this goal was not achieved.[57]

In continuing the past trends of setting targets, developing fuel economy standards, and following the EU requirements to reduce pollution of both criteria pollutants and greenhouse gases, a logical next step would be for India to set obligations that increasing shares of the country's vehicle fleet shall be zero-emissions vehicles. This would ensure that India can achieve the targets that it has set for zero emissions vehicle market share and reduction in petroleum imports; and it would continue India's history of setting stringent standards to protect public health and air quality. This would continue the country's history of mandating efficient technologies and protecting its environment.

54 India Bharat Stage VI Emission Standards. ICCT. April 2016.

55 New cars sold in EU must be zero-emission from 2035. Carbon Brief. March 29, 2023. https://www.carbonbrief.org/daily-brief/new-cars-sold-in-eu-must-be-zero-emission-from-2035/

56 Fuel efficiency | Bureau of Energy Efficiency, Government of India. https://beeindia.gov.in/en/programmesenergy-efficiency-in-transport-sector/fuel-efficiency

57 India's dependency on oil imports likely to rise above 80% by 2027. BW Business World. 5 August 2023. https://www.businessworld.in/article/India-s-Dependency-On-Oil-Imports-Likely-To-Rise-Above-80-By-2027-Informs-Centre-/05-08-2023-486716/

4. DESIGNING ZEV OBLIGATIONS

In general, obligations can apply to either to prices or physical quantities of goods produced or consumed. The target level can be specified either in absolute terms (for instance, a certain number of ZEVs to be sold in a given year) or in relative terms such as a fixed share in annual sales. Obligations can be technology-specific, requiring either the use of certain technologies (such as catalytic converters on vehicles) or a ban on production or sales of certain products (for instance, plastic bags, incandescent light bulbs or nuclear energy), or the obligations can be technology-neutral, specifying performance standards in terms of emissions per kilometer traveled or energy efficiency standard.

In order to reduce the overall cost of the obligations, they can be designed to permit trading of credits for compliance across firms. If trading is permitted, that introduces more flexibility as the obligation will apply to the industry as a whole rather than any specific firm. Obligations can also allow banking of credits, in which case a company could over-comply with a regulation in one year to be allowed to under-comply the following year. An obligation could be designed to allow borrowing from the future, in which case a company would commit to over-comply in the future. Obligations can be designed with or without a safety valve, which would offer the option to purchase exemptions from compliance from obligations. This would protect the regulated industry from excessively high compliance costs, and would also provide an opportunity to raise revenues that could support research and development of new technologies among other things.

Obligations can encompass multiple vehicle segments and allow trading across segments to exploit greater variation in costs across firms. However, this might lead to concentration of innovation and cost reductions in a narrower set of segments. In the case of ZEVs, this could mean most of the compliance is achieved by selling more 2-wheelers and 3-wheelers instead of 4-wheelers or focusing only on light duty vehicles and not on medium or heavy-duty vehicles, or by allotting different numbers of credits to different vehicle segments.[58]

58 Jonn Axsen, Scott Hardman, Alan Jenn. What Do We Know about Zero-Emission Vehicle Mandates? Environ. Sci. Technol. 2022, 56, 7553−7563

Lastly, from an equity standpoint, obligations can be designed to include or exclude certain segments of the market. For example, cars sold below a certain price point could be exempt from complying with the obligation which can minimize the impact on products or models that lower income households tend to consume. This is equivalent to how subsidies might be designed to benefit households below a certain income or products below a certain price threshold.

5. COMPLEMENTARY POLICIES

To further assist OEMs in meeting ZEV obligations and reduce political opposition from the OEMs, additional complementary steps could be considered. One strategy is to complement ZEVO on OEMs with obligations on owners or operators of large fleets of cars (such as Uber or Olacabs) and trucks (such as large commercial freight service providers) to procure a fixed share of ZEVs. Since commercial vehicles are used more intensively than private vehicles, they can realize quicker financial payback and lead to faster reduction in both oil consumption and pollution. An obligation on large fleets can help OEMs target ZEV sales to this segment. An example of such a policy is the California Clean Miles Standard, which requires rideshare companies that operate in California to increase the share of passenger-miles traveled using zero-emissions means.[59]

A second strategy is to allocate a greater share of ZEV subsidies for the creation of robust charging infrastructure. A number of surveys of potential ZEV adopters suggests a good battery charging or H2 refueling infrastructure increases the willingness to adopt ZEVs and this is especially true for commercial adopters for whom the fuel cost savings accrue fast given the higher vehicle usage.[60] In addition to directly funding the installation of chargers, the government could allow manufacturers to earn ZEV credits by installing chargers.

A third complementary policy is to enact a clean fuel standard (CFS), which would require that transportation fuel in India decrease its carbon intensity over time. An example of such a regulation is the California Low Carbon Fuel Standard. A benefit of complementing a ZEV with an CFS is like with direct subsidies, it also create incentives for setting battery charging and Hydrogen fueling stations. Under an LCFS, those who sell fossil fuels would have to purchase LCFS credits, which could be sold by anyone who sells a low-carbon transportation fuel, such as electricity, hydrogen, or biofuels.

