

ICCT HD2027 Briefing for NACAA

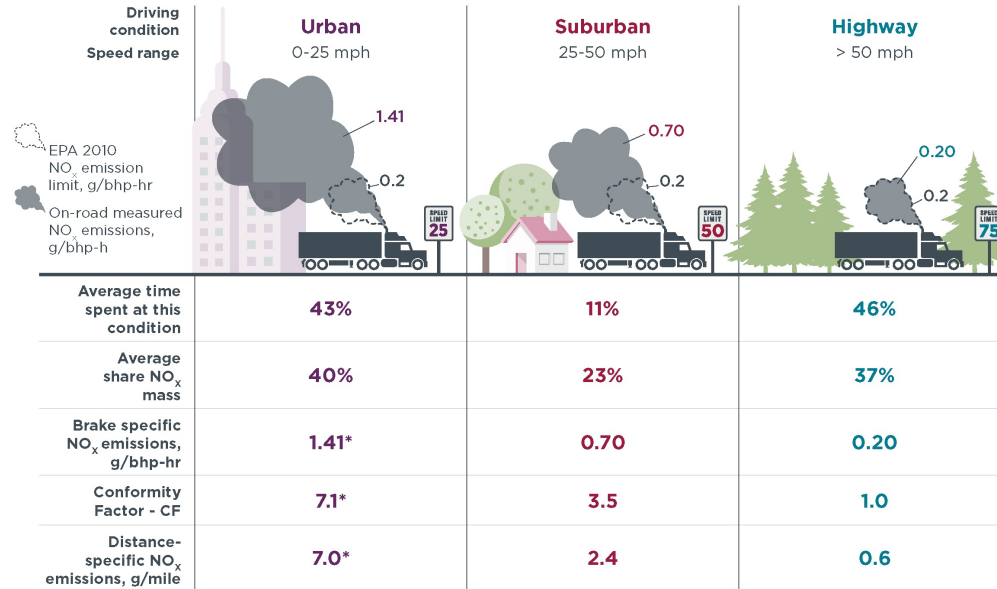
Ray Minjares, Director, Heavy-Duty Vehicles Program

22 February 2022

Key Points

1. A .02 g/bhp-hr NOx engine standard is technically feasible and cost-effective;
2. The HD2027 NPRM is the first step towards a national transition to a zero-emissions HDV fleet;
3. These actions advance Biden Administrative objectives to protect public health, secure environmental justice for disadvantaged communities, and address the climate crisis

A line-haul truck emits the NO_x equivalent of 100 cars for each urban mile driven



* Brake and distance specific NO_x emissions for Urban bin do not include Idle operation, only 1-25 mph operation is included

Figure ES-1 Comparison of line-haul vehicle NO_x emissions under urban, suburban, and highway driving conditions. Conformity factor is defined as ratio of measurement to engine dynamometer emission limits.

A key lesson from Dieselpgate: excess NO_x from HDVs in the U.S. linked to ~ 1,000 premature deaths annually in 2015 – 10x greater than from light-duty vehicles

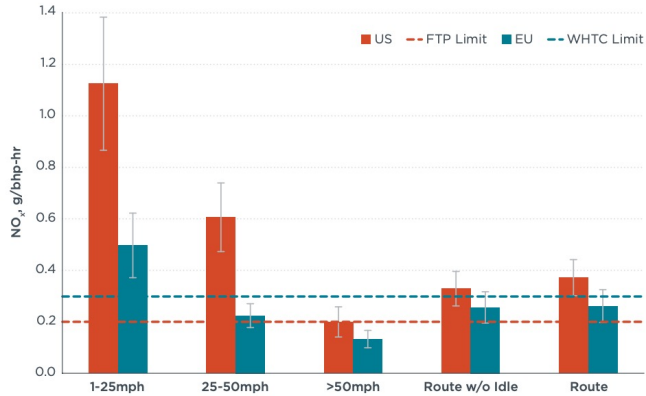


Figure ES-1. NO_x emissions by speed bin for European and U.S. HDVs. Dotted lines represent engine emission NO_x limits for U.S. and European HDVs. Error bars show confidence intervals at 95%.

