ICCT **POLICY UPDATES** SUMMARIZE REGULATORY AND OTHER DEVELOPMENTS RELATED TO CLEAN TRANSPORTATION WORLDWIDE.

POLICY UPDATE

JULY 2020

California's Advanced Clean Trucks regulation: Sales requirements for zero-emission heavy-duty trucks

Claire Buysse and Ben Sharpe

On June 25, 2020, the California Air Resources Board (CARB) adopted the final rule for new standards that require the sale of zero-emission heavy-duty trucks (HDTs), starting with the 2024 model year.[1] The Advanced Clean Trucks (ACT) rulemaking finalizes standards that were initially proposed on October 22, 2019 and strengthened in a revised proposal on April 28, 2020. The regulation, first of its kind in the world to require manufacturers to sell increasing percentages of zero-emission trucks, is expected to reduce the lifecycle emission of greenhouse gases (GHGs), eliminate tailpipe emissions of air pollutants, and foster a market for zero-emission HDTs. Since California holds a sizeable share of the HDT market in the United States, this regulation will have implications far beyond the state's borders. The truck brands that represent the majority of sales in California sell in multiple regions around the world. As these global companies look to disperse their research and development costs by introducing similar technology platforms across various markets, California's ACT regulation is expected to accelerate the adoption of zero-emission and near zero-emission HDTs across North America and around the world.

This HDT regulation is one of a series of rules that aim to advance climate and air quality strategies in California, which requires statewide GHG reductions of 40% below the 1990 level by 2030.[2] The sales requirements in the ACT are complemented by series of fleet purchase requirements, such as the Innovative Clean Transit rule for buses, which goes into effect in 2023 and requires 100% zero emission bus purchases by 2029.[3] Forthcoming purchase requirements targeting other commercial fleet types

1 California Air Resources Board, "Advanced Clean Trucks Regulation," accessed June 26, 2020, https://ww2.arb.ca.gov/rulemaking/2019/advancedcleantrucks.

2 "California Global Warming Solutions Act of 2006: Emissions," 32 SB § 38566 (2016), https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201520160SB32.

3 California Air Resources Board, "Innovative Clean Transit 2018," accessed June 26, 2020, https://ww2.arb.ca.gov/rulemaking/2018/innovative-clean-transit-2018.

www.theicct.org
communications@theicct.org
twitter @theicct

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are expected in the next few years.[4] This policy update summarizes key elements of the ACT rule and provides regulatory context in California, the United States, and other major vehicle markets.

KEY ELEMENTS

TIMELINE

The ACT rule requires the sale of zero-emission or near zero-emission HDTs starting with the manufacturer-designated model year 2024. Sales requirements are defined separately for three vehicle groups, shown in Table 1: Class 2b-3 trucks and vans, Class 4-8 rigid trucks, and Class 7-8 tractor trucks. Shown in Figure 1, the share of zero-emission sales required for each vehicle group increases over time to model year 2035. These sales requirements are more aggressive than those in the original proposal and, according to CARB's assessment, are motivated by a growing market for zero-emission pickup trucks and manufacturer plans for early product launches.[5]

Table 1: Gross vehicle weight rating for regulated vehicle groups and sub-groups.

Vehicle group	Vehicle sub-group	Gross vehicle weight rating	
Class 2b-3 pickup trucks and vans	—	8,501-14,000 lbs	3,856-6,350 kg
Class 4-8 rigid trucks	Class 4-5	14,001-19,500 lbs	6,351-8,845 kg
	Class 6-7	19,501-33,000 lbs	8,846-14,969 kg
	Class 8	33,001+ lbs	14,969+ kg
Class 7-8 tractor trucks	—	26,001+ lbs	11,794+ kg

