

TRANSPORTATION DECARBONIZATION

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I. INTRODUCTION

In September 2020, California Governor Gavin Newsom signed Executive Order (EO) N-79-20 to ban the sale of all internal combustion engine vehicles (ICEs) by 2035.¹ In August 2022, the California Air Resources Board (CARB) will vote on the final resolution that formalizes and codifies the details of this pledge. This put California on track to set the most ambitious standard for electric vehicle adoption among states.² Soon after California's N-79-20 was announced, New Jersey,³ Virginia, Washington state, and Massachusetts⁴ pledged to join California in reaching this 2035 goal. But until August 2022, when CARB is expected to make California's targets official, these pledges are meaningless, given that the other states must choose to enact California's exact regulation with respect to the Clean Air Act (CAA) § 209 and § 177 waivers, which were revoked in 2019 by the Trump administration, and recently determined by the Biden administration to be once again legitimate. Since the U.S. Environmental Protection Agency (U.S. EPA) rescinded the waiver revocation, this opens the door for state leadership of vehicle emissions.⁵

There are dozens of options for both supply-side and demand-side approaches to reducing the carbon footprint of passenger and freight

1. Jennifer L. Hernandez et al., *California Governor Bans Internal Combustion Engines, Effective 2035, to Combat Climate Change*, HOLLAND & KNIGHT (Sept. 24, 2020), <https://www.hklaw.com/en/insights/publications/2020/09/california-governor-bans-internal-combustion-engines>.

2. Solomon Moore, *Viewpoint: California Leads National ZEV Charge*, ARGUS MEDIA (Dec. 30, 2020), <https://www.argusmedia.com/en/news/2173304-viewpoint-california-leads-national-zev-charge>.

3. Michael S. Warren, *New Jersey Eyes All-Electric Vehicle Shift by 2035*, GOV'T TECH. (Oct. 20, 2020), <https://www.govtech.com/transportation/New-Jersey-Eyes-All-Electric-Vehicle-Shift-by-2035.html>.

4. See EXEC. OFF. OF ENERGY AND ENV'T AFFAIRS & THE CADMUS GRP., MASSACHUSETTS 2050 DECARBONIZATION ROADMAP 7 (Dec. 2020) (referencing environmental commitments made by Massachusetts).

5. *Vehicle Emissions California Waivers and Authorization*, U.S. ENV'T. PROT. AGENCY, <https://www.epa.gov/state-and-local-transportation/vehicle-emissions-california-waivers-and-authorizations> (last visited Jan. 23, 2022).

movement.⁶ This paper outlines some successes and challenges to date of the Zero Emission Vehicle (ZEV) regulatory landscape at the federal and state levels. Our analysis aims to inform policymakers and practitioners at all levels. This paper begins by identifying several different “pathways” the U.S. EPA, U.S. Department of Transportation (USDOT), and other federal regulators can pursue to reduce transportation emissions. The latter part of the paper includes a deep dive on the activities of states regarding light- and heavy-duty ZEV policies. The goal of this analysis is to raise issues and consider the effectiveness of different possible options for zero-emission passenger and freight vehicles for the U.S. Federal Government, and U.S. states. This paper will focus on three broad categories of zero-emission transportation policy.

A. Recognizing Need for Equitable Decarbonization Policy

Before we begin this discussion, it is necessary to recognize that dialogue about how to reduce carbon and criteria pollutants are inherently conversations about equity. Which power plants and which tailpipes to clean first can replay historic patterns of neglect for black, indigenous, and people of color (BIPOC), as well as many low-income people, who have historically been more burdened with the health consequences brought on by the design of our transportation system, including disparities in cardiovascular health⁷ and higher traffic fatality rates.⁸

The question posed here is whether transportation decarbonization policies can contribute to correcting these injustices. For example, policies that propose to price or regulate carbon should begin with a conversation about how to ensure that emissions improvements are captured equitably by all people and communities. A University of Washington study of electric vehicle charging investments found that there was an inequitable distribution of charger access in Seattle.⁹ In San Diego, to address this issue, a partnership with a community-based organization, The Greenlining Institute, resulted in targeted installation of 1,625 charging stations.¹⁰

6. *Reducing Your Transportation Footprint*, CTR. FOR CLIMATE & ENERGY SOLS., <https://www.c2es.org/content/reducing-your-transportation-footprint/> (last visited Jan. 22, 2022).

7. Emily M. D’Agostino et al., *Longitudinal Effects of Transportation Vulnerability on the Association Between Racial/Ethnic Segregation and Youth Cardiovascular Health*, 163 J. RACIAL & ETHNIC HEALTH DISPARITIES (2020).

8. Madeline Brozen & Annaleigh Yahata Ekman, *The Need to Prioritize Black Lives in LA’s Traffic Safety Efforts*, 3 LEWIS CTR. FOR REG’L STUD. (2020), <https://escholarship.org/content/qt0dm6x8k4/qt0dm6x8k4.pdf>.

9. Yohan Min & Hyun Woo Lee, *Social Equity of Clean Energy Policies in Electric-Vehicle Charging Infrastructure Systems*, CONSTR. RSCH. CONG. 2020 (2020).

10. *Clean Transportation and Mobility*, GREENLINING INST., <https://greenlining.org/our-work/environmental-equity/electric-vehicles/> (last visited Jan. 22, 2022).

Best practices for ensuring policy equity are threefold: (1) process equity should aim to meaningfully engage all community members in the policy process, (2) practice equity should test policy mechanisms to ensure no direct benefits or burdens are disproportionately distributed, and (3) outcome equity ensures long-term impacts of each policy to ensure that fairness can be captured.¹¹ All the policy recommendations included in this report should be tailored to fit the needs of the implementing community, by way of an intentional equity strategy.

II. FEDERAL ZEV POLICY LANDSCAPE

This section introduces the Federal ZEV Policy Landscape, which will dictate the boundaries of state ZEV policy efforts. Mitigating climate change is a primary goal of most ZEV policies, as well as reducing harmful pollutants, (e.g., nitrous oxides and particulate matter) especially focusing on mitigating pollution which has disproportionately harmed communities of color and low-income neighborhoods.¹²

Transportation decarbonization will require significant national and state policy actions in combination with rapid technological advances. One of the pinnacles of the ZEV policy debate rests on the CAA § 209 waiver.¹³ CAA § 209 is both the partial cause and the possible result of a states-led ZEV policy landscape and we will provide a short history of this critical policy.

A. History of California Clean Air Act Waiver

Congress first granted California the freedom to lead on setting light-duty vehicle emission standards with the passage of the CAA in 1970. California has been granted approximately 100 waivers over the last 50 years, some of which have allowed the California Air Resources Board to set more stringent vehicle emissions standards than the U.S. EPA.¹⁴ This leadership has resulted in 11 states¹⁵ following suit. CAA § 177 grants any state the ability to adopt California's model year standards, as long as they are

11. Mollie D'Agostino et al., *Equitable Congestion Pricing*, INST. OF TRANSP. STUD., UNIV. OF CAL. 1 (2020), <https://escholarship.org/uc/item/17h3k4db>.

12. Hana Creger et al., *Mobile Equity Framework, How to Make Transportation Work for People*, GREENLINING INST. (Mar. 2018), https://greenlining.org/wp-content/uploads/2019/01/MobilityEquityFramework_8.5x11_v_GLI_Print_Endnotes-march-2018.pdf.

13. See generally 42 U.S.C. § 7543.

14. *Attorney General Becerra Files Lawsuit Challenging Trump Administration's Attempt to Trample California's Authority to Maintain Longstanding Clean Car Standards*, CAL. DEP'T JUST. (Sept. 20, 2019), <https://oag.ca.gov/news/press-releases/attorney-general-becerra-files-lawsuit-challenging-trump-administration%E2%80%99s>.

15. Blane Erwin, *What is a ZEV Credit and how does Tesla make money with them?* (July 31, 2020), <https://www.currentautomotive.com/what-is-a-zev-credit-and-how-does-tesla-make-money-with-them/>.

“identical to the California standards for which a waiver has been granted for such model year.”¹⁶

However, in September 2019, the Trump Administration’s U.S. EPA’s Safer Affordable Fuel-Efficient (SAFE-1) action withdrew the 2013 CAA waiver and interpreted the CAA to not allow other states to adopt California’s GHG emission standards.¹⁷ Fortunately, the Biden Administration’s U.S. EPA issued a notice of decision on March 14th, 2022, finding that the actions taken as a part of SAFE-1 were decided in error and are now entirely rescinded.¹⁸ The actions by both the previous and current administrations are sobering reminders of how fragile these policy decisions can be in an increasingly polarized political climate.

B. Pathways for U.S. EPA Actions Towards Decarbonization

There are a number of options for the U.S. EPA to consider in order to pursue a climate friendly policy agenda, including:

Pathway 1—Adopt Vehicle Standards that Meet or Exceed California’s Standards: The U.S. EPA could implement new federal standards for new vehicles that exceed California’s existing standards or meet or exceed the standards set out in EO § N-79-20. This would be within the purview of the U.S. EPA for several reasons. The CAA empowers the U.S. EPA to set ever restrictive standards, because the agency is tasked with pursuing a continuous reduction strategy for emissions.¹⁹ President Biden signed executive order 14037, Strengthening American Leadership in Clean Cars and Trucks in 2021 setting a goal that 50 percent of all new passenger cars and light trucks sold in 2030 be zero-emission vehicles.²⁰ Section 6(b)–(c) of this executive order empowers the Secretary of Transportation and the U.S. EPA to implement this policy and directs the agencies to coordinate their activities with the state of California.²¹

16. 42 U.S.C § 7507.

17. The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule Part One: One National Program, 84 Fed. Reg. 188, 51329 (Sept. 27, 2019).

18. California State Motor Vehicle Pollution Control Standards; Advanced Clean Car Program; Reconsideration of a Previous Withdrawal of a Waiver of Preemption; Notice of Decision, 87 Fed. Reg. 49, 14278 (Mar. 14, 2022), <https://www.govinfo.gov/content/pkg/FR-2022-03-14/pdf/2022-05227.pdf>.

19. See Joseph Goffman & Laura Bloomer, *Disempowering the EPA: How Statutory Interpretation of the Clean Air Act Serves the Trump Administration’s Deregulatory Agenda*, 70 CASE W. RES. L. REV. 929, 932–34 (2020) (outlining the EPA’s ability, and mandate, to progressively tighten restrictions).

20. Exec. Order No. 14,037, 86 Fed. Reg. 151 (2021).

21. Exec. Order No. 14,037, 86 Fed. Reg. 151 (2021).

Pathway 2—Classification of CO₂ as Criteria Pollutant: The U.S. EPA is statutorily obligated to strive for the “lowest achievable emissions rate”²² based on U.S. EPA assessments every five years identifying the “maximum achievable technology”²³ (MACT). While interpretations such as *Massachusetts v. EPA* clarified that the U.S. EPA has the authority to regulate mobile sources of greenhouse gas emissions (GHG),²⁴ they are not classified as criteria pollutants.²⁵ Vehicle emissions have been regulated under the CAA, given the criteria pollutants in tailpipe emissions (nitrogen oxides, hydrocarbons, carbon monoxide (CO), and particulate matter).²⁶ While CO₂ is not classified as a criteria pollutant under the CAA vehicle emissions, the U.S. EPA could choose to re-classify carbon dioxide as a criteria pollutant which would trigger several requirements from the administration and states.²⁷ First, U.S. EPA would have to conduct an annual National Ambient Air Quality Standards assessment to determine which states were in attainment and require states to make plans to reduce CO₂ emissions.²⁸ The extent to which this type of assessment would increase uptake of CO₂ reduction strategies in the least ambitious states is difficult to predict, but it still represents an interesting option for the U.S. EPA.