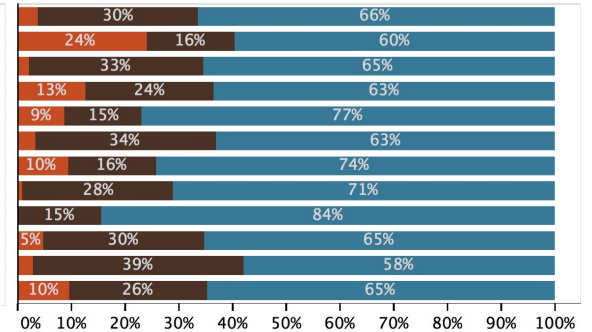
<https://theicct.org/publication/in-use-nox-emissions-and-compliance-evaluation-for-modern-heavy-duty-vehicles-in-europe-and-the-united-states/>

Annual premature deaths attributable to on-road diesel vehicle NO_x emissions, 2015

Total deaths

China	31,397
EU-28	28,456
India	26,739
Rest of world*	8,968
Russia	3,380
U.S.	2,982
Japan	1,970
Brazil	1,818
Mexico	907
South Korea	788
Canada	220
Global	107,626

Share of deaths by source



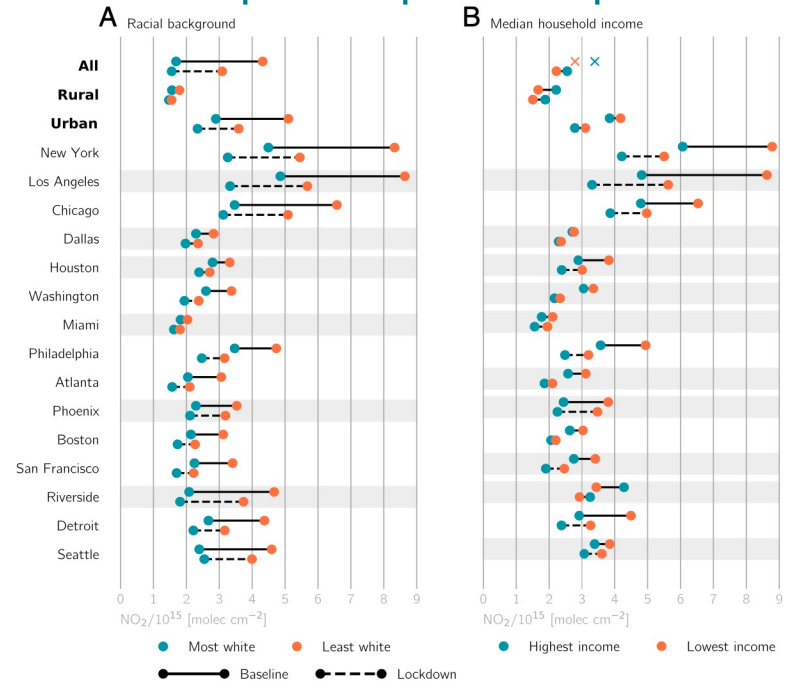
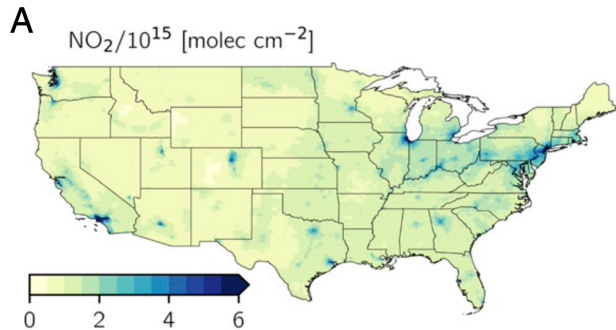
*Counts only those premature deaths resulting from NO_x emissions produced in the other regions shown here.