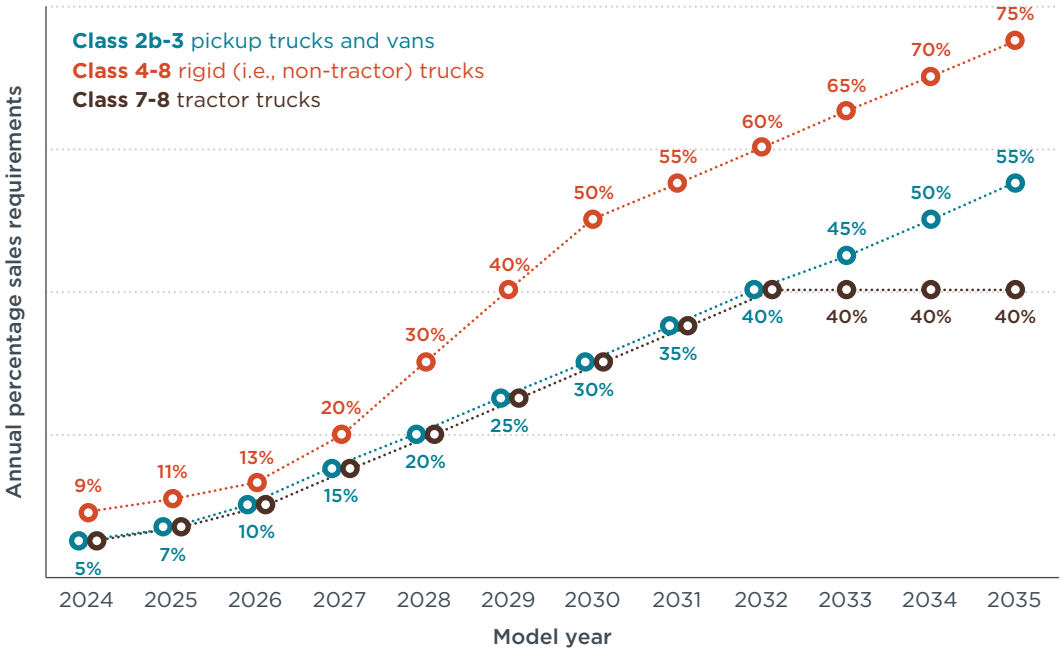

Figure 1: Zero-emission sales percentage schedule by vehicle group and model year.

4 California Air Resources Board, "Advanced Clean Truck Fleets," accessed June 26, 2020, https://ww2.arb.ca.gov/our-work/programs/advanced-clean-fleets; California Air Resources Board, "Zero-Emission Fleet Rule Workshop: Advanced Clean Truck Fleets" (presentation, Diamond Bar, CA, February 12, 2020), https://ww2.arb.ca.gov/sites/default/files/2020-02/200212presentation_ADA_1.pdf.

5 California Air Resources Board, "Updated Analysis Regarding Increased Manufacturer Zero-Emission Vehicle Sales Requirements," April 28, 2020, https://ww3.arb.ca.gov/regact/2019/act2019/30dayattb.pdf.

STRUCTURE

The regulation is structured as a credit and deficit accounting system. A manufacturer accrues deficits based on the total volume of on-road HDT sales within California beginning with model year 2024 vehicles. These deficits must be offset with credits generated by the sale of zero-emission vehicles (ZEVs)[6] or near zero-emission vehicles (NZEVs)[7] starting in model year 2021. A schematic diagram of this accounting system is shown in Figure 2.

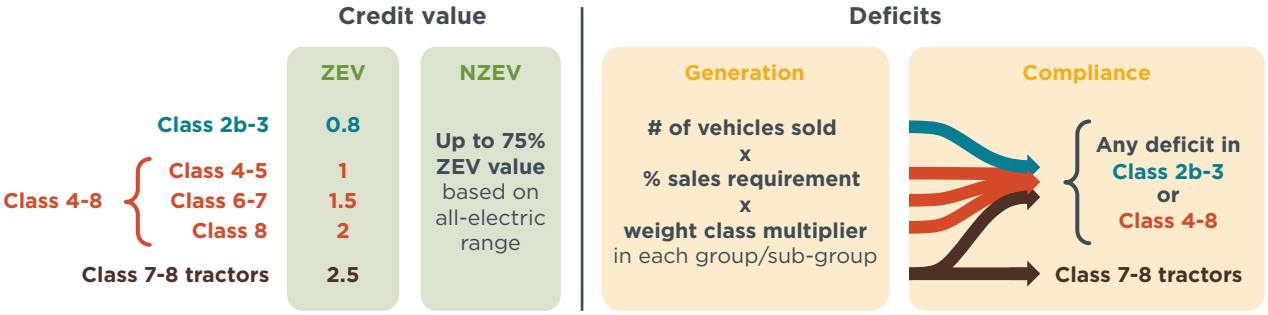

Figure 2: Diagram of credit values, deficit calculation, and regulatory compliance for a manufacturer in a given year.

