Vehicle Emission Control in U.S. and California (a *quick update on where things stand)*

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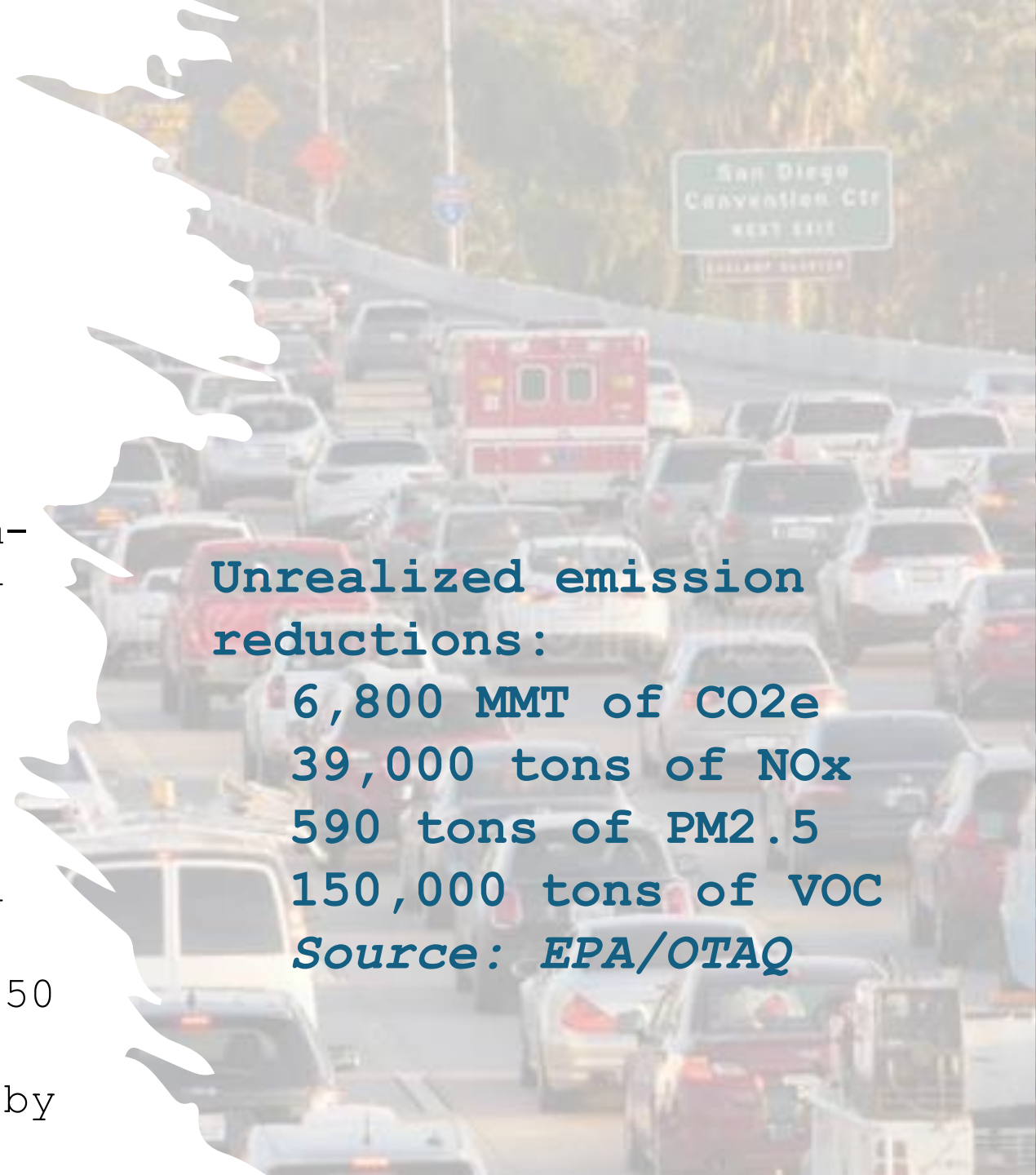
- Emission standards on new vehicles/engines still most effective policy intervention
- Complimentary actions for fleet modernization via public funding investments are critically important
- Importance of Periodic Inspection - ensuring adequate in-use performance for life of vehicle/engine
- Growing role of OBD for LDV and HDV - still evolving and improving
- LD & HD sectors converging towards common compliance approach for in-use performance
- Rescission of 2009 GHG Endangerment Finding and Motor Vehicle GHG Emission Standards
- EPA's deregulatory agenda has rescinded all 4 LDV GHG standards and all 3 MDV/HDV/engine standards previously adopted
- Actions results in very large foregone emission reductions
- Interventions for existing or new standards – for both ambient air quality and tailpipe emissions – at a standstill
- Incongruent policy priorities between California and federal government