Legend:
■ NO_x within regulated limits
■ Excess NO_x from trucks and buses
■ Excess NO_x from cars and vans

COVID19 has revealed the central role of HDVs in pollution exposure disparities

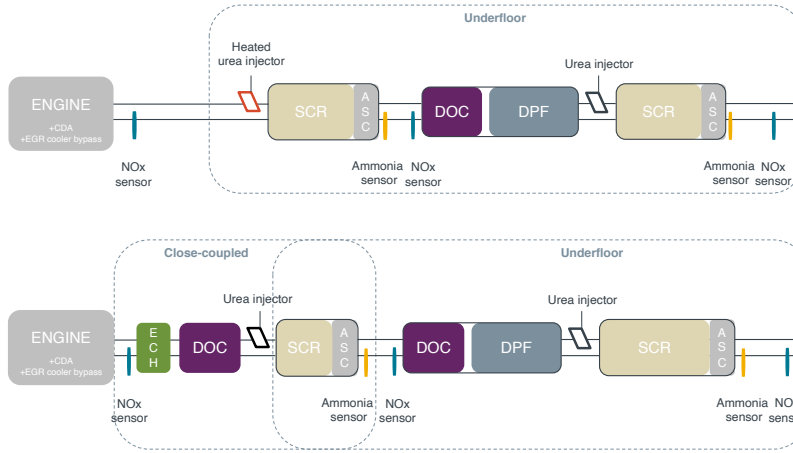
Disparities in NO₂ exposure pre- and post COVID19

‘... targeting NO_x emissions from heavy-duty diesel vehicles is likely the most effective strategy for reducing disparities nationwide.’
- Hunter et al. (2021)



Pathways to a 90% reduction in tailpipe NO_x

Diesel:



→ Demonstrated by SwRI, up to 600k miles with 30% compliance room (Status Dec/2021)

Source: SwRI 2021. Ultra Low NOX Working Group -Webinar

→ Ongoing project in Europe at the vehicle level in real world use

Source: AECC 2021. <https://www.aecc.eu/wp-content/uploads/2021/10/211005-AECC-presentation-Aachen-1.pdf>

Gas and opposed piston engines:

Heavy Duty Engines Certified to Meet CARB's Optional Low NO_x Emission Standards

Low NO _x Engine	Engine Family	Displacement (Liters)	NO _x Certification Standard (g/bhp-hr)	NO _x Reduction Percent (%)	Fuel	Intended Service Class
2020 EQs						
PSI 8.8	LPSIE8.8LN1	8.8	0.02	90%	LPG	HDO
Cummins 6.7	LCEXH0408BBC	6.7	0.02	90%	NG	MHDD
Cummins 8.9	LCEXH0540LBN	8.9	0.02	90%	NG	HHDD
Cummins 8.9	LCEXH0540LBL	8.9	0.02	90%	NG	MHDD
Cummins 8.9	LCEXH0540LBM	8.9	0.02	90%	NG	UB
Cummins 11.9	LCEXH0729XBC	11.9	0.02	90%	NG	HHDD-UB

Source: EPA 2021, <https://www.epa.gov/sites/default/files/2021-01/documents/420f21002.pdf>



Source: Achates Power 2020, <https://achatespower.com/achates-engine-reaches-2027-emissions-levels/>