Deficits are generated separately for each vehicle group, including sub-groups for Class 4-8 rigid trucks: Class 4-5, Class 6-7, and Class 8. A weight class multiplier is applied to account for differences in emissions by internal combustion engine HDTs: a larger emissions footprint corresponds to a larger weight class multiplier. Deficits from Class 2b-3 and Class 4-8 vehicle groups can be met with ZEV and NZEV credits from any vehicle group or sub-group. Deficits from Class 7-8 tractor trucks, however, may only be met with credits from that same vehicle group.

To be eligible for ZEV or NZEV credits, Class 4-8 and Class 2b-3 HDTs must be certified to CARB's zero-emission powertrain standards[8] starting in the 2024 model year. Additionally, credits for Class 2b-3 HDTs may be earned under either the Advanced Clean Cars[9] or the Advanced Clean Trucks regulations, but not both. The value of ZEV and NZEV credits varies by vehicle group and sub-group, with ZEV credit values equivalent to the respective weight class multiplier. To encourage ZEV adoption, each NZEV credit is only worth up to 75% of the ZEV credit value for each vehicle group or sub-group; in addition, NZEV credits are only allowed to meet up to half of annual deficits. The value of each NZEV credit is determined by multiplying the ZEV credit value by an NZEV factor value, equal to the product of 0.01 and the all-electric range but capped at 0.75. Beginning with model year 2030, eligible NZEVs must have a minimum all-electric range of 75 miles, such that the NZEV factor value is always 0.75.

6 A ZEV is defined in the regulation as "an on-road vehicle with a drivetrain that produces zero exhaust emissions of any criteria pollutant (or precursor pollutant) or greenhouse gas under any possible operational modes or conditions."

7 A NZEV is defined in the regulation as "an on-road hybrid electric vehicle that utilizes an internal combustion or heat engine as well as an externally-rechargeable energy storage system that affords the vehicle an all-electric range."

8 California Air Resources Board, "Zero-Emission Powertrain Certification Regulation," accessed June 26, 2020, https://ww2.arb.ca.gov/rulemaking/2019/zepcert2019.

9 California Air Resources Board, "Advanced Clean Cars Program," accessed June 26, 2020, https://ww2.arb.ca.gov/our-work/programs/advanced-clean-cars-program.

To offset annual deficits, manufacturers may generate early credits starting with the 2021 model year through the 2023 model year, and these may be used until the end of the 2030 model year. After the sales requirement goes into effect in model year 2024, credits generated in excess of deficits may be banked for only five subsequent model years. Credits can also be sold or traded between manufacturers.

COMPLIANCE

To achieve compliance, the number of credits banked or newly generated by a manufacturer must meet or exceed the number of deficits in a given year. Manufacturers are given one model year to make up any outstanding deficits, which may only be satisfied with ZEV credits. Failure to make up outstanding deficits results in a civil penalty that is largely equivalent to the penalty for non-compliance with emission standards or test procedures.

The following examples illustrate how regulatory compliance is determined, using two fictional manufacturers with 1,000 total HDT sales in the 2024 model year. Figure 3 shows the calculation of deficits, which are based each manufacturer's total HDT sales in California, including ZEVs, NZEVs, and internal combustion engine vehicles. Credit-deficit accounting for two scenarios, compliance and non-compliance, for each manufacturer are detailed in the following tables. Table 2 shows accounting for Manufacturer 1 and illustrates the use of Class 7-8 tractor truck credits to meet deficits in Class 4-8. Table 3 shows accounting for Manufacturer 2 and illustrates the use of NZEV credits.

Manufacturer 1

	Total CA sales in 2024		2024 MY ZEV sales requirement		Weight class modifier		Deficits	
Class 4-5 rigid trucks	250	x	9%	x	1	=	22.5	
Class 6-7 rigid trucks	250	x	9%	x	1.5	=	33.8	**101.3 Class 4-8** rigid trucks
Class 8 rigid trucks	250	x	9%	x	2	=	45.0	
Class 7-8 tractor trucks	250	x	5%	x	2.5	=	31.3 →	**31.3 Class 7-8** tractor trucks

Manufacturer 2

Class 2b-3	1,000	x	5%	x	0.8	=	40.0

Figure 3: Deficit calculations for two fictional manufacturers in the 2024 model year (MY).

Table 2: Credit-deficit accounting of fictional Manufacturer 1 for two scenarios for the 2024 model year.