Light- and medium-duty vehicle emission control policy update

- GDI dominates new LDVs
- Rescinded EPA's Multipollutant Standards for Light-duty and Medium-duty Vehicles MY 2027-2032 (adopted March 2024)
- Intended to cut ROG+NOx 30 mg/mi limit by 50% to 15 mg/mi by 2032
- Over 200 models already meeting 15 mg/mi
- PM mass limit of 0.5 mg/mi expected to be met with GPF
- California MY 2026 cert data shows 50 models certified with GPF
- BMW with most models (21) followed by Ford (14)



Unrealized emission reductions:

6,800 MMT of CO2e
39,000 tons of NOx
590 tons of PM2.5
150,000 tons of VOC

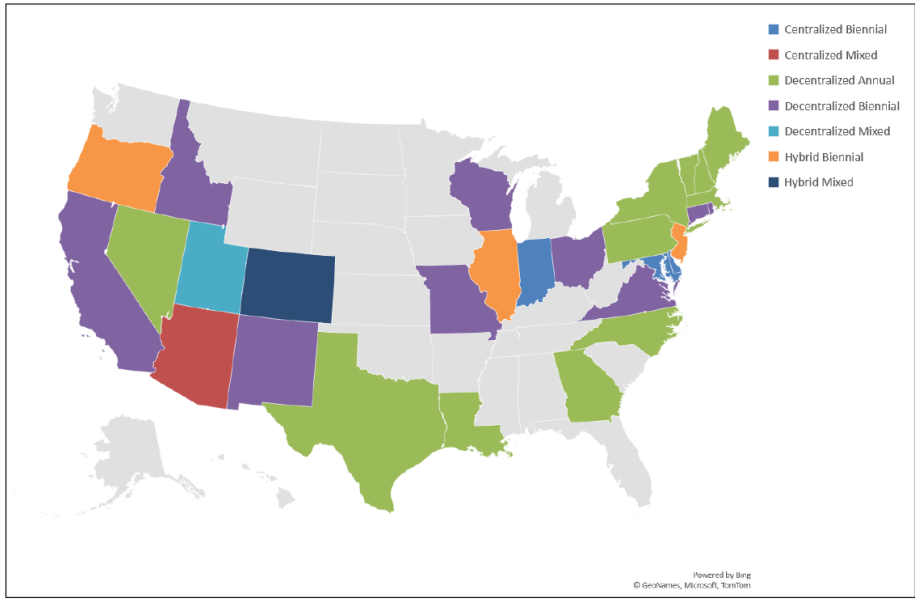
Source: EPA/OTAQ

LDV Fleet Inspection and Maintenance

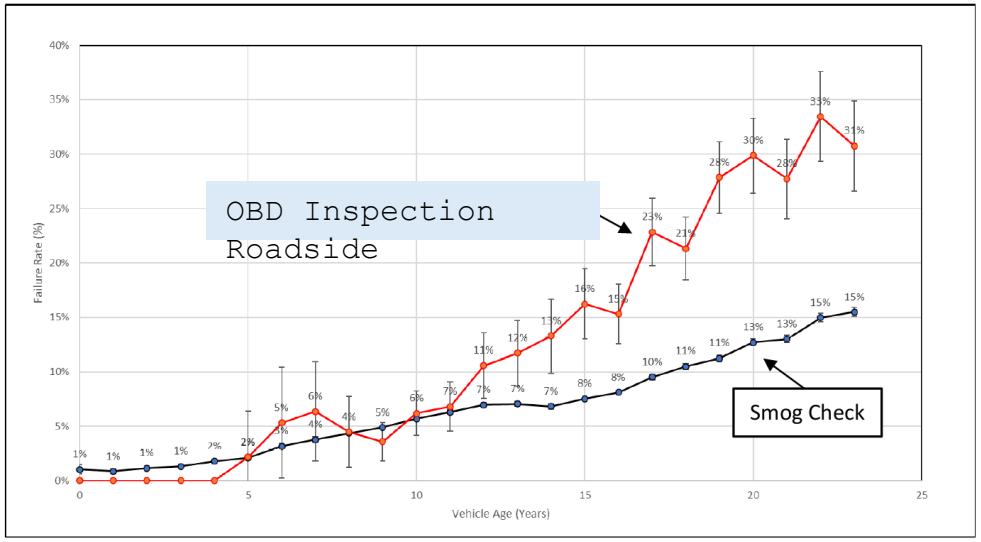
- I/M Programs throughout the US
- Remote Sensing, OBD telematics, OBD kiosks, and Mobile On-site Testing
- In California:
  - Smog Check for all cars 8 years and older every 2 years
  - OBD based only for MY1996 and newer vehicles
  - Roadside testing for more fail captures