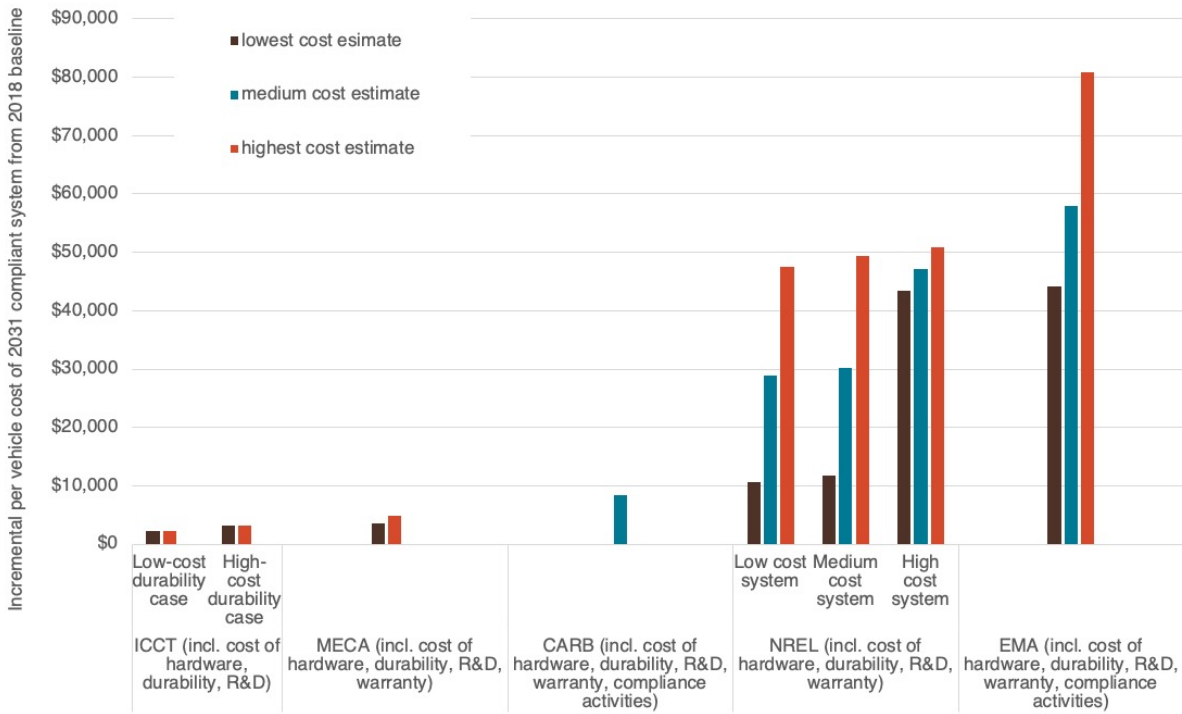
Incremental costs to meet CARB 2024/2027

Regulatory step	7 L	13 L
Baseline technology costs EPA 2010 in 2024	\$2,570	\$3,997
Total costs to meet CARB 2024	\$2,675 - \$3,575	\$4,102 - \$5,090
Incremental costs to meet CARB 2024	\$105-\$1,005	\$105-\$1,093

Regulatory step	7 L		13 L	
Baseline technology costs EPA 2010 in 2027	\$2,431		\$3,769	
Total costs to meet CARB 2027	Low-cost durability case	High-cost durability case	Low-cost durability case	High-cost durability case
	\$4,214-\$4,288	\$4,925-\$4,996	\$5,919-\$6,031	\$6,864-\$6,988
Incremental costs EPA 2010 to CARB 2027	\$1,803-\$1,877	\$2,514-\$2,585	\$2,170-\$2,282	\$3,115-\$3,239

<https://theicct.org/sites/default/files/publications/HDV-emissions-compliance-cost-may2020.pdf>

What will it really cost to build the next generation of low-NOx trucks?



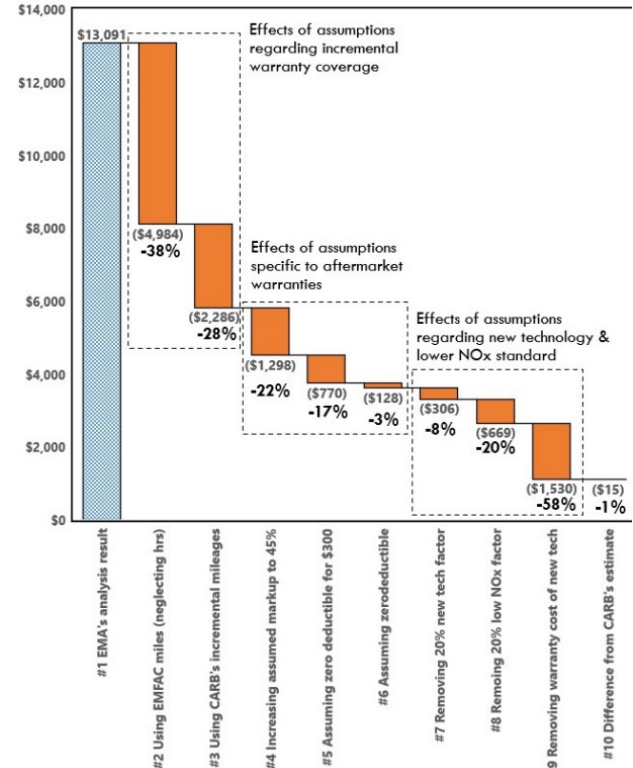
ARB Warranty & Compliance Cost Analysis

Table I.1. Summary of Estimated Step 2 Warranty Costs and Assumptions

	CARB Step 2 Warranty	NREL	ACT Research	EMA
Incremental warranty cost per HHDD engine ^a	\$1,104	\$23,061 ^b	\$7,227 ^c	\$13,091