1	Guide	Vehicle group or sub-group	Weight class multiplier (WCM)	Scenario 1: Compliance		Scenario 2: Non-compliance	
				ZEV sales	Credits = WCM * ZEV sales	ZEV Sales	Credits = WCM * ZEV sales
	A	Class 4-5 rigid trucks	1.0	20	20	20	20
	B	Class 6-7 rigid trucks	1.5	20	30	20	30
	C	Class 8 rigid trucks	2.0	20	40	20	40
	D	Class 7-8 tractor trucks	2.5	30	75	10	25
	E = A+B+C	**Total Class 4-8 rigid truck credits**			**90**		**90**
	F	**Total Class 4-8 rigid truck deficits**[a]			**101.3**		**101.3**
	G = E-F	**Rigid truck credits - deficits**			**-11.3**		**-11.3**
	H = D	**Total Class 7-8 tractor credits**			**75**		**25**
	I	**Total Class 7-8 tractor deficits**[a]			**31.3**		**31.3**
	J = H-I	**Tractor credits - deficits**			**+43.7**		**-6.3**
	(see G)	**Class 7-8 tractor credits used to cover Class 4-8 deficits**			11.3		0
	K = G+J	**Overall balance**			**32.4 carry-over credits**		**17.6 unmet deficits**

[a] Calculation of deficit values is shown in Figure 3.

Table 3: Credit-deficit accounting of fictional Manufacturer 2 for two scenarios for the 2024 model year.

2	Guide	Vehicle group	Weight class multiplier (WCM)	NZEV factor value (FV)	Scenario 1: Compliance		Scenario 2: Non-compliance	
					ZEV/ NZEV sales	Credits = WCM * sales * FV	ZEV/ NZEV sales	Credits = WCM * sales * FV
	A	**Class 2b-3** ZEVs	0.8	—	40	32	30	24
	B	**Class 2b-3** NZEVs[a]	0.8	0.5	40	16	10	4
	C = A+B	**Total Class 2b-3 credits**				**48**		**28**
	D	**Total Class 4-8 deficits**[b]				**40**		**40**
	E = C-D	**Credits - deficits**				**+8**		**-12**
	F = E	**Overall balance**				**8 carry-over credits**		**12 unmet deficits**

[a] NZEVs sold by this manufacturer are assumed to have an all-electric range of 50 miles, such that the NZEV Factor Value is equal to 0.5 (50 miles x 0.01).

[b] Calculation of deficit values is shown in Figure 3.

FLEXIBILITY AND EXEMPTIONS

Manufacturers selling 500 or fewer HDTs in California are exempt from the ACT regulation. Still, these manufacturers may generate ZEV and NZEV credits to be banked, traded, or sold. Larger manufacturers that are not exempt from regulation, but those that accrue 25 or fewer deficits in the Class 7-8 tractor trucks vehicle group are given the flexibility to offset their tractor deficits with credits from any vehicle group.

REPORTING

The ACT regulation requires annual reporting of HDTs sales and any transfer of ZEV or NZEV credits. Manufacturers are also required to maintain documentation of vehicle delivery to California, since fleet purchases are often placed out-of-state.

The regulation additionally stipulates large entity reporting requirements, which require large entities,[10] large fleet owners and brokers,[11] and government agencies that operated any heavy-duty vehicles in California in 2019 to report general information about business practices relating to heavy-duty vehicle use and transportation emissions reduction goals. Entities must also report specific information for each heavy-duty vehicle or vehicle group, including details about operating characteristics, such as the average vehicle miles traveled and typical length of ownership, as well as the vehicle home base, such as refueling infrastructure and trailer types. This information is intended to help CARB assess its regulatory strategy for zero-emission HDTs—particularly the development of forthcoming regulations to require the purchase of zero-emission heavy-duty vehicles.

PROJECTED COSTS AND BENEFITS

As part of the rulemaking process, CARB performed a cost-benefit analysis of the ACT regulation, which included estimates of emission reductions as well as health, climate, and economic benefits. Key cost-benefit metrics from the analysis are summarized in Table 4.

10 Large entities are defined as those with gross annual revenues greater than $50 million.

11 Large fleet owners and brokers are defined as those operating a facility in California and owning or dispatching 50 or more heavy-duty vehicles.

Table 4: Estimated cost-benefit metrics for the final ACT rulemaking.