Source: California Bureau of Automotive Repair

I/M Program Administration and Inspection Frequency by Area

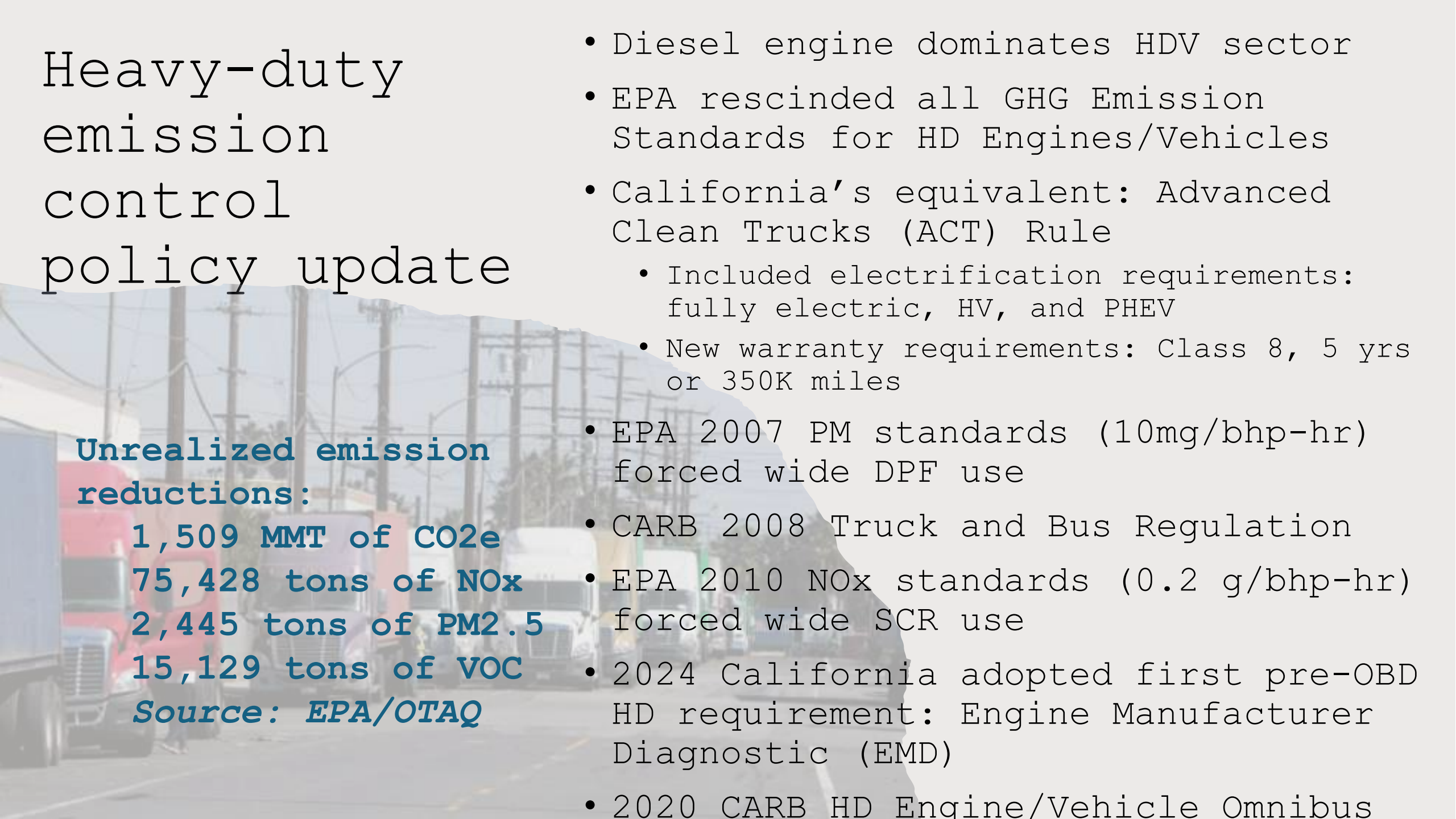


OIS Fail Rates by Vehicle Age using Smog Check and Roadside Testing Data (CY 2022-2023, MY 2023 and Older Gasoline-Powered Vehicles) *