CARB analyzed discrepancies with EMA's warranty cost estimates. Three areas:

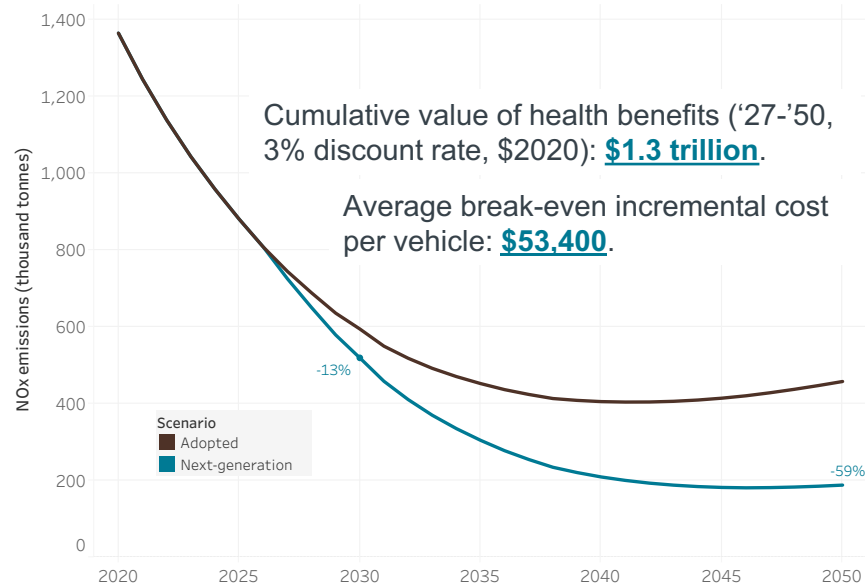
1. 40% owners already purchase extended warranties voluntarily. Not all segments have high mileages. Many vehicles reach warranty hour-limits first.
2. Differences in the profit of the aftermarket service, and accounting of deductibles.
3. Extending durability is an R&D cost, not warranty. New technology costs are offset by improvements in current technologies. Increasing warranty costs for new technology does not change the CBA greatly.



Benefits outweigh costs

Study	Cost range (HHDD)	Remarks
ICCT	\$2,200 to \$3,200	Bottom-up. No warranty included
MECA	\$3,500 to \$4,800	1 MM mile FUL, 800k mile warranty
CARB	\$6,000 to \$6,700	Range MY27/MY31. Accounting for ACT regulation
NREL	\$10,000 to \$50,000	Survey. 4 anonymous respondents plus EMA
ACT R. for EMA	\$17,000 to \$65,000 MY27 \$26,000 to \$80,000 MY31	Confidential industry input. Range represents low/high volume/discount.
Ricardo for EMA	\$5,900 to \$35,000	Low/high for current/extended UL/Warr. Methodology unknown