C. Notable Policy Pathways Outside of U.S. EPA Purview

Pathway 3—National Highway and Traffic Safety Administration (NHTSA) Actions: in 2022, the NHTSA finalized CAFE Standards for MYs 2024-2026; the final rule establishes standards that would require an industry-wide fleet average of approximately 49 mpg for passenger cars and light trucks in model year 2026, by increasing fuel efficiency by 8% annually for model years 2024 and 2025, and 10% annually for model year 2026.²⁹ While further claims for preemption of California’s right to set their own

22. 42 U.S.C. § 7411(j)(1)(A)(iii).

23. 42 U.S.C. § 7412(d).

24. *Massachusetts v. EPA*, 549 U.S. 497 (2007).

25. 40 C.F.R. § 50 (1971).

26. *Regulatory Information by Topic: Air*, U.S. ENV’T PROT. AGENCY (Jan. 28, 2021), <https://www.epa.gov/regulatory-information-topic/regulatory-information-topic-air>.

27. *Criteria Air Pollutants*, U.S. ENV’T PROT. AGENCY (last updated Mar. 22, 2021), <https://www.epa.gov/criteria-air-pollutants>.

28. 42 U.S.C. § 7409(d)(2)(B).

29. *Technical Support Document: Final Rulemaking for Model Years 2024-2026 Light-Duty Vehicle Corporate Average Fuel Economy Standards*, U.S. DEPT. TRANSP. (Mar. 2022), https://www.nhtsa.gov/sites/nhtsa.gov/files/2022-04/Final-TSD_CAFE-MY-2024-2026.pdf.

fuel economy standards rests on the Energy Policy and Conservation Act (EPCA) of 1975, which according to NHTSA's interpretations, the EPA and their agency reserve sole authority for setting fuel efficiency standards.³⁰ Federal courts have thus far upheld California's authority to set fuel economy standards.³¹

Pathway 4—USDOT and USDOE Action:³² the Infrastructure Investment and Jobs Act (IIJA) established a National Electric Vehicle Infrastructure Formula Program (NEVI Formula) to provide funding to States to strategically deploy electric vehicle (EV) charging infrastructure and to establish an interconnected network to facilitate data collection, access, and reliability.³³ The NEVI Formula has a goal of developing 500,000 chargers by 2030.³⁴ The Federal Highway Administration (FHWA), under the supervision of the USDOT, is to apportion these funds proportionate to the funding states already receive from FHWA and pending approval of state developed implementation plans.³⁵

Additionally, the USDOT can also work with EPA to update the National Environmental Policy Act (NEPA) guidance or develop climate change criteria for grant programs such as The Rebuilding American Infrastructure with Sustainability and Equity program, (RAISE Discretionary Grant).³⁶ As of late 2021, the Department now asks RAISE Grant applicants to consider how their projects can address climate change.³⁷

It is also possible that USDOT can utilize its Federal Highway Administration (FHWA) authority through the Congestion Mitigation and Air Quality (CMAQ) Management Program to aid state and local agencies to

30. Union of Concerned Scientists v. National Highway Traffic Safety Administration, No. 20-1175 (D.C. Cir., filed Sept. 21, 2020).

31. Environmental & Energy Law Program, Harvard University, *CAFE Standards, and the Energy Policy and Conservation Act* (June 19, 2018), <https://ceelp.law.harvard.edu/2018/06/california-cafe-standards-and-the-energy-policy-and-conservation-act/>.

32. See generally Vicki Arroyo et al., *Climate 21 Project: Transition Memo*, U.S. DEP'T OF TRANSP., https://climate21.org/documents/C21_DOT.pdf (last visited Jan. 22, 2022) (explaining budgeting requirements for different programs like BUILD).

33. See generally, Andrew C. Rogers, *The National Electric Vehicle Infrastructure (NEVI) Formula Program Guidance*, (Feb. 10, 2022) https://www.fhwa.dot.gov/environment/alternative_fuel_corridors/nominations/90d_nevi_formula_program_guidance.pdf.

34. *Id.* at 1.

35. *Id.* at 9.

36. RAISE Discretionary Grants, U.S. DEP'T OF TRANSP. (Jan. 28, 2022), <https://www.transportation.gov/RAISEgrants>.

37. *Id.*

invest in charging infrastructure.³⁸ The U.S. Department of Energy (USDOE) can also utilize funding programs to provide grants for charging infrastructure projects.³⁹ However, funding for these programs would be dependent on congressional appropriations of funds.

Pathway 5—Establish a Federal Low Carbon Fuel Standard (LCFS): while this may require a legislative mandate, a Federal LCFS could model off the California system, and require that the average carbon intensity of transportation fuels decline over time, meaning the total GHG emissions they produce is reduced, from a full cradle to grave life cycle standpoint. This includes incentivizing the use of lower carbon fuel or alternative fuel sources, such as ethanol, or biodiesel, as well as electricity (depending on the grid production fuel sources).⁴⁰ In California, as of 2020, the LCFS has increased the use of alternative fuels (non-fossil fuel derived) from 7% to 16% of total fuel consumption.⁴¹

Pathway 6—Establish a Carbon Pricing System: a market-based approach that allows carbon trading on a federal level will make emitting carbon more expensive. This would emulate the cap-and-trade systems administered in the 12 U.S. states⁴² and many countries.⁴³ While these market-based strategies make the most efficient reductions possible for the economy, which explains their global popularity, there are many critics in the U.S. who would prefer a carbon pricing system that could be more equitable if it priced carbon higher in disadvantaged areas, who have historically faced the brunt of dangerous air pollution.⁴⁴

Pathway 7—Establish a Federal GHG/Passenger Mile Fee Based System: reforms to the gas tax that shift revenue generation towards pricing that favors ZEVs and higher occupancy will allow the flexibility for markets

38. Fixing America's Surface Transportation Act (FAST Act), U.S. DEP'T OF TRANSP., <https://www.fhwa.dot.gov/fastact/factsheets/cmaqfs.cfm> (last visited Jan. 22, 2022).

39. *Guide to Federal Funding, Financing, and Technical Assistance for Plug-in Electric Vehicles and Charging Stations*, U.S. DEP'T OF ENERGY & U.S. DEP'T OF TRANSP. 1 (Jul. 2016), <https://doi.org/10.2172/1416162>.

40. *Id.*

41. Austin L. Brown et al., CARBON NEUTRALITY STUDY 1: DRIVING CALIFORNIA'S TRANSPORTATION EMISSIONS TO ZERO 109, INST. OF TRANSP. STUD., UNIV. OF CAL. (Oct. 2020).

42. *Market-Based State Policy*, CTR. FOR CLIMATE AND ENERGY SOLUTIONS, <https://www.c2es.org/content/market-based-state-policy> (last visited Jan. 22, 2022).

43. *Carbon Pricing Dashboard*, WORLD BANK (last updated Nov. 1, 2020), https://carbonpricingdashboard.worldbank.org/map_data.

44. *Ensuring Equity*, CARBON TAX CTR., <https://www.carbontax.org/ensuring-equity/> (last visited Jan. 23, 2022); see discussion *infra* Section II.B.2.

to adapt efficiently. California implemented the Clean Miles Standard⁴⁵ which will regulate emissions from transportation network companies using a GHG/Passenger miles Traveled metric. Developing such a system for privately held vehicles will have technical challenges, but this type of system would be ideal in that it would send price signals to drivers about the true impacts of their travel choices.⁴⁶ Section 13002 of the Infrastructure Investment and Jobs Act directed the U.S. Department of Transportation to establish a national motor vehicle per-mile user fee pilot program while continuing to support state-level pilots.⁴⁷ These programs will be a first major step in disincentivizing private VMTs, but they are not without their implementation challenges, which include addressing privacy issues and concerns about creating potentially unfair burdens to households displaced on the exurban fringe.

1. Non-vehicular Transportation Decarbonization Policies

While vehicles are the primary focus of this paper, it is worth mentioning that other supportive policies will also be essential in order to achieve transportation decarbonization, and both demand- and supply-side levers exist. A few will be briefly introduced in this section, which is by no means exhaustive.

2. Decarbonize the Power Sector

To fully realize the benefits of electrifying the transportation sector, power generation must be decarbonized. California has several policies targeting the decarbonization of the power sector.⁴⁸ The renewable portfolio standard (RPS) was adopted in 2002 through SB 1078, to require a minimum amount of retail electric sales to be generated from renewable sources (solar, wind, geothermal, and some hydroelectric).⁴⁹ It also required that a minimum of 20% of California's power generation come from renewable sources by

45. See discussion *infra* Section III.

46. See CARBON TAX CTR., *supra* note 44 (characterizing carbon taxes as a shift in revenue sources).

47. Infrastructure Investment and Jobs Act, Pub. L. No. 117-58, § 13002, 135 STAT. 429, 624 (2021).

48. *California Climate Policy*, ENERGY INNOVATION POL'Y & TECH., <https://energyinnovation.org/policy-programs/california-climate-policy/> (last visited Jan. 23, 2023); Brown et al., *supra* note 41.

49. *Renewable Portfolios Standard Program*, CAL. PUB. UTIL. COMM'N (2021) <https://www.cpuc.ca.gov/rps/>.

2017.⁵⁰ The minimum target has been increased in subsequent years, to 50% by 2030 by SB 350, and increased again by SB 100 to 60% by 2030 and 100% of retail sales.⁵¹

However, the authority of the EPA to regulate greenhouse gas emissions from stationary sources, such as power plants, is currently somewhat restricted after the recent *West Virginia v. EPA* decision before the Supreme Court of the United States.⁵² In July 2022, the majority issued an opinion determining that the EPA's Clean Power Plan falls under the major question doctrine, surpassing the regulatory authority of that agency.⁵³ The *West Virginia* decision may have two possible effects on transportation decarbonization. First, a clean transportation system is contingent on a clean grid and this decision may have a chilling effect on EPA efforts to decarbonize energy grids nationwide. Second, the major questions doctrine may open regulators to legal scrutiny, which could have a broader dampening effect on emissions reduction efforts.

3. Cap-and-Trade Policy

Following the lead of European states, between 2006 and 2008 California passed and adopted the first U.S. Cap-and-Trade policy in 2006, and updated it in 2017.⁵⁴ California's carbon pricing system operates by requiring permits to an allowable cap for industries that produce CO₂ emissions, including transportation.⁵⁵ The cap declines each year, in line with California's emissions reduction goals.⁵⁶ Permits are auctioned once every quarter, and may be traded, which creates a market mechanism for emissions.⁵⁷ Some industries, like refineries, are given a set of permits to cover expected emissions, to prevent outside competition to import their product.⁵⁸ The \$19.2 billion collected from permits between 2012-2022 have been invested in a variety of programs and projects around the state, the vast majority for

50. *Id.*

51. *Id.*

52. See generally *West Virginia v. EPA*, 597 U.S. (2022).

53. *Id.*

54. *Cap-and-Trade Program*, CAL. AIR RES. BD., <https://ww2.arb.ca.gov/our-work/programs/cap-and-trade-program> (last visited Jan. 22, 2022).

55. *California's Cap-and-Trade Program Step by Step*, ENV'T DEF. FUND, <https://www.edf.org/sites/default/files/californias-cap-and-trade-program-step-by-step.pdf> (last visited Jan. 23, 2022).

56. *Cap-and-Trade Program: Allowance Distribution Factsheet*, CAL. AIR RES. BD. (2020), <https://ww2.arb.ca.gov/resources/documents/cap-and-trade-program-allowance-distribution-factsheet>.