*Error bars reflect the 95% confidence levels. The greater the sample size, the smaller the variation around the mean.

Heavy-duty emission control policy update



Unrealized emission reductions:

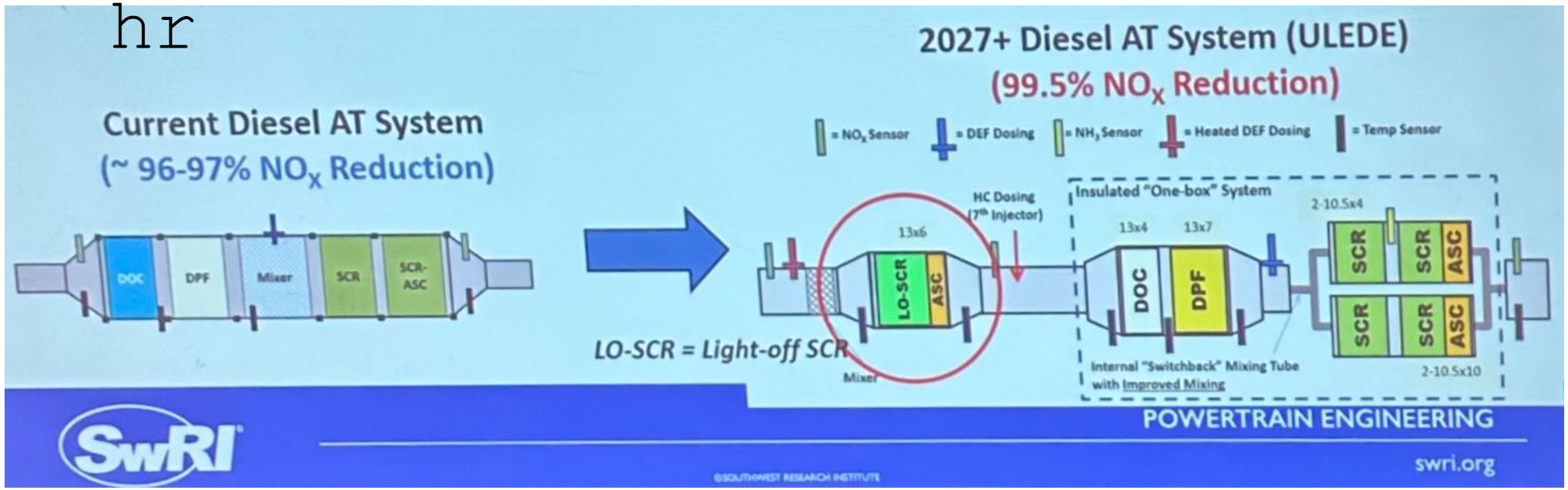
1,509 MMT of CO2e
75,428 tons of NOx
2,445 tons of PM2.5
15,129 tons of VOC
Source: EPA/OTAQ

- Diesel engine dominates HDV sector
- EPA rescinded all GHG Emission Standards for HD Engines/Vehicles
- California's equivalent: Advanced Clean Trucks (ACT) Rule
  - Included electrification requirements: fully electric, HV, and PHEV
  - New warranty requirements: Class 8, 5 yrs or 350K miles
- EPA 2007 PM standards (10mg/bhp-hr) forced wide DPF use
- CARB 2008 Truck and Bus Regulation
- EPA 2010 NOx standards (0.2 g/bhp-hr) forced wide SCR use
- 2024 California adopted first pre-OBD HD requirement: Engine Manufacturer Diagnostic (EMD)
- 2020 CARB HD Engine/Vehicle Omnibus