Annual tailpipe NO_x emissions from U.S. diesel HDV fleet



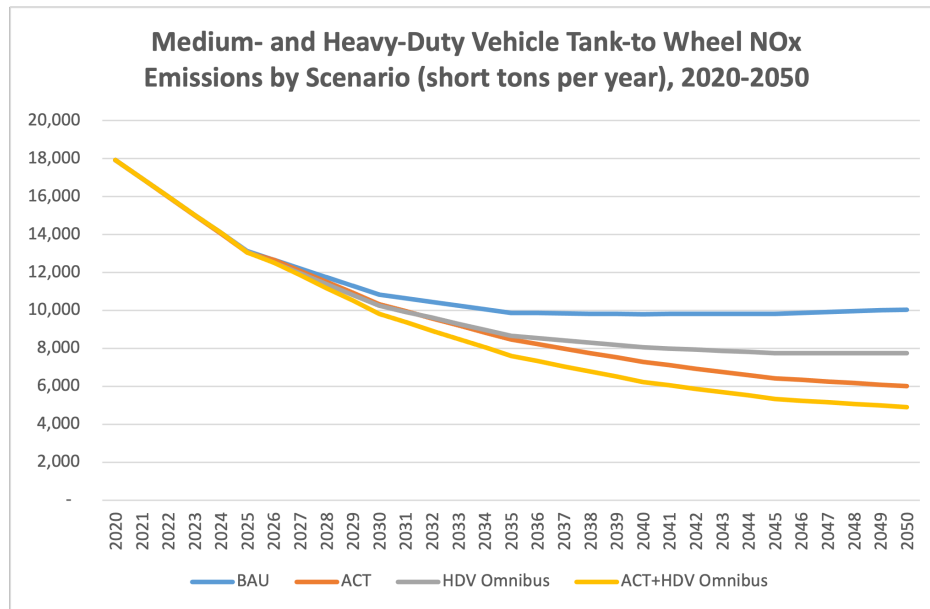
Source: ICCT 2021, <https://theicct.org/publication/air-quality-and-health-impacts-of-heavy-duty-vehicles-in-g20-economies/>

Source: Various. Summary: ICCT 2021, <https://theicct.org/what-will-it-really-cost-to-build-the-next-generation-of-low-nox-trucks/>

Benefits of state-level adoption of California HDV programs

- Oregon, Massachusetts, and California have adopted HDV Omnibus
- 5 states plus California have adopted ACT
- ICCT benefit estimates available for twelve states + DC

Example: Massachusetts



100% 'emissions-free'
truck and bus sales no
later than 2040

OPINION
GUEST ESSAY

These Carbon-Spewing Vehicles Must Be Stopped

Jan. 12, 2022



President Biden at the Ford Rouge Electric Vehicle Center in Dearborn, Mich. Doug Mills/The New York Times



By Margo Oge and Drew Kodjak

Ms. Oge is the chair of the International Council on Clean Transportation and was the director of the U.S. Environmental Protection Agency's Office of Transportation and Air Quality from 1994 to 2012. Mr. Kodjak is the executive director of the I.C.C.T.

Oge, M. and Kodjak, D. (2022) *These Carbon-Spewing Vehicles Must Be Stopped*. 12 January 2022. New York, NY: The New York Times. <https://www.nytimes.com/2022/01/12/opinion/climate-change-biden-trucks-buses.html>

Questions

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icct

THE INTERNATIONAL COUNCIL
ON CLEAN TRANSPORTATION

San Francisco ●

Mexico City ○

Bogotá ○

● São Paulo

★ Washington, DC
(headquarters)