Category	Metric	Value
Emission reductions[a] *in 2040*	NO_x	27.9 tons/day
	$PM_{2.5}$	0.85 tons/day
	Well-to-wheel GHG	2.9 tons/day
Health benefits *2020-2040*	Avoided premature deaths	943
	Value of all avoided health outcomes	$8.9 billion
Climate benefits *2020-2040*	Avoided GHG emissions	17.3 MMT[b]
	Social cost-benefit of CO_2 *3% discount rate*	$1.2 billion
Economic benefits *2020-2040*	Net direct cost-benefit	$5.9 billion
	Change in state GDP	+0.01%
	Employment growth	7,442 jobs
Overall *2020-2040*	Total costs	$21.3 billion
	Total benefits[c]	$32.5 billion
	Net benefits	$11.2 billion
	Benefit-cost ratio	1.5

Note: Data are reproduced from CARB's cost-benefit analysis, with cost-benefits in $2018.

[a] Emissions reductions are reported relative to the business-as-usual scenario in 2040. Reductions are not reported by percentage but can be estimated from CARB's figures as ~16% (NO_x), ~14% ($PM_{2.5}$), and ~7% (Well-to-Wheel GHG).

[b] million metric tons

[c] Total benefits include health benefits, direct cost-saving benefits, and declines in revenue from taxes and fees; climate and macroeconomic benefits are not included.

An important takeaway from the CARB analysis is the overall cumulative benefit, estimated to be $11.2 billion between 2020 and 2040, with a large portion of savings coming from reduced fuel costs. Avoided health outcomes are also a considerable source of savings; the majority of these savings are located in the South Coast air basin, a non-attainment area for both the 8-hour ozone and $PM_{2.5}$ national ambient air quality standards. The region suffers the highest population-weighted exposure to ozone and the fourth highest population-weighted exposure to annual average fine particle concentrations in the United States.[12] Direct annual costs for the regulation are projected to peak in 2028, with net savings beginning in 2030. Notably, the ACT regulation is expected to promote job growth in California, particularly in the construction and transportation industries.

CALIFORNIA CONTEXT

Regulation of the environmental impacts of HDTs in California has been successful at requiring the accelerated deployment of vehicle emission control and efficiency technologies. With respect to GHG emissions, California has implemented three major regulations: a tractor-trailer GHG regulation, as well as Phase 1 and Phase 2 GHG regulations.[13] The primary requirements of the tractor-trailer GHG regulation

12 American Lung Association, "State of the Air 2020," 2020, http://www.stateoftheair.org/assets/SOTA-2020.pdf.

13 California Air Resources Board, "Tractor-Trailer Greenhouse Gas Regulation," 2009, https://ww3.arb.ca.gov/msprog/truckstop/trailers/ttghg_regorder.pdf; California Air Resources Board, "Phase 1 Greenhouse Gas Regulations," 2014, https://ww3.arb.ca.gov/regact/2013/hdghg2013/hdghgfrot13.pdf; California Air Resources Board, "Phase 2 Greenhouse Gas Regulations and Tractor-Trailer GHG Regulations," 2019, https://ww3.arb.ca.gov/regact/2018/phase2/finalatta.pdf.

were low-rolling resistance tires and aerodynamic devices. Requirements under the Phase 1 and Phase 2 GHG regulations were largely harmonized with the U.S. Environmental Protection Agency's Phase 1 and Phase 2 regulations,[14] and include performance-based fuel efficiency and GHG emission standards.

The ACT regulation builds on these previous rulemakings, but instead of encouraging improved efficiency of existing combustion engine technology, the regulation aims to accelerate the market transition to electric drive technology. As shown in Figure 4, CARB staff intend to complement the ACT rule with forthcoming regulations that require fleets operating in California to purchase an increasing proportion of zero-emission or near zero-emission HDTs.[15] While the ACT rule only applies to trucks sold in California, the forthcoming Advanced Clean Truck Fleets regulations will affect any fleet that operates in California, including HDTs entering from neighboring states, Mexico, and Canada.