57. *California Cap-and-Trade Program Summary of California-Quebec Joint Action Settlement Prices and Results*, CAL. AIR RES. BD. (Feb. 2021), https://ww2.arb.ca.gov/sites/default/files/2020-08/results_summary.pdf.

58. AVAILABLE AND EMERGING TECHNOLOGIES FOR REDUCING GREENHOUSE GAS EMISSIONS FROM THE PETROLEUM REFINING INDUSTRY, ENV'T PROT. AGENCY (Oct. 2010).

emissions reductions, and climate change adaptation and mitigation. Investments include incentives to consumers to purchase electric vehicles.⁵⁹ Sixty-five percent of the funds are continuously appropriated to transit, affordable housing near transit, and high speed rail construction.⁶⁰

Other states have explored implementing similar programs. For example, in 2009 the Regional Greenhouse Gas Initiative (RGGI) was implemented to reduce emissions from the power sector.⁶¹ States participating include Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, and Vermont.⁶² The RGGI program, however, does not cover the transportation sector, but supporting clean energy in the power sector will benefit transportation electrification.⁶³ Washington state also adopted the Washington Clean Air Rule in 2016, which would reduce emissions from stationary sources and petroleum refiners, however the Washington Supreme Court ruled in early 2020 that portions of the rule are invalidated.⁶⁴

While Congress is still heavily divided on this issue, there are two bills, both still in committee, that seek to establish a national carbon cap-and-trade policy. The Save Our Future Act (S. 2085) would impose a "fee" on carbon and other pollutants to be reinvested in the clean energy transition.⁶⁵ The House's Energy Innovation and Carbon Dividend Act (H.R. 2307) would impose a "fee" of \$15/metric ton (tonne) on carbon and other pollutants. The fees would be reinvested or returned to taxpayers and would increase \$10/year until carbon reduction targets are met.⁶⁶

4. Policies that Aim to Reduce Vehicle Miles Traveled

Road- and area-pricing policies can be a very effective tool for reducing vehicle miles traveled (VMT) traffic congestion and emissions, while

59. *Id.*

60. CAL. LEGIS. ANALYST'S OFF., CAP-AND-TRADE AUCTION UPDATE AND GGRF PROJECTIONS (Dec. 2021), <https://lao.ca.gov/reports/2021/4480/cap-and-trade-120621.pdf>.

61. *Regional Greenhouse Gases Initiative (RGGI)*, CTR. FOR CLIMATE & ENERGY SOL., <https://www.c2es.org/content/regional-greenhouse-gas-initiative-rggi/> (last visited Jan. 22, 2022).

62. *Market-Based State Policy - Regional Greenhouse Gas Initiative (RGGI)*, CTR. FOR CLIMATE & ENERGY SOL., <https://www.c2es.org/content/market-based-state-policy/> (last visited Jan. 22, 2022).

63. Sarah Shemkus, *As States Look to Cut Transportation Emissions, RGGI Offers A Model - And Room to Improve*, ENERGY NEWS NETWORK (Feb. 5, 2019), <https://energynews.us/2019/02/05/as-states-look-to-cut-transportation-emissions-rggi-offers-a-model-and-room-to-improve/>.

64. *See generally Overview of the Clean Air Rule*, WASH. DEP'T OF ECOLOGY, <https://ecology.wa.gov/Regulations-Permits/Laws-rules-rulemaking/Closed-rulemaking/WAC-173-442-441-Overview> (summarizing the clean air rule); *Ass'n of Washington Bus. v. Washington Dep't of Ecology*, 455 P.3d 1126, 1138 (Wash. 2020).

65. S. 2085, 117th Cong. (2021–2022)

66. H.R. 2307, 117th Cong. (2021–2022).

generating revenue for transportation investments.⁶⁷ The most effective strategies include low-emission zones and congestion pricing, which restrict access to a given segment of a city based on vehicle engine type.⁶⁸ In order for these policies to be effective and equitable, it is critical that the revenues generated from the zones are reinvested in transit and active transport modes (e.g., walking and cycling).⁶⁹ As discussed previously, the U.S. Department of Transportation recently established a national motor vehicle per-mile user fee pilot program.

5. Role of Shared E-Bicycles and E-Scooters in Reducing Transportation Emissions

Encouraging people to use active modes of transportation, like bicycling, scooters, and walking is an important step to shift people out of single-occupancy vehicles. Improving roadways so that streets are safer for pedestrians and cyclists can result in a reduction in motorized VMT and GHG emissions, by replacing vehicle trips and providing a feeder service to transit.⁷⁰ An exemplary policy is California's Active Transportation Program in 2013 (resulting from S.B. 99).⁷¹ The goals of the program are to improve public health and make California a leader in active transportation, while supporting California's GHG reduction goals.⁷²

III. DECARBONIZING THE LIGHT-DUTY VEHICLE SECTOR

In addition to redesigning transportation to include alternate modes, decarbonizing the vehicle fleet is essential. This section dives deeper into policy strategies for decarbonizing the light-duty fleet. Cars and light trucks make up a significant share of emissions from transportation.⁷³ ZEVs include plug-in electric vehicles (PEVs) or battery electric vehicles (BEVs), and also

67. U.S. DEPT. OF TRANSP., SYNTHESIS OF CONGESTION PRICING-RELATED ENVIRONMENTAL IMPACT ANALYSES 23 (2010).

68. See generally *Applications for the Environment: Real-Time Information Synthesis (AERIS): Low Emissions Zones: Operational Concept*, U.S. DEP'T OF TRANSP., https://www.its.dot.gov/research_archives/aeris/pdf/AERIS_Capstone_ExecSummary.pdf (last visited Jan. 22, 2022).

69. D'Agostino *supra* note 11, at 22–23.

70. See Louise Bedsworth et al., *Driving Change: Reducing Vehicle Miles Traveled in California*, PUB. POL'Y INST. OF CAL. (2011), https://www.ppic.org/content/pubs/report/R_211LBR.pdf.

71. *Active Transportation Program (ATP)*, CAL. TRANSP. COMM'N, <https://caltc.ca.gov/programs/active-transportation-program> (last visited Jan. 22, 2023).

72. *Active Transportation Program Fact Sheet*, CAL. TRANSP. COMM'N (Jan. 2020), <https://dot.ca.gov/-/media/dot-media/programs/local-assistance/documents/atp/2020/atpfactsheet20202024.pdf>.

73. *Fast Facts on Transportation Greenhouse Gas Emissions*, U.S. ENV'T PROT. AGENCY, <https://www.epa.gov/greenvehicles/fast-facts-transportation-greenhouse-gas-emissions> (last visited Jan. 22, 2022).

include fuel cell electric vehicles (FCEVs/FCVs). While they have batteries, plug-in hybrid electric vehicles (PHEVs) are not considered to be ZEVs.⁷⁴

A. Supply-Side ZEV Policies

On the supply-side there are certain policy levers that aim to stoke the ZEV market and increase production volumes, competition, and reduce prices.⁷⁵ State or federal programs that buy out and decommission older vehicles, such as the “Cash for Clunkers” programs have high costs but have broader public appeal than punitive ICE on-road bans. A graduated approach to achieving ZEV fleet-wide adoption is more common, where a set of incremental goals are identified.⁷⁶

1. ZEV Phasing: International ZEV

ZEV goal setting can occur by executive order (EO), legislative action, or by regulatory action.⁷⁷ Codifying goals is an important guiding step that can enable regulatory authorities to take actions to meet the goals in the EO or statute and set more effective supply-side policies.⁷⁸

Norway has the world’s most ambitious timeline and plans to ban ICE car sales as well as light vans after 2025.⁷⁹ This policy is accompanied by a set of strong ZEV-supportive policies, including purchase incentives, exemption from sales taxes, exemptions from tolls on all roads, and free parking. Currently, as of 2022 65% of new sales are ZEVs. Many countries are starting by setting limits on the sales of new vehicles (which will hasten the turnover of vehicles on the road) and fewer are setting timelines for

74. See generally Josh Goldman, *Comparing Electric Vehicles*, UNION OF CONCERNED SCIENTISTS, <https://blog.ucsusa.org/josh-goldman/comparing-electric-vehicles-hybrid-vs-bev-vs-phev-vs-fcev-411> (last updated June 26, 2020).

75. Tejvan Pettinger, *Supply Side Policies*, ECON. HELP (Oct. 30, 2019), <https://www.economicshelp.org/macroeconomics/economic-growth/supply-side-policies/>.

76. Marianne Tyrrell & John C. Dernbach, *The “Cash For Clunkers” Program: A Sustainability Evaluation*, 42 U. TOL. L. REV. 467 (2011).

77. *Governor Newsom Announces California Will Phase Out Gasoline-Powered Cars & Drastically Reduce Demand for Fossil Fuel in California’s Fight Against Climate Change*, Off. of Governor Gavin Newsom, STATE OF CAL. (Sept. 23, 2020), <https://www.gov.ca.gov/2020/09/23/governor-newsom-announces-california-will-phase-out-gasoline-powered-cars-dramatically-reduce-demand-for-fossil-fuel-in-californias-fight-against-climate-change/>.

78. Mollie D’Agostino et al., *Global Census of Zero Emission Vehicle Goals*, (2022), https://policy.institute.ucdavis.edu/sites/g/files/dgvnsk9866/files/media/documents/ZEV%20Goals_2022_Formatted%20Version_2022.1.25.pdf.

79. *National Transport Plan 2018–2029*, NORWEGIAN MINISTRY OF TRANSP. & COMM’N 30, <https://www.regjeringen.no/contentassets/7c52fd2938ca42209e4286fe86bb28bd/en-gb/pdfs/stm201620170033000engpdfs.pdf> (last visited Jan. 22, 2022).

restricting road access for gas-powered vehicles.⁸⁰ Fourteen countries have set a 100% ZEV goal of 2030 (Austria, Barbados, Belgium, Cyprus, Denmark, Germany, Iceland, Ireland, Israel, Luxembourg, Malaysia, Netherlands, Slovenia, Sweden) (note some of these goals do include PHEVs).⁸¹ Many other nations are aiming for 2035 after a COP26 memorandum of understanding was circulated.⁸² China will limit auto sales to ZEVs and plug-in hybrids by 2035⁸³ (which aligns with California's goal). France, Spain, and Canada will limit sales to ZEVs by 2040.⁸⁴ The City of Paris will ban ICE vehicles from entering Paris's Low Emission Zone after 2030.⁸⁵ This approach takes ICE sales restriction goals one step further than a sales ban.

While these timelines are subject to change, there are important differences to point out regarding the scale of these markets. The U.S. is now the third largest market globally with approximately 668,000 EV sales in 2021, making up about 4% of new LDV sales for 2021. As of 2020 Europe edged out the US for the second most EVs, with Germany is the second largest EV market. China has remained the largest EV market globally, with over 1 million EVs in 2018, accounting for 56% of global EV sales and 2.58 million in 2019.⁸⁶ The Chinese auto market is a dominant force for global electrification, but availability and tastes vary considerably between Chinese markets and elsewhere.⁸⁷ U.S. consumers prefer midsize and large vehicles,

80. *Gasoline Vehicle Phaseout Advances Around the World*, CULTURA, <https://www.cultura.org/world-gasoline-phaseouts#:~:text=The%20EU%20wants%20to%20phase,countries%20have%20announced%20similar%20plans.&text=Many%20countries%20are%20planning%20for,ban%20for%20new%20car%20sales> (last visited Jan. 22, 2022).

81. Mollie D'Agostino et al., *Global Census of Zero Emission Vehicle Goals* (2022), https://policyinstitute.ucdavis.edu/sites/g/files/dgvnsk9866/files/media/documents/ZEV%20Goals_2022_Formatted%20Version_2022.1.25.pdf.

