



# **Workshop on Hydrogen Internal Combustion Engines and Their Use in California's Trucks**

November 28, 2023

# Overview of Today's Workshop

12:00 – 12:15 p.m. Staff, California Air Resources Board

12:15 – 12:30 p.m. Tyson Eckerle, GO-Biz

12:30 – 2:15 p.m. Panelists Presentations

2:15 – 3 p.m. Panel Discussion Moderated by Jennifer Hamilton with  
California Hydrogen Business Council

Open Public Comment

CARB Closing Remarks

For meeting materials and to view a recording, see [Clean Truck Partnership website](https://ww2.arb.ca.gov/clean-truck-partnership) (<https://ww2.arb.ca.gov/clean-truck-partnership>)

# Clean Truck Partnership

- CARB agrees to align with 2027 Environmental Protection Agency (EPA) oxides of nitrogen (NOx) standards, provide flexibility and lead time
- Manufacturers agree to comply with all CARB regulations regardless of litigation outcomes
- Means full commitment to cleaner combustion and zero-emission vehicles (ZEV) including 100% ZE sales by 2036
- "In calendar year 2023, CARB will hold a public workshop to discuss the appropriate role of hydrogen-fueled internal combustion engines towards meeting the requirements of the ACT and ACF regulations."



DAIMLER TRUCK



general motors



ISUZU

NAVISTAR

PACCAR Inc

STELLANTIS





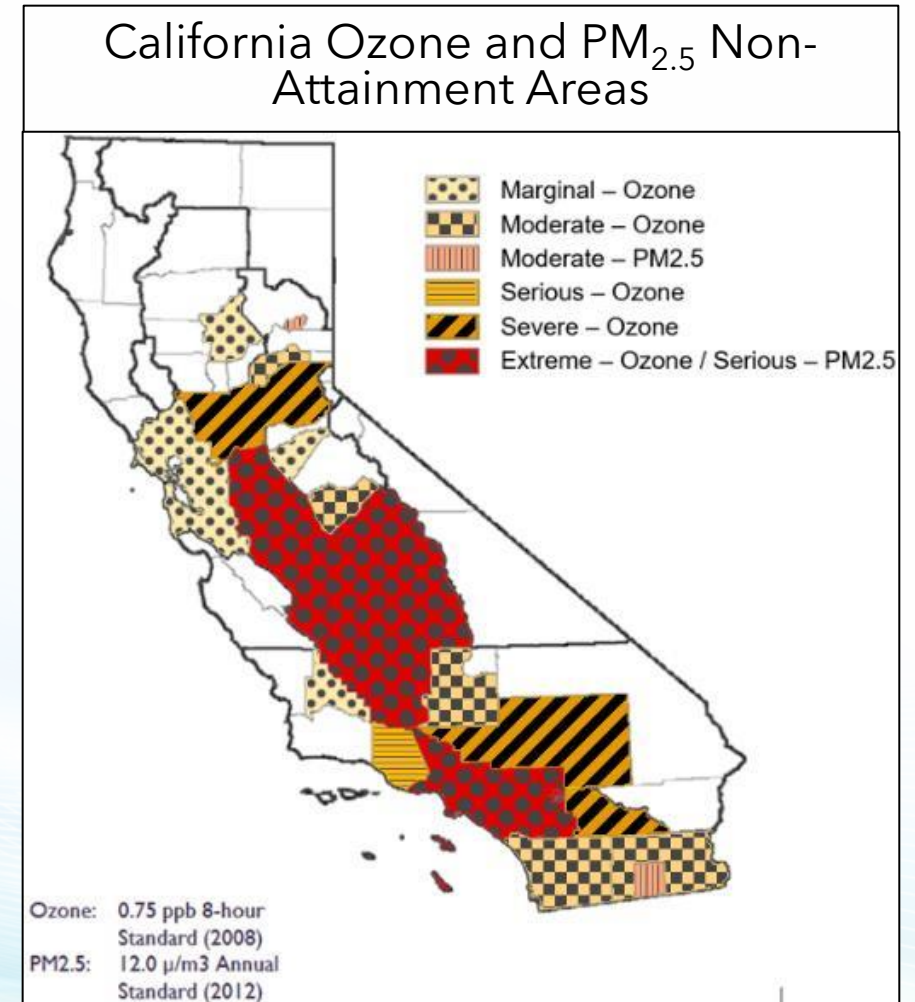
# **California's Regulations for Medium- and Heavy-Duty Trucks**