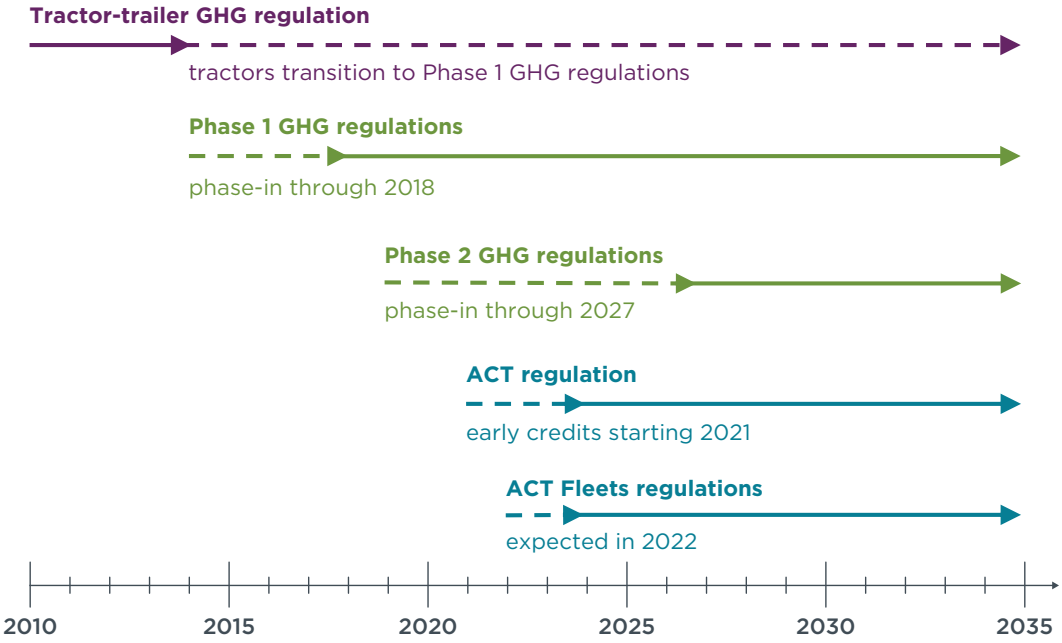

Figure 4: Timeline of policies regulating HDTs in California.

U.S. CONTEXT

The most recent U.S. EPA Phase 2 GHG regulation set national emission requirements for new HDTs in model years 2018 to 2027. While ZEVs and NZEVs earn Advanced Technology Credits in the Phase 2 regulation, there are several low-cost pathways for compliance, including low rolling resistance tires, aerodynamics, idle reduction, and

14 Federal Register, "Greenhouse Gas Emissions Standard and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles," 40 CFR § 85, 86, 523, 534, 535, 600, 1033, 1036, 1037, 1039, 1065, 1066, 1068 (2011), https://www.govinfo.gov/content/pkg/FR-2011-09-15/pdf/2011-20740.pdf; Federal Register, "Greenhouse Gas Emissions and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles—Phase 2," 40 CFR § 9, 22, 85, 86, 523, 534, 535, 538, 600, 1033, 1036, 1037, 1039, 1042, 1043, 1065, 1066, 1068 (2016), https://www.govinfo.gov/content/pkg/FR-2016-10-25/pdf/2016-21203.pdf.

15 California Air Resources Board, "Advanced Clean Truck Fleets."

powertrain technologies.[16] Despite its ambitious GHG reduction goals, the Phase 2 regulation was not designed and is not expected to drive zero-emission HDTs into the market in large numbers.

Figure 5 compares the estimated sales share of zero-emission HDTs in California and the rest of the United States.[17] Based on these projections, California's sales share will dramatically outpace other U.S. states, with these states projected to achieve only a zero-emission sales share of 4% by 2035. However, because California holds a large share of the U.S. market for HDTs, the average U.S. sales share is nearly double that of other states, highlighting the significance of the ACT regulation in driving the U.S. market.