82. *COP26 Declaration on Accelerating the Transition to 100% Zero Emission Cars and Vans*, (2021), <https://www.gov.uk/government/publications/cop26-declaration-zero-emission-cars-and-vans/cop26-declaration-on-accelerating-the-transition-to-100-zero-emission-cars-and-vans>.

83. *China Explores Ambitious Goal for EV Sales 2035*, AUTOMOTIVE NEWS (Sept. 8, 2019), <https://www.autonews.com/china/china-explores-ambitious-goal-ev-sales-2035>.

84. *Zero Emission Vehicle Infrastructure Program*, GOV'T CAN., <https://www.nrcan.gc.ca/energy-efficiency/energy-efficiency-transportation/zero-emission-vehicle-infrastructure-program/21876> (last visited Jan. 22, 2022).

85. Yoann Bernard et al., *Impacts Of The Paris Low-Emission Zone and Implications For Other Cities*, INT'L COUNCIL ON CLEAN TRANSP. 6 (Mar. 2020), <https://theicct.org/publications/true-paris-low-emission-zone>.

86. *Electric Vehicles*, INT'L ENERGY AGENCY, <https://www.iea.org/reports/electric-vehicles> (last visited Jan. 22, 2022).

87. Shiqi Ou et al., *Light-Duty Plug-In Electric Vehicles in China: An Overview on the Market and its Comparisons To The United States*, 112 RENEWABLE & SUSTAINABLE ENERGY REV. 747, 750 (2019).

whereas micro-compact and compact vehicles were the most popular in China.⁸⁸

Furthermore, while ZEV goals are important, they need to be backed by strong supportive policies to facilitate a transition towards the intended goals. China's steep ZEV adoption curve was the direct result of a large set of supportive policies. In 2013 China began subsidizing the production of ZEVs, offering suppliers a subsidy that aimed to make up the cost difference between ZEV production and gas-powered vehicle production.⁸⁹ In 2013 China also set targets on the city level for ZEV adoption and provided support for meeting the targets.⁹⁰ Purchase incentives were originally mapped to sunset in 2020, with annual 10–20% reductions in incentives.⁹¹ However, in April of 2020, they announced plans to extend subsidies through 2022, and continue reducing, but not eliminating purchase incentives.⁹² Despite promising advancement in battery technology in China that will lead to price parity for electric vehicles (EVs) in the next 5 to 7 years, government intervention will still be necessary in order to hasten the pace of widespread vehicle electrification.⁹³

2. Domestic ZEV Phasing

Twenty-nine U.S. states have at least one stated or formal goal for ZEV adoption, with most of those goals emerging from inter-state agreements and compacts.⁹⁴ California recently passed an EO setting a goal for 100% of sales of passenger cars, trucks, and drayage trucks to be ZEVs by 2035.⁹⁵ The EO also stipulates that all off-road vehicles in use be electrified by 2035 and instructs CARB to begin work on a rule that would codify the goal.⁹⁶ The EO does provide a caveat for sales of heavy-duty vehicles, and these are instructed to be electrified by 2045 “everywhere feasible” (Executive Order

88. Yilei Sun & Brenda Goh, *GM Venture's Mini Car Becomes China's Most Sold EV, Surpassing Tesla's Model 3*, REUTERS (Sept. 15, 2020), <https://www.reuters.com/article/gm-electric-china/gm-ventures-mini-car-becomes-chinas-most-sold-ev-surpassing-teslas-model-3-idUSKBN25Z1E6>.

89. *Notice on Continuing to Promote and Apply New Energy Vehicles* Caijian (2013), http://www.gov.cn/zwqk/2013-09/17/content_2490108.htm.

90. *Id.*

91. *Id.*

92. Yilei Sun & Brenda Goh, *China to Cut New Energy Vehicle Subsidies by 10% this Year*, REUTERS (Apr. 23, 2020), <https://www.reuters.com/article/us-china-autos-electric-subsidies/china-to-cut-new-energy-vehicle-subsidies-by-10-this-year-idUSKCN225177>.

93. Ou et al. *supra* note 87.

94. Mollie D'Agostino et al., *Global Census of Zero Emission Vehicle Goals* (Jan. 25, 2022), https://policyinstitute.ucdavis.edu/sites/g/files/dgvnsk9866/files/media/documents/ZEV%20Goals_2022_Formatted%20Version_2022.1.25.pdf.

95. Ou et al. *supra* note 87.

96. Cal. Exec. Order No. N-79-20 (Sept. 23, 2020).

N-79-20), which is in line with the Advanced Clean Truck Rule, also finalized in 2020.⁹⁷

In taking this step California has set a precedent that other states could adopt, after the EO is codified in August 2022. In 2021, several other states pledged to adopt California's goals—Massachusetts, Washington, and Virginia have informally adopted California's ZEV targets.

B. The Fiscally Sustainable ZEV Consumer Incentives: A Feebate

There is some debate about when ZEV consumer incentives can and should sunset to ensure the ZEV market matures rapidly while ensuring sound use of public funds.⁹⁸ However, at least until the ZEV market reaches purchase cost parity with gas cars, both monetary and non-monetary ZEV incentives will encourage faster ZEV adoption than the market alone would deliver.⁹⁹

The National Conference of State Legislatures report that 47 states and the District of Columbia provide some incentives for EVs and PHEVs.¹⁰⁰ As of December 2020, California offered the largest total state incentive package (\$11,000) for low-income EV buyers,¹⁰¹ but has since reformed this incentive and as of May 2022 now offers \$9,000 in state incentives.¹⁰² These state incentives can be coupled with the Federal EV Credit (\$7,500), assuming applicants have a \$7,500 tax liability.¹⁰³

Smart fiscal policy is needed to ensure the sustainability of ZEV credits. In a 2020 review of ZEV policies UC Davis researchers, Scott Hardman and Dan Sperling, conclude that “incentives tend to decrease in value over time, as increasing sales make them more costly for governments.”¹⁰⁴ The authors warn that governments will need to identify reliable funding sources for incentives and suggest a “feebate” structure that charges high-emitting

97. *Id.*

98. PETER SLOWIK ET AL., INT'L COUNCIL ON CLEAN TRANSP., FUNDING THE TRANSITION TO ALL-ZERO EMISSION VEHICLES 30 (2019).

99. *Id.* at 3.

100. Kristy Hartman & Laura Shields, *State Policies Promoting Hybrid and Electric Vehicles* (2021), <https://www.ncsl.org/research/energy/state-electric-vehicle-incentives-state-chart.aspx>.

101. See Jameson Dow, *California Adds \$1,500 Incentive for New EVs, Total State + Fed Incentives Now Up to \$13.5K*, ELECTREK (Nov. 17, 2021), <https://electrek.co/2020/11/17/california-adds-1500-incentive-for-new-evs-total-state-fed-incentives-now-up-to-14-5k-until-end-of-year/> (listing the state and federal EV incentives available to Californians).

102. *Drive Clean CA*, CAL. AIR RES. BD., <https://driveclean.ca.gov/search-incentives> (last visited May 3, 2022).

103. *Incentives*, PLUGSTAR, <https://plugstar.zappyride.com/tools/incentives> (last visited Jan. 22, 2022).

104. *EV Uptake in the Transport Fleet: Consumer Choice, Policy Incentives and Consumer-Centric Business Models*, 122 OXFORD ENERGY F. (July 2020), <https://www.oxfordenergy.org/wpcms/wp-content/uploads/2020/07/OEF122.pdf>.

vehicles to subsidize ZEVs as a viable solution for maintaining the long-term viability of ZEV incentives.¹⁰⁵ Such a self-funded system would ensure that there is a reliable source for ZEV incentives, and this will help in sending the right price signals to consumers.¹⁰⁶ As governments approach their ZEV goals, they could leverage the feebates to put additional pressure on the late adopters.

While the current focus of feebate mechanisms has been to incentivize both BEV and PHEV sales, certain aspects of the mechanism will need a different approach to push for a ZEV transition, while addressing equity concerns for producers and, especially, consumers.

In Europe there are many more mature examples of CO₂-based vehicle taxation that operate like a feebate.¹⁰⁷ About 23 out of 31 countries in Europe have some form of CO₂-based vehicle taxation. France has one of the most mature feebates in operation, also known as the ‘Bonus-Malus’ scheme. Over time, the French feebate has turned revenue surplus, allowing for additional funds to be utilized for other EV infrastructure investments including charging, over and above the funding for EV purchase rebates. The Netherlands taxes CO₂ by way of a circulation tax and a registration tax. More recently, since 2017, countries such as France, Germany, the UK have revised their feebates to introduce more stringent emission fees, while countries such as Sweden and Italy have introduced feebates in 2018 and 2019, respectively.¹⁰⁸

The U.K. has a circulation tax paid annually.¹⁰⁹ Cambridge Econometrics conducted an analysis in 2013 of European CO₂-based or feebate systems, demonstrating that consumers are responsive to feebate systems.¹¹⁰ Similar results from a 2012 study by Klier and Linn showed success of the feebate approach in France, Germany, and Sweden. At the same time, while the UK has revised the CO₂-based fee on LDVs, it has reduced the rebate for EVs significantly, resulting in concerns around affordability of EVs for a mass transition.¹¹¹

An example of a nascent feebate system can also be found in New Jersey.¹¹² To register a new vehicle in New Jersey buyers must pay a 0.4%

105. *Id.*

106. *Id.*

107. *The Effectiveness of CO₂ Based ‘Feebate’ Systems in the European Passenger Vehicle Market Context*, INT’L COUNCIL ON CLEAN TRANSP. (Nov. 1, 2013), <https://theicet.org/publications/effectiveness-co2-based-fee-bate-systems-european-passenger-vehicle-market>.

107. *Id.*

108. *Id.*

109. *Id.*

110. *Id.*

112. *New Jersey Laws and Incentives*, U.S. DEP’T OF ENERGY, <https://afdc.energy.gov/laws/all?state=NJ> (last visited Jan. 22, 2022).

fee for new vehicles that have fuel efficiency ratings below 19 mpg or are over \$45,000.¹¹³ This type of fee system represents an element of a feebate structure, although these fees are not solely responsible for funding the other consumer incentive benefits.¹¹⁴

In a detailed review of European feebates, researchers found that current feebate mechanisms incentivize a shift to both PHEVs and ZEVs, but there are key design elements that will need to be incorporated to facilitate a shift towards a higher ZEV ratio. They recommend that periodic revisions to the feebate mechanism provide a continuous signal to the market resulting in a greater shift to EVs by manufacturers and consumers. Feebates need not exist in perpetuity, and will be needed to create sufficient disincentive towards ICE purchases initially, and beyond a certain inflexion point of new EV sales becoming a significant share of total LDV sales, the feebate design can be adjusted to generate marginal revenues from non-zero emission vehicles (including PHEVs) which can be used for investments in charging infrastructure, and prioritizing other equity issues in affordability of ZEVs. More importantly, the paper finds that feebates are most effective with legislative backing, which creates a clear stream of fee revenue that can sustain rebates and other fiscal incentives for purchase of ZEVs. For the US LDV market, the authors find that over 56% of the sales in 2021 were emitting more than 300 gCO₂/mi, with average fuel efficiency ranging from 15 mpg to 28 mpg, far from the new 40.6 mpg CAFE target set by NHTSA for the 2024 Model Year. It is estimated that if a potential feebate mechanism for the US LDV market were to be implemented from 2023, the fee impact will be less than 1.5% of total revenue from LDV sales up to 2030.¹¹⁵

Monetary incentives are the most impactful type of consumer incentive. In a study of all 50 states consumer purchasing behavior is found to be most responsive to monetary purchase incentives.¹¹⁶ In a similar study, researchers surveyed California plug-in vehicle buyers between 2010 and 2017 and found that in ordered ranking the federal tax credit was rated as most important) in their decision to purchase a ZEV.¹¹⁷ Notably, at the time of the survey Federal incentives were the largest incentive, and in some cases there are more state and local incentives. Ranked as the second most important incentive was the State of California program, the Clean Vehicle Rebate Program (CVRP), which was the only available state financial incentive at the time.¹¹⁸ Ranked last was the high occupancy vehicle (HOV) lane access

113. N.J. Rev Stat § 39:3-8.4 (2013).

114. Sherilyn Wee et al., *Do Electric Vehicle Incentives Really Matter? Evidence from the 50 U.S. States*, 47 RSCH. POL'Y 1601, 1604 (2018).