HDE NOx control demonstrated, but system growing in complexity

200 mg/bhp-hr

35 mg/bhp-hr



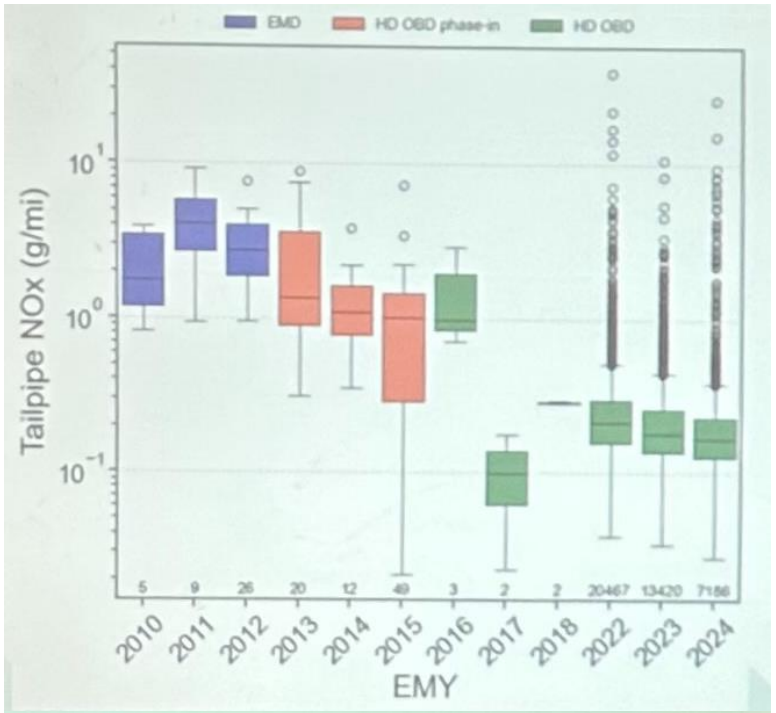
Source: Chris Sharp/SwRI

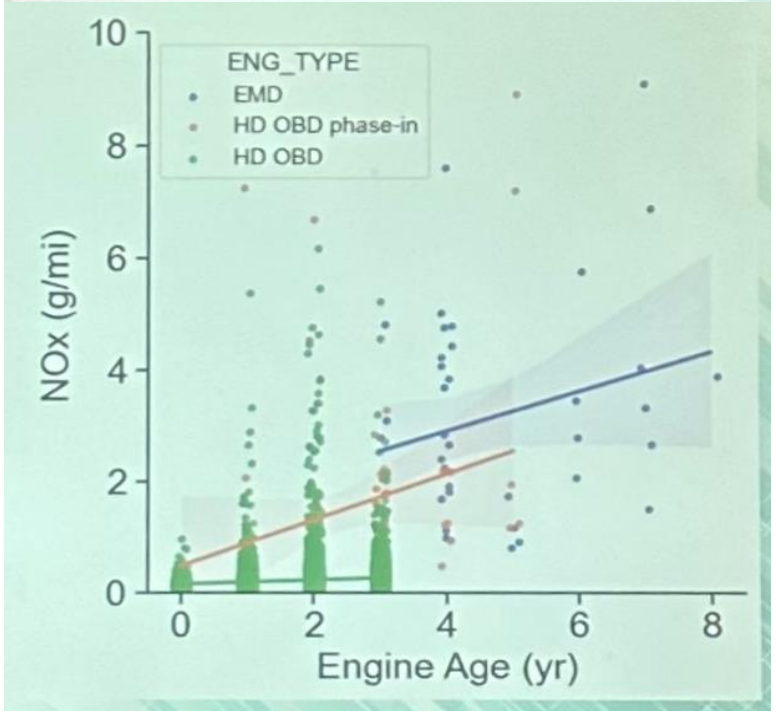
HDV Periodic Inspection History in California

- Since 1990s, HD Vehicle Inspection Program (HDVIP) and Periodic Smoke Inspection Program (PSIP)
- Since 2016, Truck and Bus Surveillance Program – chassis dynamometer and PEMS testing
- HDV I/M (Truck Smog Check) – periodic testing starting Jan 2024:
  - Roadside vehicle emission monitoring
  - Automated license plate recognition network
  - Compliance tied to vehicle registration
  - On board sensing for ID high emitting vehicles
  - OBD – telematics or plug-in test devices
  - California Highway Patrol inspections for compliance certificates, MIL lights, and visible smoke.