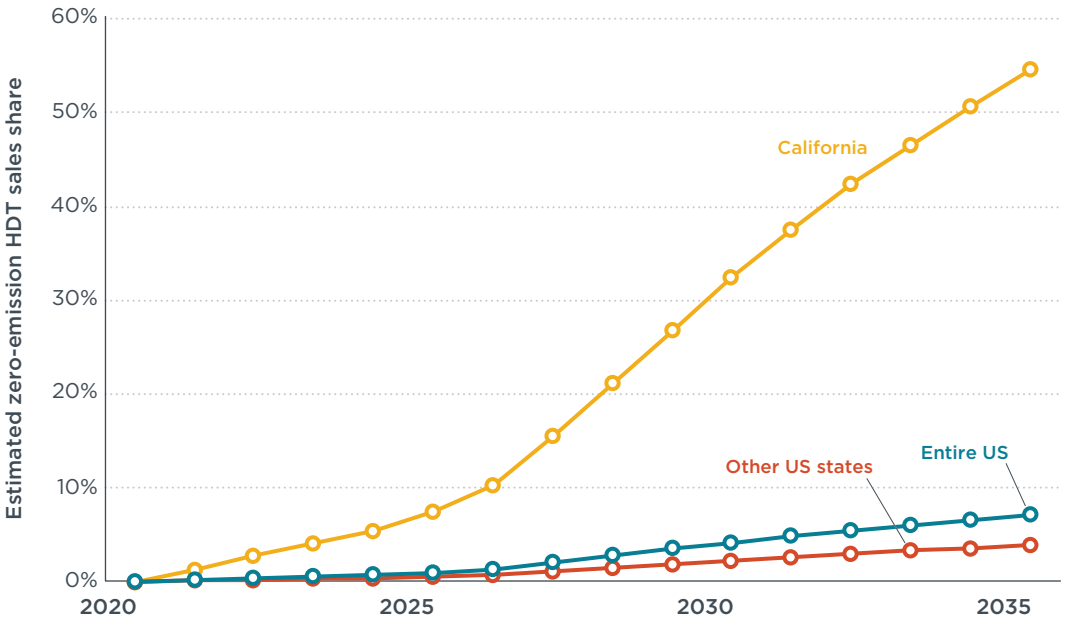

Figure 5: Projected share of zero-emission HDT sales in California compared to other states and the US overall.

16 Benjamin Sharpe, Mehul Garg, and Oscar Delgado, *Compliance Pathways in the U.S. Phase 2 Heavy-Duty Vehicle Efficiency Regulation*, (ICCT: Washington, D.C., 2018), https://theicct.org/publications/compliance-pathways-US-phase-2-HDV.

17 The share of zero-emission HDT sales in California is weighted by projected HDT sales across vehicle groups, from the U.S. EPA MOVES model. Annual deficits are assumed to be met with credits from the same vehicle group or sub-group. The share of zero-emission HDT sales in other U.S. states is estimated by the ICCT and is based on their share of the 2011-2018 market for passenger ZEVs relative to California and their share of HDVs in 2015 relative to California.

INTERNATIONAL CONTEXT

Around the world, the passenger car segment has led vehicle electrification, but recent focus has shifted to the electrification of heavy-duty vehicles. In the heavy-duty vehicle market, zero-emission products first gained traction in the transit bus segment. The electrification trend has been slower for HDTs but is rapidly increasing. Established global truck manufacturers, as well as several well-capitalized startup companies, have made significant investments to bring zero-emission HDTs to market.

In terms of domestic sales and production, China has dominated the global market for heavy-duty ZEVs to date.[18] This growth has largely been driven by a combination of industrial support policies, robust end-user incentives, and infrastructure investments.[19] Electrification efforts have also been underway in Europe, with significant action at the city level.[20] In North America, the heavy-duty ZEV market is also on the rise, albeit much slower than in China and Europe.[21]

Recent industry investments, along with growing global ZEV markets and ambitious electrification policy, reflect the fundamental shift underway in the heavy-duty vehicle sector. California's ACT rule enacts the first ZEV sales requirements for HDTs in the world and is a testament to California's leadership in vehicle electrification policy. It is only the latest in a series of regulations aimed to electrify the state's heavy-duty vehicle fleet in coming years. As with the state's regulatory actions to accelerate passenger vehicle electrification, the ACT rule—along with forthcoming zero-emission purchase requirements aimed at trucking fleets—is expected to have significant impacts on the HDT segment in the United States, North America, and around the world.

18 Benjamin Sharpe, Nic Lutsey, Cedric Smith, and Carolyn Kim, *Power Play: Canada's Role in the Electric Vehicle Transition,* (ICCT: Washington, D.C., 2020), https://theicct.org/sites/default/files/publications/Canada-Power-Play-ZEV-04012020.pdf.

19 China Climate Change, Center on Global Energy Policy, "Electric Vehicles: Guide to Chinese Climate Policy," Columbia University, accessed June 26, 2020, https://chineseclimatepolicy.energypolicy.columbia.edu/en/electric-vehicles#/_ftn2.

20 European Commission, "European Clean Bus Deployment Initiative," Mobility and Transport, accessed June 26, 2020, https://ec.europa.eu/transport/themes/urban/cleanbus_en.

21 Sharpe et al., *Power Play: Canada's Role in the Electric Vehicle Transition.*