115. Aditi Ramji, et al., *Vehicle Feebate Designs: Lessons Learned for a Zero Emissions Future*, *Institute of Transportation Studies*, U. CAL. DAVIS (DRAFT 2022).

116. *Id.*; Alan Jenn et al., *An In-Depth Examination of Electric Vehicle Incentives: Consumer Heterogeneity and Changing Response Over Time*, 132 TRANS. RSCH. PART A: POL'Y & PRAC. 97, 108 (2020).

117. Jenn et al., *supra* note 116.

118. Alan Jenn et al., *Effectiveness of Electric Vehicle Incentives in the United States*, 119 ENERGY POL'Y 349, 351 (Feb. 2020), <https://doi.org/10.1016/j.enpol.2018.04.065>.

sticker incentives.¹¹⁹ There are many factors that will influence the effectiveness of incentives:

Cash Incentives (as of May 2022): the larger the incentives the more effective they are. UC Davis researchers found that for “every \$1000 offered as a rebate or tax credit increases average sales of electric vehicles by 2.6%.”¹²⁰

- California offers \$9,000 for low-income ZEV buyers. The incentives topped out in 2020 when state incentives had a maximum payout of \$11,000 in a combination of grants, discounts, and rebates (the max payouts are only for low-income ZEV buyers, see more on income-based incentives below).¹²¹
- Maine has a similarly tiered system, offering the largest \$8,000 incentive for Battery Electric Work Van or Cargo vans a \$7,500 incentive for battery electric vehicle purchased by a government or tribal entity (up to \$5,500 for low-income and a \$2,000 rebate for the general population).¹²²
- Colorado offers a tax credit of up to \$5,500 for light-duty trucks and \$5,000 for light-duty passenger vehicles until January 2021, after which they will reduce incentives to \$3,500 and \$2,500 respectively.¹²³
- New Jersey has instituted a maximum \$5,000 state incentive.¹²⁴ New Jersey also offers a sales tax exemption on top of the rebate, which equals an additional 6.625% savings.¹²⁵
- Vermont now offers a maximum of \$4,000 ZEV rebate. Notably Vermont, as of November 2020, had to pause their ZEV incentive

119. *Id.*

120. *Id.*; see generally *Massachusetts v. EPA*, 549 U.S. 497 (2007) (ruling that EPA has authority to regulate greenhouse gases from vehicles).

121. *Incentives*, *supra* note 103.

122. *Electric Vehicle Rebates*, EFFICIENCY MAINE, <https://www.energymaine.com/electric-vehicle-rebates/> (last visited May 3, 2022).

123. *Income 69: Innovative Motor Vehicle and Truck Credits for Electric and Plug-in Hybrid Electric Vehicles*, COLO. DEP’T OF REVENUE (Dec. 2019) <https://www.colorado.gov/pacific/sites/default/files/Income69.pdf>.

124. *Vermont Laws and Incentives*, U.S. DEP’T OF ENERGY, <https://afdc.energy.gov/laws/all?state=VT> (last visited Jan. 22, 2022).

125. *Air Quality, Energy, & Sustainability: Incentives to Drive Green*, U.S. DEP’T OF ENV’T PROT. (Feb. 2, 2021), <https://www.drivegreen.nj.gov/dg-electric-vehicles-affordability.html>.

system, having spent the \$1.1 million in state coffers authorized for plug-in purchase incentives before the end of 2020.¹²⁶

- Delaware,¹²⁷ Massachusetts,¹²⁸ and Oregon¹²⁹ offer \$2,500 rebates. Louisiana¹³⁰ offers a \$2,500 tax credit.¹³¹
- New York offers a \$2,000 rebate.
- Connecticut offers up to a \$1,500 rebate.¹³²

Income-Based Incentives: there is an important discussion about the equitability of purchase incentives to be had. Many states including Vermont, Maine, and California have instituted income caps on their EV incentive programs to direct funds towards more cost sensitive buyers.¹³³ In 2019 Vermont passed a bill identifying income eligibility requirements for capturing purchase incentives, setting eligibility caps that are 160% of “the State’s prior five-year average Median Household Income (MHI) level.”¹³⁴ This translated to incentives for Vermonters earning under \$96,122.¹³⁵ California instituted both an income cap and an extra bonus for very low-income buyers participating in the CVRP.¹³⁶ CVRP applicants get no financial award if their incomes are greater than \$150,000 for single filers, \$204,000 for head-of-household filers, and \$300,000 for joint filers.¹³⁷ If the buyers also fall below 300% of federal poverty levels (\$78,600 for a family

126. *Purchase Incentives*, DRIVE ELECTRIC VT., <https://www.driveelectricvt.com/why-electric/purchase-incentives> (last visited Jan. 22, 2022).

127. *The Delaware Clean Vehicle Rebate Program*, STATE OF DEL., <https://dnrec.alpha.delaware.gov/climate-coastal-energy/clean-transportation/vehicle-rebates/> (last visited Jan. 22, 2022).

128. *Massachusetts Laws and Incentives*, U.S. DEP’T OF ENERGY, ALT. FUELS DATA CTR., <https://afdc.energy.gov/laws/all?state=MA> (last visited Jan. 22, 2022).

129. *Oregon Clean Vehicle Rebate Program, Frequently Asked Questions*, OR. DEP’T OF ENV’T QUALITY (last updated Jan. 27, 2020), <https://www.oregon.gov/deq/FilterDocs/zev-faq.pdf>.

130. *Electricity Laws and Incentives*, U.S. DEP’T OF ENERGY, <https://afdc.energy.gov/fuels/laws/ELEC?state=LA> (last visited Jan. 22, 2022).

131. LA. STAT. ANN. § 47:6035(D) (2021).

132. *Electric Vehicle & Solar Incentives*, TESLA., <https://www.tesla.com/support/incentives> (last visited Jan. 22, 2022).

133. *Id.*

134. H. 529, (Vt. 2014), <https://legislature.vermont.gov/Documents/2020/Docs/ACTS/ACT059/ACT059%20As%20Enacted.pdf>

135. *Plug-In Electric Vehicle (PEV) Incentive*, U.S. DEP’T OF ENERGY, <https://afdc.energy.gov/laws/12230> (last visited Jan. 22, 2022).

136. *Income Eligibility*, CLEAN VEHICLE REBATE PROJECT (Mar. 29, 2016), <https://cleanvehiclerebate.org/eng/income-eligibility>.

137. *Id.*

of four) they qualify for a full \$4,500 rebate, and they can apply for up to a \$5,000 grant, and a \$1,500 discount at the dealership.¹³⁸

Non-Monetary Incentives: non-monetary incentives play a complementary role to monetary incentives. Non-monetary incentives include access to high occupancy vehicle (HOV) lanes can also incent consumer interest.¹³⁹ These include lane access for peak hour commuting, charging, or parking perks, fee, or toll waivers, as well as licensing incentives.¹⁴⁰ New Jersey and California are among the states that offer non-monetary incentive options, such as lane access, toll discounts, or exemptions.¹⁴¹

Timing of Incentives: the timing of incentives is also a critical factor for influencing purchase decisions.¹⁴² Instantaneous discount options are likely the most effective, yet most state ZEV consumer incentives require customers to file for a reimbursement.¹⁴³ The CVRP offers a reimbursement approximately six weeks after the vehicle purchase paperwork is submitted.¹⁴⁴ Delaware has an eight to ten week ZEV rebate request wait time.¹⁴⁵ For example, when Colorado offers a tax credit, the timing of the credit could be delayed depending on when the purchase and tax filing occurs.¹⁴⁶ California has provided an alternative option for pre-sale grants for low-income buyers since 2018.¹⁴⁷ Recently California also opened a pilot to

138. *Id.*

139. Thomas Stephens et al., *Incentivizing Adoption of Plug-in Electric Vehicles: A Review of Global Policies and Markets*, U.S. DEP'T OF ENERGY, OFF. OF SCI. AND TECH. INFO. (Jun. 1, 2018), <https://www.osti.gov/biblio/1480507-incentivizing-adoption-plug-electric-vehicles-review-global-policies-markets>.

140. Scott Hardman, *Understanding the Impact of Reoccurring and Non-financial Incentives on Plug-in Electric Vehicle Adoption – A Review*, 132 TRANSP. RSCH. POL'Y & PRAC. 97, 10-13 (2019).

141. *Id.*

142. ZIFEI YANG ET AL., THE INT'L COUNCIL ON CLEAN TRANSP., PRINCIPLES FOR EFFECTIVE ELECTRIC VEHICLES INCENTIVE DESIGN 29 (2016).

143. See generally Kristy Hartman & Laura Shields, *State Policies Promoting Hybrid and Electric Vehicles*, NAT'L CONF. STATE LEGISLATORS (Mar. 12, 2021), <https://www.ncsl.org/research/energy/state-electric-vehicle-incentives-state-chart.aspx> (last visited Jan. 22, 2022).

144. *FAQs*, CLEAN VEHICLE REBATE PROGRAM, <https://cleanvehiclerebate.org/eng/faqs> (last visited Jan. 22, 2022).

145. The Delaware Clean Vehicle Rebate Program, STATE OF DEL., <https://dnrec.alpha.delaware.gov/climate-coastal-energy/clean-transportation/vehicle-rebates/> (last visited Jan. 22, 2022).

146. Tamara Chuang, *As More Electric Vehicles are on the Way, Colorado's Tax Incentives Begin to Wind Down*, COLO. SUN (Mar. 9, 2020), <https://coloradosun.com/2020/03/09/evs-electric-vehicles-tax-incentives-refund-colorado-tesla-zev/>.

147. *Choose the Vehicle that is Right For You*, CLEAN VEHICLE ASSISTANCE PROGRAM, <https://cleanvehiclegrants.org/vehicles/> (last visited Jan. 22, 2022).

expand pre-sale grants to all income groups.¹⁴⁸ The pilot program is called Rebate Now, and allows customers in San Diego County to get pre-approval that will allow them to apply their rebate as a down payment for the vehicle purchase.¹⁴⁹

Secondary Markets: California's Clean Vehicle Assistance Program offers up to \$5,000 for a new or used ZEV or PHEV.¹⁵⁰ In order to qualify, used vehicles must have less than 75,000 miles or be less than eight years old.¹⁵¹ There are several programs that are administered by California's air districts that allow for incentives for used vehicle purchases. Many local air districts are offering used vehicle incentives. For example, the South Coast Air Quality Management District has a program that offers \$5,000 to \$9,500 for used vehicles within certain qualifying areas.¹⁵²

C. State ZEV Coalitions

Another method allowing states to move forward with ZEV initiatives are coalitions. Various states have joined together producing state coalitions that have been able to leverage support between member states and make ZEV goal setting easier and more achievable.¹⁵³ The Multi-State ZEV Task force (ZEV Memorandum of Understanding; ZEV MOU), the ZEV Alliance, and the Multi-State Medium- and Heavy-Duty Zero Emissions Vehicle MOU (MHDV ZEV MOU).¹⁵⁴

Three major interstate compacts have garnered state signatories:

- Multi-State ZEV Task Force: California, Connecticut, Maine (2019), Maryland, Massachusetts, New Jersey (2018), New York, Oregon, Rhode Island, and Vermont are part of the Multi-State ZEV Task force and have the collective goal of putting 3.3 million ZEVs on the

148. *State and Federal Electric Vehicle Incentives*, CLEAN VEHICLE REBATE PROJECT, <https://cleanvehiclerebate.org/eng/cv/incentives/state-and-federal> (last visited Jan. 22, 2022).