This would be an extra stream of revenue for those vendors, thus providing an extra incentive to induce investment in the low-carbon transportation industrial ecosystem. The California LCFS has a provision for “fixed guideway” systems such as electric rail based public transit systems to sell LCFS credits. Since the Indian rail network is almost entirely electric, this can be an additional source of revenue for urban metro systems, which are undergoing rapid development in India, as well as for Indian Railways, which will face

59 California Air Resources Board. Clean Miles Standard. https://ww2.arb.ca.gov/our-work/programs/clean-miles-standard
60 Accelerating transport electrification in India by 2030. JMK Research & Analytics.

budgetary constraints as the country shifts away from the use of coal which currently constitutes the rail network's biggest source of revenue.[61]

A fourth complementary strategy is an obligation on oil marketing companies to make available charging or fueling infrastructure for ZEVs. This is akin to the obligation on regulated and government-owned power distribution companies to procure renewable energy from solar and wind power projects through the policy of renewable purchase obligations (RPOs).[62]

Last but not least, a fifth measure is requiring state-owned banks to lend at favorable rates for ZEV investors and individual buyers. Currently, ZEVs investors and vehicle buyers face higher borrowing and transaction costs as these are seen as seen as riskier relative to lending to investments in ICE vehicles.

India has a history of using obligations on corporations to achieve social and environmental progress. In addition to RPOs electricity distribution companies, stringent emissions norms have been mandated for vehicle tail pipe emissions which automakers have complied with. A ZEV obligation would therefore not be unprecedented from a political economic standpoint and provide an enormous boost for ZEVs and for the ZEV market, accelerating the development of the ZEV industrial ecosystem in India. In conclusion, ZEVOs can help India achieve its ambitious targets for reduction in both oil use and emissions faster and at a lower cost to both the taxpayer and poorer households and the logical next addition to the clean energy and climate policy ecosystem in India.

61 Yuthika Bhargava. Coal is railways' cash cow – why India's climate goals post risk for transporter. The Print. 21 June 2023. https://theprint.in/india/governance/coal-is-railways-cash-cow-why-indias-climate-goals-pose-risk-for-transporter/1634060/

62 Renewable Purchase Obligation. Ministry of New and Renewable Energy, Government of India. https://rpo.gov.in/Home/Objective

6. CONCLUSION

With its economy set to grow drastically in the coming years and decades, India is expected to see a large increase in both vehicle stock and vehicle kilometers traveled. The consequences of such developments for India's oil consumption and imports, air quality and GHG emissions are not hard to imagine. Recognizing the need to mitigate these trends, India has announced targets for ZEVs through vehicle electrification and production of green hydrogen, which is intended for use in both transportation and industrial applications. Currently, these targets are being pursued entirely by providing various forms of financial incentives to OEMs and consumers both at the central and state government levels. Despite these incentives, the market price of ZEVs is higher than that of ICE vehicles and consequently adoption is slow. Higher market price of ZEVs do not suggest that ZEVs are inherently costlier to producer but more likely reflect the lack of scale in production and limited competition in the supply of ZEVs. Driving down the production cost of ZEVs requires large-scale and coordinated investments across the value chain including battery and fuel cell manufacturing, fueling infrastructure and end of life management. Each of these different steps entail learning externalities and high fixed costs which cannot be recouped without achieving a scale of production and in turn sales that can make these investments profitable. And without such a scale of production, the cost of ZEVs will remain too high to be competitive without an unsustainable level of subsidies per vehicle, which in turn will limit the number of vehicles that can be subsidized for a given total budget. Therefore, it is critical to create sufficient guaranteed demand for ZEV that can in turn lead to investments at the scale needed to ensure that the ZEV industry can compete without subsidies in the long-run. In this context a ZEV obligation is a necessary next step to ensure that India meets its targets for ZEV adoption. A ZEV obligation on automakers complemented with obligations downstream (e.g., large fleet operators and oil marketing companies to provide charging) and subsidies for battery manufacturing and charging infrastructure creation can help reduce uncertainty to investors across the supply chain. Given that India has a long and successful history of adopting stringent targets for tailpipe emissions and energy efficiency despite the obvious burden of these policies on the auto industry, enacting binding ZEV obligations is both a politically viable and economically prudent strategy from a taxpayer perspective.