● Berlin

● New Delhi

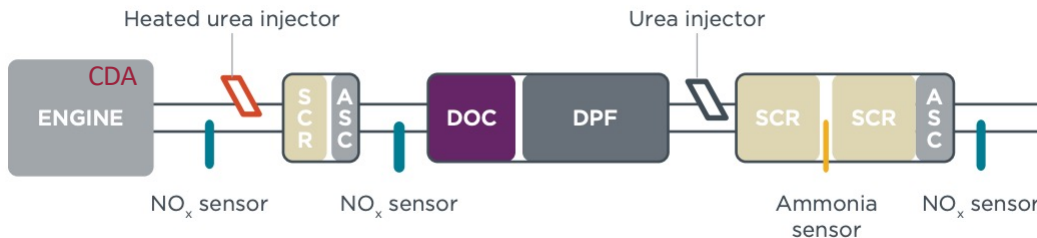
● Beijing

○ Jakarta

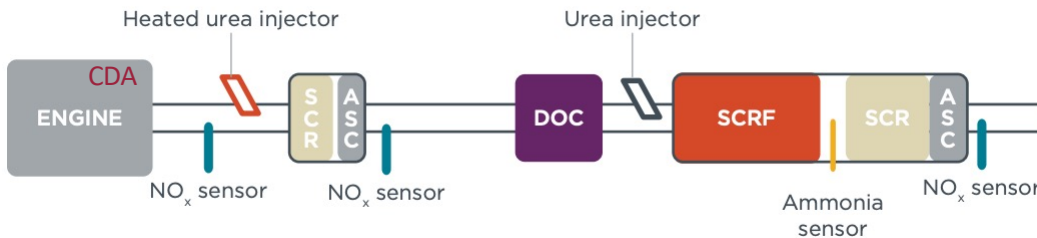


Possible configurations to meet CARB'27

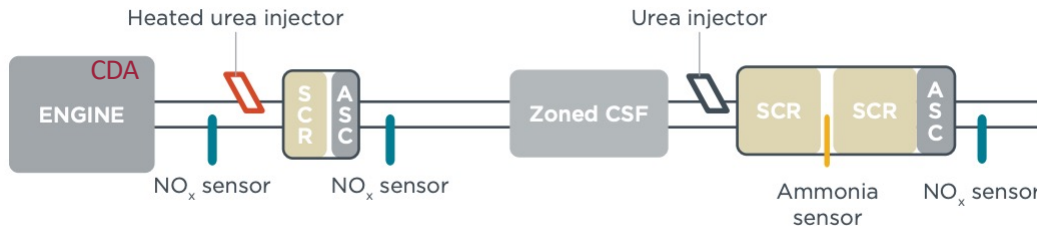
CARB 2027: Configuration 1



CARB 2027: Configuration 2

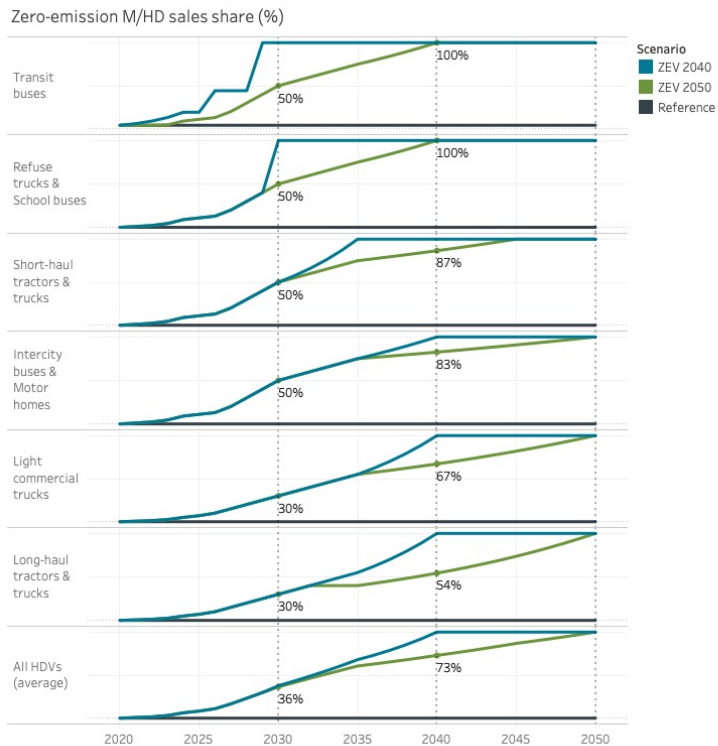


CARB 2027: Configuration 3



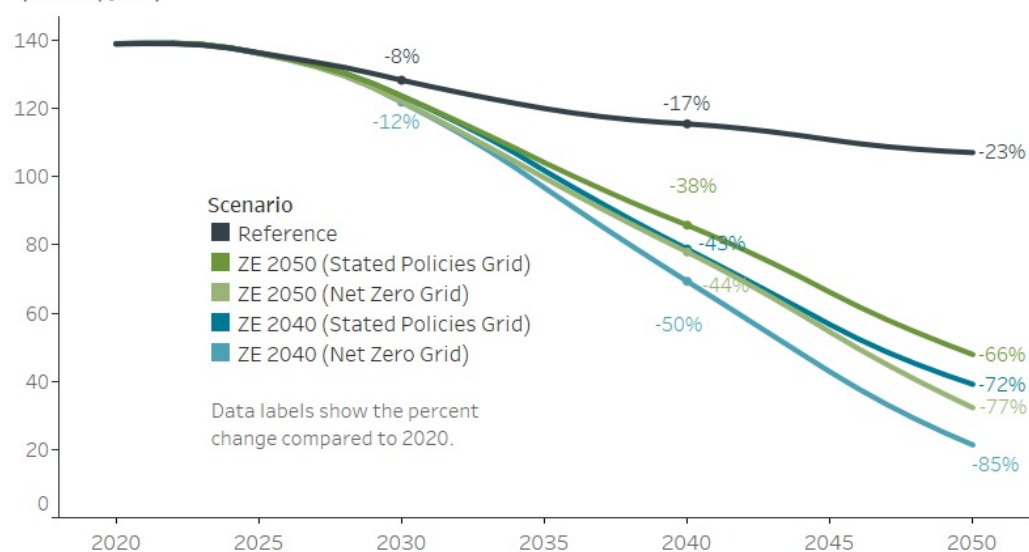
Importance for US EPA to accelerate EV penetration in key market segments

State-level actions could reduce 15 states' M/HDV CO₂ emissions by 50% in 2040 and 85% in 2050. But these actions are likely to only cover at most 35% of M/HDVs nationwide and likely a much smaller share of long-haul tractor trucks.



Assumed sales shares of new zero-emission M/HD vehicles in MOU signatories, not including California, from 2020–2050.