149. *Id.*

150. *Evolving Health and Economic Crisis Impacts on the CVA Program*, CLEAN VEHICLE ASSISTANCE PROGRAM, <https://cleanvehiclegrants.org/faq/> (last visited Jan. 22, 2022).

151. *Id.*

152. *Replacement Options*, S. COAST AIR QUALITY MGMT. DIST., <https://xapprod.aqmd.gov/RYR/Home/ReplacementOptions> (last visited Jan. 22, 2022).

153. *Multi-State ZEV Action Plan*, NE STATES FOR COORDINATED AIR USE MGMT., ZEV TASK FORCE (2018), <https://www.nescaum.org/documents/2018-zev-action-plan.pdf>.

154. *Id.*

road by 2025.¹⁵⁵ While this interstate compact was originally formed in 2013 with eight signatories, New Jersey signed on in 2018 and Maine in 2019.¹⁵⁶ Important to note, the ZEV MOU also requires states to invest in ZEV infrastructure, consider ZEV incentives, and establish state goals for public fleets.¹⁵⁷

- ZEV Alliance: California, Connecticut, Maryland, Massachusetts, New York, New Jersey (2019), Oregon, Rhode Island, Vermont, and Washington (2019) are also part of the international compact ZEV Alliance.¹⁵⁸ Their shared goal is to make all passenger vehicle ZEVs by 2050.¹⁵⁹ Similarly to the ZEV MOU, most states signed on in 2015, with New Jersey and Washington joining in 2019.¹⁶⁰

Thus far, these state coalitions have accomplished so much more than they would have on their own. Specifically, the Multi-State ZEV Task Force has already successfully implemented or is close to implementing many of their 2014 Action Plans recommendations. These recommendations range from enacting ZEV purchase and infrastructure incentive programs to establishing a state or dealership workgroup; to fostering collaboration with dealers; to opening up public utility commission proceedings; to considering utility and transportation electrification programs.¹⁶¹

D. Light-Duty Public and Private Fleet Electrification

Electrifying public and commercial fleets present significant opportunities. Economies of scale encourage bulk purchasers to consider the total costs of ownership more carefully, which in many cases will favor EVs.¹⁶² This will be especially true for light-duty vehicles operating with

155. *Multi-State ZEV Action Plan 2*, ZEV PROGRAM IMPLEMENTATION TASK FORCE, (May 2014) <https://www.nescaum.org/documents/multi-state-zev-action-plan.pdf> (2014).

156. *Id.*

157. *Id.* at 14, 19, 30

158. *Members*, ZEV ALLIANCE, <http://www.zevalliance.org/members/> (last visited Jan. 22, 2022).

159. *Id.*

160. *Id.*

161. *California Applauds Multi-State Coalition's Releases New Zero-Emission Vehicle Action Plan*, CAL. AIR RES. BD. (June 20, 2018), <https://ww2.arb.ca.gov/news/california-applauds-multi-state-coalitions-releases-new-zero-emission-vehicle-action-plan>.

162. Tom Gelinis, *Calculating Cost of Ownership, Especially for a Private Fleet, This is a Figure that's Important to Know, But Not One That's Easy to Calculate*, FLEET EQUIP. MAG. (Apr. 17, 2013), <https://www.fleetequipmentmag.com/calculating-cost-of-ownership/>.

VMT within the ranges of ZEVs available in the market today.¹⁶³ ZEV fleets can also be a source for increasing data collection efforts to coordinate making efficient use of different fleet vehicles to meet organizational needs and maximize energy efficiency.¹⁶⁴

Barriers to public sector fleet electrification can include procurement challenges associated with separate capital and operating budgets, which can mean that those making decisions to purchase EVs may not be the same offices tasked with charging and maintenance of the vehicles.¹⁶⁵ This is where ensuring buy-in from all stakeholders is critical to ensure the successful integration of the EV vehicles into the fleet.

Massachusetts offers public agencies, governments, colleges, and universities a per vehicle incentive of \$7,500 towards the costs of ZEV procurement.¹⁶⁶ This far exceeds the \$2,500 offered to individuals, organizations, and companies.¹⁶⁷

1. Commercial Fleets: Focus on Transportation Network Company Electrification

Transportation Network Companies (TNC) vehicles, or ride-hailing vehicles, (e.g. Uber and Lyft) represent a high-impact strategy for reducing emissions.¹⁶⁸ Under pre-pandemic market circumstances, non-pooled TNC vehicles drove more than three times more daily miles than personal vehicles and emitted 47% more GHGs per passenger mile.¹⁶⁹ While TNC vehicles made up a small percentage of overall vehicle use, the number of people who used TNCs had increased substantially over the last several years, doubling from 23% in 2015 to 46% in 2018.¹⁷⁰ TNC usage dropped by 63% in 2020 during the height of the COVID-19 pandemic, but blue collar riders were

163. ZEV PROGRAM IMPLEMENTATION TASK FORCE, *supra* note 155, at 28.

164. *Emissions Modeling, ZEV Programs, & Data Collection*, CAL. AIR RES. BOARD (May 9, 2019), <https://www.epuc.ca.gov/WorkArea/DownloadAsset.aspx?id=6442461296>.

165. TRANSPORTATION RESEARCH BOARD AND NATIONAL RESEARCH COUNCIL, *OVERCOMING BARRIERS TO DEPLOYMENT OF PLUG-IN ELECTRIC VEHICLES, CHAPTER 3: UNDERSTANDING THE CUSTOMER PURCHASE AND MARKET DEVELOPMENT PROCESS FOR PLUG-IN ELECTRIC VEHICLES* (2015).

166. *Massachusetts Laws and Incentives*, U.S. DEP'T OF ENERGY, <https://afdc.energy.gov/laws/all?state=MA> (last visited Jan. 22, 2022).

167. *Id.*

168. Alan Jenn, *Emissions Benefits of Electric Vehicles in Uber and Lyft Services*, UNIV. OF CAL., DAVIS, INST. OF TRANSP. STUD. (Aug. 2019), <https://scholarship.org/content/qt15s1h1kn/qt15s1h1kn.pdf?&open=1>.

169. Maria Cecilia Pinto de Moura et al., *Ride-Hailing's Climate Risks*, UNION OF CONCERNED SCIENTISTS 7 (Feb. 2020), www.ucusa.org/ride-hailing-climate-risks.

170. *Id.* at 5.

more consistently using TNCs during this time, and ridership levels among these workers dropped from 15.8% to 14.9%.¹⁷¹

The Uber third quarter earnings report in 2020 showed that mobility rides (i.e., rides with passengers) were down 50%, but delivery rides were up 135%, resulting in a 10% overall reduction in gross bookings year over year.¹⁷²

The two leading U.S. TNCs, Uber and Lyft, have both set ambitious ZEV phasing targets for their fleets, aiming for 2030.¹⁷³ In 2018 Uber pledged to make every car in their London app a ZEV by 2025.¹⁷⁴ In 2020 they expanded this goal, and pledged to convert the whole Uber platform in the U.S. and Europe to ZEVs by 2030.¹⁷⁵ Lyft also announced in 2020 that they are pledging to convert their entire U.S. passenger fleet to ZEVs by 2030.¹⁷⁶ Corporate pledges like this are common, and far from legally binding. However, these goals are worth mentioning to contextualize the corporate goals of the states and countries in which the companies are operating.

CARB has released a regulation order that set regulations to target TNC vehicle emissions.¹⁷⁷ This regulation is a result of the California legislature mandating CARB to create the Clean Miles Standard Program, after the passage of SB1014 in 2021 (Section 5431 of the Public Utilities Code).¹⁷⁸ SB1014 calls for a timeline of emissions reductions for TNCs using two metrics: (1) an EV miles traveled (eVMT) basis and (2) a GHG per passenger mile (PMT) basis.¹⁷⁹ This latter metric is notable, in that the GHGs/PMT metric allows flexibility for TNC operators to achieve emissions reductions by either reducing tailpipe emissions or by increasing occupancy per vehicle (sharing or pooling), or by generating transit trips, or making investments in bike or pedestrian infrastructure.¹⁸⁰ The regulations call for a 90% reduction

171. Grant Matson et al., *Policy Brief: Ridehailing Demand Is Resilient Among Low-Income Travelers During the COVID-19 Pandemic* (2021), <https://escholarship.org/uc/item/05z1x7m6>.

172. *Uber Announces Results for Third Quarter 2020*, UBER TECHS. (Nov. 5, 2020), <https://investor.uber.com/news-events/news/press-release-details/2020/Uber-Announces-Results-for-Third-Quarter-2020/default.aspx>.

173. Cal. Reg. Code § 2490, 2490.1, 2490.2, 2490.3, and 2490.4. (2021)

174. *The Clean Air Plan*, UBER TECHS., <https://www.uber.com/gb/en/ride-journey-to-electric/> (last visited Jan. 22, 2022).

175. Andrew J. Hawkins, *Uber Pledges to Shift to '100 Percent' Electric Vehicles by 2030*, THE VERGE (Sept. 8, 2020) <https://www.theverge.com/2020/9/8/21427196/uber-promise-100-percent-electric-vehicle-cv-2030>.

176. *Leading the Transition to Zero Emissions: Our Commitment to 100% Electric Vehicles by 2030*, LYFT (June 17, 2020), <https://www.lyft.com/blog/posts/leading-the-transition-to-zero-emissions>.

177. CAL. REG. CODE § 2490, 2490.1, 2490.2, 2490.3, and 2490.4. (2021).

178. CAL. PUB. UTIL. CODE § 5431 (2014).

179. *Id.*

180. *Clean Miles Standard*, CAL. CLEAN AIR RES. BD. <https://ww2.arb.ca.gov/our-work/programs/clean-miles-standard/about> (last visited Jan. 22, 2022).

in eVMT from TNCs by 2030, as well as a 0 GHG/PMT basis.¹⁸¹ Theoretically, the companies could meet both targets by bringing their fleet to 100% ZEVs, or they could bring 90% of their fleet to ZEVs and make up the remainder with other supportive credits offered within the Clean Miles Standard Program.¹⁸²

Local policymakers are also sending price signals to the TNCs to green their fleets. San Francisco passed a TNC taxation structure that requires riders to pay a 3.25% tax, except those who request a shared ride will only pay 1.5%.¹⁸³ This is incentivizing increasing the denominator of the GHG/PMT metric, and will send a price signal that reducing emissions is the preferred behavior.¹⁸⁴ Similarly the City of Phoenix began charging \$4.00 in 2019 and up to \$4.25 as of January 1, 2021 for TNC trips to the local airport (Phx Ariz., Code § 4-78(A)(1)).¹⁸⁵ These fees are discounted, “when drivers use alternative-fuel-powered or zero-emission vehicles or pick-up/drop-off passengers at PHX Sky Train stations located away from terminals.”¹⁸⁶

New York City is also sending price signals to riders regarding the full environmental costs of their TNC trips.¹⁸⁷ New York State is charging a 4% tax on gross fare trips in TNCs.¹⁸⁸ Inside Lower Manhattan there is an additional \$2.00 charge for solo-riders, and only a \$0.75 charge for riders using Lyft Share or Uber Pool.¹⁸⁹

2. TNC Charging Considerations

A significant barrier to EV adoption, especially among ride-hailing drivers, is the lack of availability for charging. Ride-hailing drivers have different driving and charging behavior than private vehicle owners.¹⁹⁰ For example, ride-hailing drivers tend to charge their vehicles at public charging

181. CAL. REG. CODE § 2490, 2490.1, 2490.2, 2490.3, and 2490.4. (2021)

182. *Id.*

183. Hannah Norman, *Uber, Lyft Agree to Proposed Ridehail Tax in San Francisco*, BUS. J. (Aug. 1, 2018), <https://www.bizjournals.com/sanfrancisco/news/2018/08/01/uber-lyft-agree-proposed-ridehail-tax-sf.html>.