ACKNOWLEDGEMENT

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Appendix – Tables and Figures

Table 1: Summary of Central and State-level ZEV policies in India

Country/ state	Target	*Year target adopted*	Regulation	Incentive
India	India has set target for ZE sales penetration of private cars to be 30%, commercial cars 70%, buses 40%, and two and three wheelers 80% by 2030	2022		FAME II has outlay of ₹10000 crore to fund e-mobility, between 2019 and 2022. This includes ₹800 crore to build 7432 public fast chargers.
India - Andhra Pradesh	Target for 1 million EVs across segments in the state by 2024 and complete transition for state bus corporation to electric by 2029. Also phase out ICE commercial vehicles in major cities by 2024 and the whole state by 2030; and have 1 lakh charging stations by 2024.	2018		Capital subsidy up to ₹1m for charging stations and swapping stations.
India - Assam	Convert state bus fleet to all electric by 2030, purchase only electric buses starting 2025, and phase out fossil commercial vehicles by 2025.	2021		State subsidies of up to ₹150k available for purchase of electric two, three, and four wheelers.
India - Delhi	EV should be 25% of all new vehicle registrations by 2025.	2020		Purchase incentive of ₹30k for electric autos. Purchase incentive of ₹10k per kWh of battery capacity for electric 4-wheelers

India- Gujarat	Target is to deploy 200k EVs, including 110000 2-wheelers, 70000 3-wheelers, and 20000 4-wheelers.	2021		The state will subsidize EV purchase ₹10k/kWh of battery capacity, with maximum subsidy capped based on vehicle class. Electricity to charge EV is exempt from electricity duty.
India- Karnataka	Autorickshaws, corporate fleets, school buses/vans, and taxis to be 100% electric by 2030.	2017		Capital subsidy of 25% for the first 100 charging stations and battery swapping stations. EVs are tax-exempt.
India- Kerala	1 million EVs on the road by 2022. Transition state bus fleet to all-electric by 2025	2019		Capital subsidy of 25%, up to ₹1m, for the first 100 chargers
India- Madhya Pradesh	100% electric commercial fleet, government fleet, and buses by 2028	2019		EVs get favorable tax treatment and free parking. The installation of EVSE can receive capital subsidy of 25%.
India- Maharashtra	In 5 targeted cities, 25% of public transit must be EV by 2025. MSRTC to convert 15% of bus fleet.	2021	All public off-road, industrial, and commercial parking will have 25% of spaces EV ready by 2023.	There are subsidies of 5000 ₹/kWh of EV battery capacity, with subsidy capped for each vehicle class. EVs are exempt from registration fees.
India- Meghalaya	Facilitate 15% adoption of EVs by 2025	2021		₹10000 / kWh for first 3500 electric 2-wheelers, ₹ 4000 /kWh for first 200 electric 3-wheelers, ₹4000 /kWh for first 2500 electric 4-wheelers.
India- Odisha	BEVs to contribute 20% of vehicle registrations by 2025. 50% of new buses purchased in next 5 years will be electric.	2021		Purchase incentive of ₹5000 for e-2-wheelers, ₹12000 for e-3-wheelers, and ₹100000 for e-4-wheelers. E-bus Purchase is subsidized at 10%.

India - Tamil Nadu	30% of the bus stock in TN to be electric by 2030. State will promote conversion of all autorickshaws in major cities to electric by 2030.	2023	New apartment complexes will be encouraged to be EV ready, and commercial centers are encouraged to install EVSE.	Purchase subsidy is ₹10000/kWh for EVs, and ₹20000/kWh for buses, with caps based on vehicle class. Funding up to ₹1million for DCFC and ₹100k for slow chargers.
India- Telangana	Electrification of state bus fleet.	2020		There is tax exemption for purchase of EVs, capped by vehicle class.
India-Uttar Pradesh	1 million EVs by 2024, 1000 electric buses by 2030	2019		
India- Uttarakhand	500 electric buses by 2023	2018		
India-West Bengal	1 million EVs by 2026, 1 lakh charging stations by 2026,	2021		Purchase incentive of ₹10000/kWh for EVs and ₹20000/kWh for trucks and buses.

Additional References for data in charts

- **International Energy Agency data on energy**: https://www.iea.org/countries/
- **International Energy Agency data on ZEVs**: https://www.iea.org/data-and-statistics/data-tools/global-ev-data-explorer
- **CA ZEV obligation for state fleet**: https://www.dgs.ca.gov/Resources/SAM/TOC/4100/4121
- **CARB ZEV program home page**: https://ww2.arb.ca.gov/our-work/programs/zero-emission-vehicle-program
- **Data on total car sales by country**: https://www.theglobaleconomy.com/rankings/passenger_cars_sales/
- **California ZEV policies**: https://www.transportpolicy.net/standard/california-zev/
- **California ZEV sales data**: https://www.energy.ca.gov/files/zev-and-infrastructure-stats-data
- **Norway EV policies**: https://elbil.no/english/norwegian-ev-policy/
- **India FAME policy timeline**: https://fame2.heavyindustries.gov.in/content/english/16_1_Timeline.aspx
- **India needs a regulatory obligation for e-vehicles, Center for Science and Environment**: https://www.cseindia.org/india-s-electric-vehicle-industry-needs-a-regulatory-obligation-for-production-and-sale-of-e-vehicles-says-new-assessment-from-cse-11597
- **India NITI Aayog e-Amrit Portal on timeline of EV policies in India**: https://e-amrit.niti.gov.in/national-level-policy