M/HD vehicle fuel lifecycle CO₂ emissions in MOU jurisdictions (MtCO₂/year)



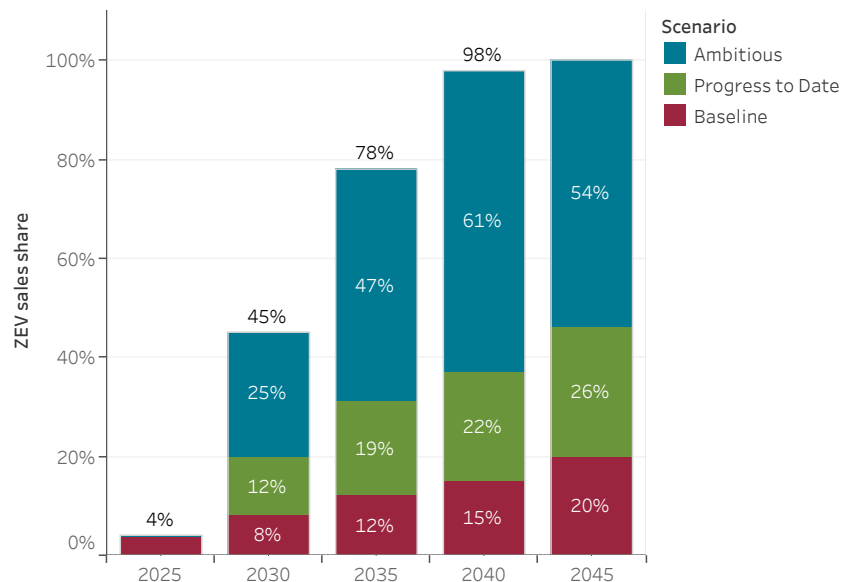
Comparison of M/HD vehicle fuel lifecycle CO₂ emissions across scenarios. *Caveat: These benefits could be undermined by out-of-state vehicles.*

Arijit Sen, Ray Minjares, Josh Miller, and Caleb Braun, “Benefits of the 2020 Multi-State Medium- and Heavy-Duty Zero-Emission Vehicle Memorandum of Understanding” 16 (forthcoming)

Importance for US EPA to accelerate EV penetration in key market segments

State-level actions and Phase 2 GHG standards are projected to reduce nationwide M/HDV CO₂ emissions by 30% in 2050. Federal action is needed to more than double the rate of zero-emission M/HDV uptake and align with a 2°C goal.

Sales share of zero-emission medium- and heavy-duty vehicles



WTW CO₂ emissions from medium- and heavy-duty vehicles