184. *Traffic Congestion Mitigation Tax (TCM)*, TREASURER & TAX COLLECTOR, CITY & CNTY. OF S.F., <https://sf.treasurer.org/business/taxes-fees/traffic-congestion-mitigation-tax-tcm> (last visited Jan. 22, 2022).

185. PHX. ARIZ. CODE § 4-78(A)(1) (2016).

186. PHX. ARIZ. CODE § 4-78(A)(6) (2016).

187. *New York State Assessment on Transportation Network Companies*, N.Y. DEP'T OF TAX'N & FIN. (Jun. 23, 2017) https://www.tax.ny.gov/pdf/memos/multitax/m17_1m_1s.pdf.

188. *Id.*

189. Will Drickey, *No Relief in Sight for Cab Drivers on Taxi Congestion Pricing*, METRO U.S. (Jan. 17, 2019), <https://www.metro.us/no-relief-in-sight-for-cab-drivers-on-taxi-congestion-pricing/>.

190. Alan Jenn, *Emissions Benefits of Electric Vehicles in Uber and Lyft Services*, at 11–12, NAT'L CTR. FOR SUSTAINABLE TRANSP. (Aug. 2019).

stations during the day (rather than at home overnight).¹⁹¹ This could be good for the climate, given that in California the grid is cleaner during the day, due to solar energy capacity.¹⁹² More than 40% of public fast chargers were utilized by non-Tesla ride-hailing drivers, an astonishingly high number considering that less than 1% of EVs on the road are driven as TNCs.¹⁹³ In order to reach the goals set out by the Clean Miles Standard a widespread, affordable, fast charging network will need to be developed. This will likely require cooperation between TNCs, utilities, and charging companies.

IV. DECARBONIZING THE MEDIUM- AND HEAVY-DUTY VEHICLE SECTOR

While heavy-duty (HD) vehicles comprise approximately 10% of vehicles on the road in the U.S., they are responsible for 28% of GHG emissions and 45% of harmful on-road NOx emissions.¹⁹⁴ Furthermore, decarbonizing the heavy-duty sector has important equity implications. Disadvantaged communities are often disproportionately impacted by diesel and particular matter pollution. Thus, strategies that focus on the electrification of these vehicles are crucial to meet climate and electric vehicle and equity goals. The pathways discussed above can apply to light-, medium-, and heavy-duty vehicles, yet there are some strategies that are specific to the two latter categories. Because states are so distinct in character, composition, and goals, there are many different methods that can and should be considered when addressing electrification of the HD sector, ranging from planning and goal setting documents; to actual legislation or regulation; to incentives for industries, infrastructure, or directly to consumers.¹⁹⁵

A. Investments and Incentives

In the freight sector, there are many state-led ZEV programs that are targeting investments to move the industry towards electrification. In California, financial injections have been invested in multiple different sectors from infrastructure to monetary incentives for operators.¹⁹⁶

191. *Id.* at 9.

192. Sammy Roth, *California has Too Much Solar Power. That Might Be a Good Thing*, L.A. TIMES (June 5, 2019), <https://www.latimes.com/business/la-fi-solar-batteries-renewable-energy-california-20190605-story.html>.

193. Jenn, *supra* note 190, at 7.

194. Jimmy O'Dea, *Ready for Work, Now Is the Time for Heavy-Duty Electric Vehicles*, UNION OF CONCERNED SCIENTISTS (Dec. 11, 2019), <https://www.ucsusa.org/resources/ready-work>.

195. *Id.*

196. *Id.*

1. Supply-Side Investments

In California, CARB manages the Low Carbon Transportation Investments and Air Quality Improvement Program, established in 2007.¹⁹⁷ This Program leverages proceeds from cap-and-trade auctions to support the development of advanced technology and clean transportation in both the light- and heavy-duty sectors.¹⁹⁸ This program aims to fund pre-commercial demonstrations and early commercial pilots in order to improve research and development while informing the public and stakeholders of new technologies.¹⁹⁹ The goal of this program is to find mutually beneficial outcomes for society and industry.²⁰⁰

In November 2021, CARB approved \$1.5 billion dollars, the largest amount to date, to transform California's vehicle and equipment fleet to zero-emission, with \$843 million dedicated to heavy-duty and off-road equipment investments.²⁰¹ This funding will be applied to demonstrations and pilot projects, vouchers for advanced clean trucks, financing for small truck fleet transitions, and drayage trucks and transit and school buses. This mixed approach will allow the state to apply some funds to incentivize companies to research and innovate further to produce safer, more cost-effective technologies that will support the main goals for ZEV production.²⁰² By starting at the beginning of the timeline, these programs can fund feasibility assessments, research and development technologies, the pre-commercial stage, and early market entry to be involved at a grassroots level to shape and nurture the technologies that they eventually want to be widespread.²⁰³

2. Consumers Investments and Incentives

A few programs have been launched to lower the costs of obtaining and utilizing zero-emission vehicles. In 2009, California launched their Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP) which lowers the capital cost of electric vehicles through vouchers directly with dealers in order to accelerate the adoption of cleaner, more efficient trucks,

197. *Low Carbon Transportation Investments and Air Quality Improvement Program*, CAL. AIR RES. BD., <https://ww2.arb.ca.gov/our-work/programs/low-carbon-transportation-investments-and-air-quality-improvement-program/about> (last visited Jan. 22, 2021).

198. *Id.*

199. *The California Air Resources Board*, CAL. CLEAN AIR RES. BD. <https://ww2.arb.ca.gov/about> (last visited Jan. 22, 2022).

200. *Id.*

201. *CARB approves \$1.5 billion investment — largest to date — in clean cars, trucks, mobility options*, CAL. AIR RES. BD. (Nov. 19, 2021), <https://ww2.arb.ca.gov/news/carb-approves-15-billion-investment-largest-date-clean-cars-trucks-mobility-options>.

202. CAL. AIR RES. BD., *Heavy-Duty Investment Strategy*, at 6–8.

203. *Id.*; see discussion *infra* Section IV.2.H.

and buses.²⁰⁴ These vouchers reduce the average cost of fuel cell electric truck or bus by roughly 25%.²⁰⁵ These programs can prove effective as they consider market challenges and work to lower them for all communities.

Even with all of these seemingly robust methods of popularizing HD ZEVs and making them more accessible, it is important to consider the source of these funding opportunities as well. The biggest question, and often considered the biggest pitfall, of incentivization and electrification investments is: Where will this money come from? Federal funds are generally sought directly by local and municipal governments, whose goals vary across the state.²⁰⁶ Other sources of funds may be available on an ad hoc basis. For example, in California, the 2018 Volkswagen Mitigation Trust provides some extra resources and by consent decree, is dedicated to low-income or disadvantaged communities.²⁰⁷ It will be a challenge for regulators to consider the equity implications of these investments, while balancing the need for early market intervention.

B. Planning Documents and Tactics

California has been a leader in issuing planning documents to provide a vision that guides the zero-emission vehicle goal process.²⁰⁸ For the medium and heavy duty sector, the California Sustainable Freight Action Plan is a prime example of such visioning and this document focused on integrating several State agencies to revitalize the California freight transportation system.²⁰⁹ Prompted by an EO by Governor Brown in July 2015 the Action Plan laid out steps, goals, targets, investment opportunities, and pilot programs.²¹⁰ These were strategies to achieve the long-term 2050 goal for California's future freight transportation system to be reliable and efficient

204. *About HVIP*, CAL. HVIP, <https://californiahvip.org/about/> (last visited Jan. 22, 2022).

205. *Hybrid and Zero-Emission Truck and Bus Voucher Invention Project: Incentives for Clean Trucks and Buses*, CAL. AIR RES. BD., <https://californiahvip.org/> (last visited Jan. 22, 2022); see Alysha Webb, *California Embracing Hydrogen Fuel-Cell Buses*, WARDS AUTO (Oct. 18, 2018), <https://www.wardsauto.com/alternative-propulsion/california-embracing-hydrogen-fuel-cell-buses> (showing a \$315,000 price reduction for average cost of fuel cell bus of \$1.2 million); *Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP)*, CAL. AIR RES. BD., <https://ww3.arb.ca.gov/msprog/let/hvip.htm> (last visited Jan. 22, 2022).

206. Rebecca Lee, *Transportation Electrification*, at 7–9, CAL. PUB. UTIL. COMM'N (June 2016).

207. *Volkswagen Environmental Mitigation Trust for California*, CAL. AIR RES. BD., <https://ww2.arb.ca.gov/our-work/programs/volkswagen-environmental-mitigation-trust-california/about> (last visited Jan. 22, 2022).

208. See *California's 2017 Climate Change Scoping Plan*, CAL. AIR RES. BD., https://ww2.arb.ca.gov/sites/default/files/classic/cc/scopingplan/scoping_plan_2017.pdf.

209. *The California Sustainable Freight Action Plan*, CAL. AIR RES. BD., <https://ww2.arb.ca.gov/our-work/programs/california-sustainable-freight-action-plan/about> (last visited Jan. 22, 2022).

210. CALIFORNIA AIR RES. BD., MOBILE SOURCE STRATEGY 26 (May 2016).

by using zero-emission equipment everywhere feasible, and near-zero emission equipment powered by clean, low-carbon renewable fuels everywhere else.

The Sustainable Freight Action Plan highlights substantial and specific goals and promises that state agencies hope to achieve. Yet, it is documents like these that, on the surface, seemingly have so much potential, but lack the enforcement and legal teeth that typically come with legislative statutes or regulations from administrative agencies. California is not bound by this Action Plan and will face no punitive measures should they not meet the goals.²¹¹

CARB made some of the strategies in the Sustainable Freight Action Plan more concrete by first establishing a Mobile Source Strategy in 2016, which laid out many environmental mandates and goals.²¹² An update in 2020 (published in 2021) focused on strategies to reduce diesel, NO_x, and GHG emissions and estimated that 77% of California's heavy-duty fleet will be electric by 2045.

The 2020 Mobile Source Strategy listed the following legislative and regulatory strategies as top priorities for the state:

- *Manufacturer requirements to foster clean technology production and sales;*
- *In-use requirements to accelerate penetration of newer technology;*
- *Incentive programs to promote and accelerate the use of advanced clean technologies;*
- *Enhanced enforcement strategies to ensure programs are achieving their anticipated benefits;*
- *Outreach and education to increase consumer awareness and acceptance of advanced vehicle and equipment technologies; and*
- *Infrastructure planning and development to support the transition to cleaner technologies.*²¹³

These planning documents are a critical step towards achieving the goals set out in California's EO N-79-20, but they are not concrete actions until

211. See generally *id.* (omitting any punitive measure for failure to meet commitment targets).

212. 2016 *Mobile Source Strategy*, CAL. AIR RES. BD., <https://ww2.arb.ca.gov/resources/documents/2016-mobile-source-strategy> (last visited Jan. 22, 2022).