CARB's Portable Emission AcQuisition System (PEAQS)

- Measurement platform captures emissions from passing vehicles
- Fuel specific emission snapshot (g pollutant/kg fuel burned)
- Real-time measurement of emissions - PM2.5, black carbon, CO2, and NOx
- Geovision camera
- Doppler radar
- Lidar
- Automated License Plate Reader for high-emitter screening





Positive Impact of HD OBD requirements

- Lower NOx with phase-in of HD OBD and improved SCR
- Less NOx deterioration of NOx controls still a concern

Source: CARB

sustainability

MDPI

Review

Excess Pollution from Vehicles—A Review and Outlook on Emission Controls, Testing, Malfunctions, Tampering, and Cheating

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Tampering, malfunctions, and cheating still problems

- Hard to quantify but likely substantial
- These are real issues that need attention
- There are solutions
- Consumer awareness
- Smart laboratory, on-road, and in-use testing + repair (e.g., PTI)
- Fixing the problem is a collective responsibility

Danke

Thank you

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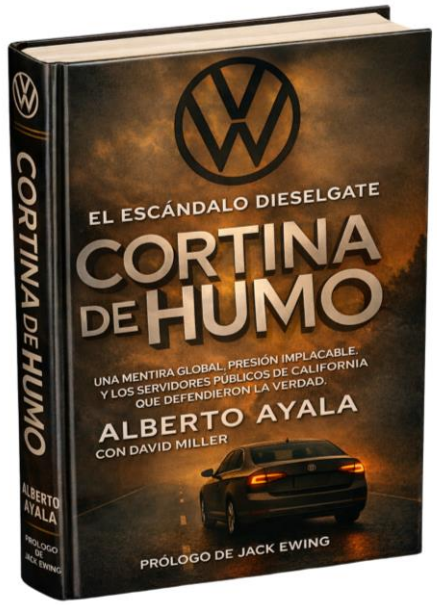

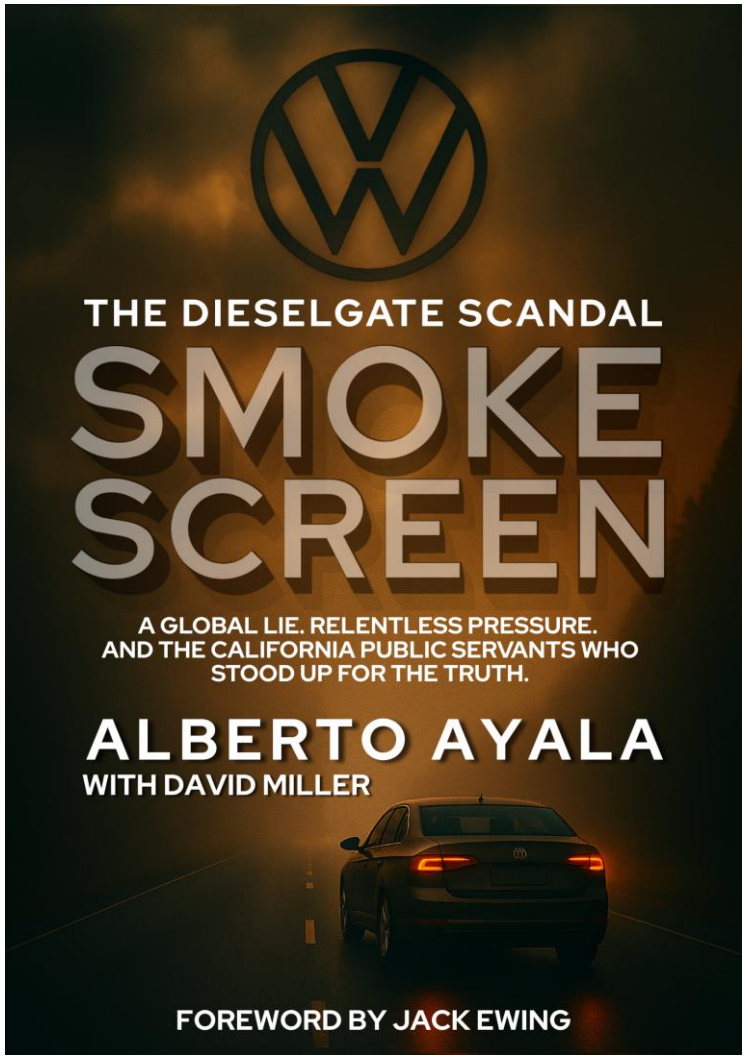

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