213. 2020 *Mobile Source Strategy*, CAL. AIR RES. BD. (2021), https://ww2.arb.ca.gov/sites/default/files/2021-12/2020_Mobile_Source_Strategy.pdf.

they are formally established as regulation.²¹⁴ This will occur during the forthcoming ACC II deliberation in 2022 and will enable CARB to develop regulations that will help direct the state towards these strategies.

C. Heavy Duty Electrification Regulations

Regulatory avenues are a necessary and effective pathway for decarbonizing the medium and heavy-duty sector. A seminal regulation is the Advanced Clean Truck regulation of 2020, which requires manufacturers to sell zero-emission trucks as an increasing percentage of their Annual California sales from 2024 to 2035.²¹⁵ This combined with the forthcoming ACC II policy will effectively compel industry to make necessary investments to meet the state's electric vehicle goals and provide the key drivers of the medium and heavy-duty vehicle market with more certainty and predictability.

D. Bus Electrification

California is applying what's referred to as a *beachhead strategy* to ZEV goals by targeting buses.²¹⁶ A beachhead strategy is a theory of change and technological application that drives programs as it infiltrates the market by first targeting an achievable market.²¹⁷ Transit buses, shuttle vans, and package delivery vans and trucks have been identified as the first zero-emission beachheads. These were chosen to increase volume through the electrification of large fleets which allows for more commercialization.²¹⁸ Furthermore, this would lead to lowering prices to economies of scale and to the sharing of wealth through componentry.²¹⁹ Thus, by starting ZEV transitioning with these vehicles, society is able to observe real change while industries are able to perfect and monitor the effects on types of operators, capabilities of technologies, and total costs of operations. Investments in these medium- and heavy-duty vehicles allows "research in daily vehicle use, economics, technological readiness, and the supplier base."²²⁰ Furthermore,

214. Cal. Exec. Order No. N-79-20 (Sept. 23, 2020), <https://www.gov.ca.gov/wp-content/uploads/2020/09/9.23.20-EO-N-79-20-text.pdf>.

215. *Advanced Clean Trucks Fact Sheet*, CAL. AIR RES. BD., <https://ww2.arb.ca.gov/resources/fact-sheets/advanced-clean-trucks-fact-sheet> (last visited Jan. 22, 2022).

216. *Global Commercial Vehicle Drive To Zero, The Program*, CALSTART, <https://globaldrivetozero.org/about/program/> (last visited Jan. 22, 2022).

217. *2016 Mobile Source Strategy*, *supra* note 212.

218. *Id.*

219. CALSTART, *supra* note 216.

220. John Boessel, *The Zero-Emissions Future for Vehicles is Coming*, MEETING OF THE MINDS (July 23, 2019), <https://meetingoftheminds.org/30731-30731>.

the beachhead strategy of choosing these vehicles allows for “technology transfer” into other similar markets such as ferries.²²¹

Researchers have concluded that considering the total cost of ownership, replacing a bus fleet of 200 with a 100% electric fleet would decrease overall costs anywhere from “\$0.1 to \$3.6 billion compared to replacing the current fleet.”²²² Specifically, electric buses are expected to have lower operating costs and lower lifetime costs as compared to conventional powertrains.²²³

E. State Coalitions

Much like for light-duty vehicles, medium- and heavy-duty coalitions can allow states to coordinate and work across borders. There is a Medium-Heavy Duty (MDHV) ZEV MOU which includes: California, Colorado, Connecticut, District of Columbia, Hawaii, Maine, Maryland, Massachusetts, New Jersey, New York, North Carolina, Oregon, Pennsylvania, Rhode Island, Vermont, and Washington.²²⁴ This MOU’s goal is to require 30% and 100% of MHDV sales to be ZEVs by 2030 and 2050, respectively.²²⁵

F. Heavy-Duty Charging Infrastructure

Medium- and heavy-duty infrastructure is an often overlooked, yet crucial part of ZEV goal making. Specifically, after California’s Advanced Clean Trucks rule was approved in June of 2020, many industry groups immediately had concerns about the costs of charging infrastructure.²²⁶ When transitioning to an electric fleet, there are many different financial factors to consider for infrastructure alone such as the site construction, equipment

221. *Guide to Federal Funding, Financing, and Technical Assistance for Plug-in Electric Vehicles and Charging Stations*, U.S. DEP’T OF ENERGY 1 (July 2016), <https://www.energy.gov/sites/prod/files/2016/07/f33/Guide%20to%20Federal%20Funding%20and%20Financing%20for%20PEVs%20and%20PEV%20Charging.pdf>.

222. Hanjino Ambrose et al., *Exploring the Costs of Electrification for California’s Transit Agencies*, (Oct. 1, 2017), <https://escholarship.org/uc/item/0fn8s2jh>.

223. *Id.*

224. *Medium and Heavy-Duty Zero Emission Vehicle (ZEV) Deployment Support*, U.S. DEP’T OF ENERGY, ENERGY EFFICIENCY & RENEWABLE ENERGY, <https://afdc.energy.gov/laws/12460> (last visited Jan. 22, 2022).

225. *Multi-State Medium- and Heavy-Duty Zero Emission Vehicle Memorandum of Understanding*, 6–21, https://www.nescaum.org/documents/mhdv-zev-mou_12-14-2021.pdf/ (last visited Jan. 22, 2022).

226. Russ Mitchell, *California Mandates Big Increase in Zero-Emission Trucks*, L.A. TIMES (June 25, 2020), <https://www.latimes.com/business/story/2020-06-25/new-california-truck-mandate-100-000-zero-emiss>.

lifecycle and installation, back-up power supplies, and maintenance.²²⁷ Furthermore, energy consumption and cost are higher due to the fact that heavy-duty trucks require significantly more power to charge than light-duty.²²⁸

Hydrogen fuel cells are emerging as an efficient, green alternative for medium- and heavy-duty vehicles.²²⁹ Since hydrogen can offer high gravimetric energy storage density, fast recharging times, and higher vehicle utilization factors, they allow for longer driving ranges.²³⁰

Thus, there have been a few initiatives that have spurred the funding in this sector. At the federal level, the Diesel Emissions Reduction Act (DERA), which was first enacted in 2010, funds various projects across the nation with the goal of reducing harmful emissions from diesel engines.²³¹ These projects have mostly taken the form of replacement of school buses.²³²

More generally, the U.S. Department of Energy/Energy Efficiency and Renewable Energy have created the Clean Cities program which funds projects to significantly accelerate the deployment of alternative fuels and infrastructure for light-, medium- and heavy-duty vehicles.²³³ Even on a localized level, San Diego Gas and Electric has produced their Power Your Drive for Fleets program which connects fleets with resources, fleet-friendly charging rates, and financial incentives to design and install charging infrastructure to power medium- and heavy-duty electric fleets.²³⁴ Each of these programs have acknowledged the global transition to transportation electrification, acknowledged the extra difficulties and obstacles that

227. *Calculating TCO for EVs: Where to Find the Greatest Long-Term Cost Savings for Medium- and Heavy-Duty Vehicles*, ADVANCED CLEAN TECH. NEWS (Aug. 26, 2020), <https://www.act-news.com/news/calculating-tco-for-medium-and-heavy-duty-evs/>.

228. *See Level 1 vs Level 2 EV Charging Stations*, CLIPPERCREEK, <https://clippercreek.com/level-1-level-2-charging-stations/> (last visited Jan. 22, 2022) (explaining that the battery size in the electric vehicle affects the amount of energy needed to charge it).

229. *Alternative Fuels Data Center: Hydrogen Basics*, U.S. DEP'T ENERGY, https://afdc.energy.gov/fuels/hydrogen_basics.html (last visited Jan. 22, 2022).

230. Jason Marcinkoski et al., *DOE Advanced Truck Technologies: Subsection of the Electrified Powertrain Roadmap*, U.S. DEP'T ENERGY 4 (Oct. 31, 2019), https://www.hydrogen.energy.gov/pdfs/19006_hydrogen_class8_long_haul_truck_targets.pdf.

231. 42 U.S.C. § 15801.

232. *Reducing Diesel Emissions from School Buses*, U.S. ENV'T PROT. AGENCY, (July 7, 2020), <https://www.epa.gov/dera/reducing-diesel-emissions-school-buses>.

233. *Guide to Federal Funding, Financing, and Technical Assistance for Plug-in Electric Vehicles and Charging Stations*, U.S. DEP'T ENERGY (July 2016), <https://www.energy.gov/sites/prod/files/2016/07/E33/Guide%20to%20Federal%20Funding%20and%20Financing%20for%20PEVs%20and%20PEV%20Charging.pdf>.

234. *Power Your Drive For Fleets*, SAN DIEGO GAS & ELECTRIC CO., <https://www.sdge.com/business/electric-vehicles/power-your-drive-for-fleets> (last visited Jan. 22, 2022).

medium- and heavy-duty fleets face, and have chosen to fund and support a crucial step: infrastructure.²³⁵

V. CONCLUSION

A key finding of this report is that while there are dozens of potential policy options, and there are some known best practices for each of these approaches, no single strategy will be enough. A comprehensive suite of supply and demand-side policies may be necessary for both the light-duty and heavy-duty sectors.

A federal zero-emission vehicle landscape has many pathways and policy options for light-, medium-, and heavy-duty vehicles. These pathways include mandates and incentives for both consumers and manufacturers. Each of these policies should keep in mind equity and environmental justice to ensure the communities that are the most disproportionately impacted by the emissions from transportation are given access to clean transportation, while also benefiting from this transition.

State ZEV policies to decarbonize the light duty sector can be done in parallel to federal efforts and focus on phasing out internal combustion engine vehicles. A suite of supply-side and demand incentive policies will be necessary.²³⁶ For a fast turnover, public and private fleet electrification can kick-start these actions. To support all these efforts, infrastructure policies will need to be prioritized and will require coordinated cooperation between private and public stakeholders.

The medium- and heavy-duty sector is responsible for a disproportionate amount of emissions and especially given the inequitable impacts of these emissions should also be decarbonized imminently.²³⁷ These larger vehicles will be harder to electrify because of their sizes and nature, but it can be done and regulators must help target investments and incentives for infrastructure and vehicle technologies.²³⁸ Prioritizing the transition of fleets like buses and medium-duty short haul fleets, like delivery trucks, will help accelerate the overall transition. Mandates like what California has passed for bus electrification will result in innovation and operational cost savings. The

235. See, e.g., *Transportation Electrification Movement*, SAN DIEGO GAS & ELEC., <https://www.sdge.com/residential/electric-vehicles/power-your-drive> (last visited Jan. 22, 2022) (describing the infrastructure built by the Power Your Drive program).

236. *State Policies Promoting Hybrid and Electric Vehicles*, NAT'L CONF. STATE LEGISLATORS (Mar. 12, 2021), <https://www.ncsl.org/research/energy/state-electric-vehicle-incentives-state-chart.aspx>.

237. BUREAU OF TRANSP. STAT., *Estimated U.S. Average Vehicle Emissions Rates per Vehicle by Vehicle Type Using Gasoline and Diesel*, at table 4-43 (last visited Jan. 22, 2022).

238. Justin Gerdes, *Next Up for Electrification: Heavy-Duty Trucks and Construction Machinery*, GREENTECH MEDIA (July 13, 2020), <https://www.greentechmedia.com/articles/read/next-up-for-electrification-heavy-duty-trucks-and-construction-machinery>.

medium- and heavy-duty vehicle sector also requires unique charging capacity and locations, and federal investment in research and infrastructure is essential to support its decarbonization.

No one sector or one type of policy will work to meet the necessary emissions reductions goals that will avoid the worst impacts of climate change. For the transportation sector to achieve necessary targets a suite of policies is crucial, in the light-, medium-, and heavy-duty sectors. Carrots and sticks must all be utilized, and equity and environmental justice should be considered as each policy is developed and refined.