# Overview of CARB's Presentation

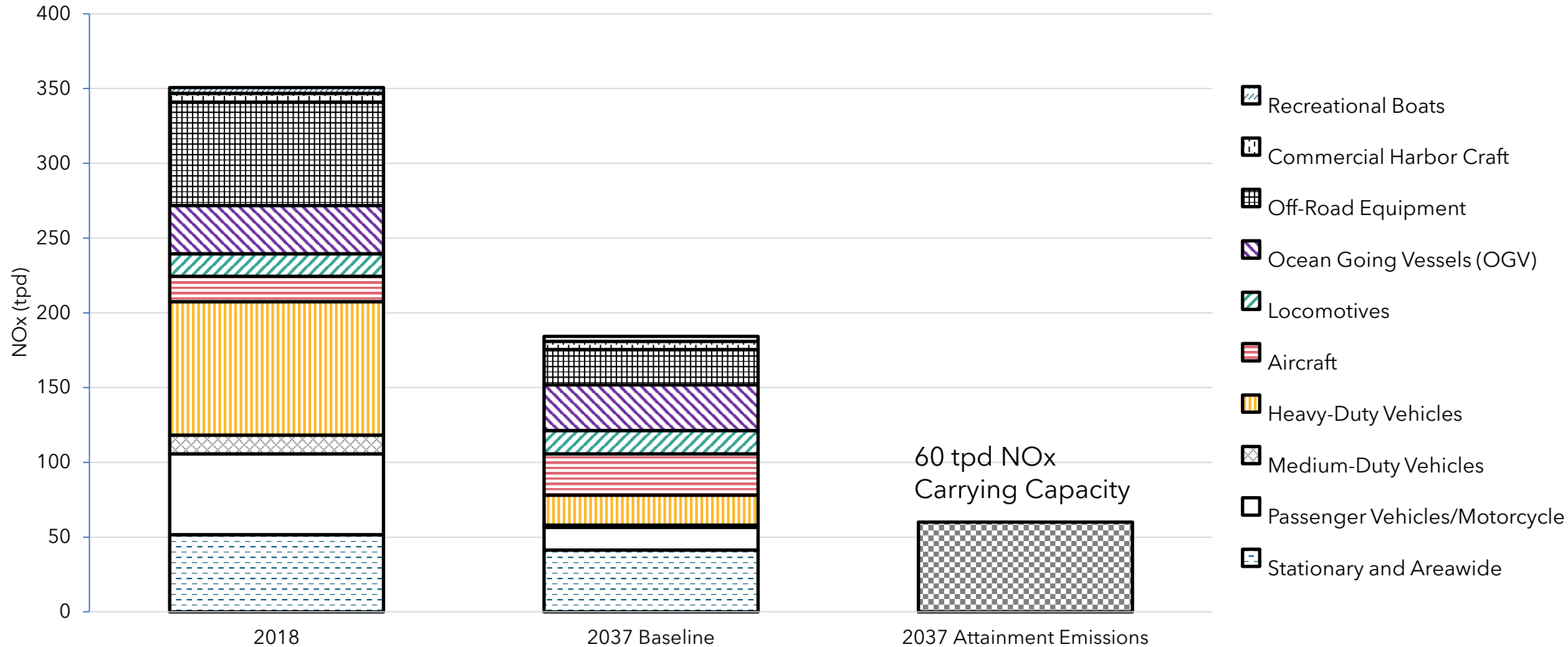
- Need for Emissions Reductions
  - Extreme Non-Attainment for Ozone (South Coast, San Joaquin Valley)
  - Climate Neutrality by 2045
- Existing Regulations
  - Low Carbon Fuel Standard Regulation
  - Heavy-Duty Omnibus Regulation
  - Advanced Clean Trucks (ACT)
  - Advanced Clean Fleets (ACF)
- Awarded Projects and Incentives for Medium-and Heavy-Duty Hydrogen Fueling Infrastructure

# Major NOx and Fine Particulate Matter (PM<sub>2.5</sub>) Emissions Reductions Needed

- California has the worst air quality in the nation
- Unique challenges in San Joaquin Valley and South Coast
- Heavy-duty (HD) trucks and federal sources\* remain largest contributors
- More reductions needed to meet 2031 and 2037 attainment

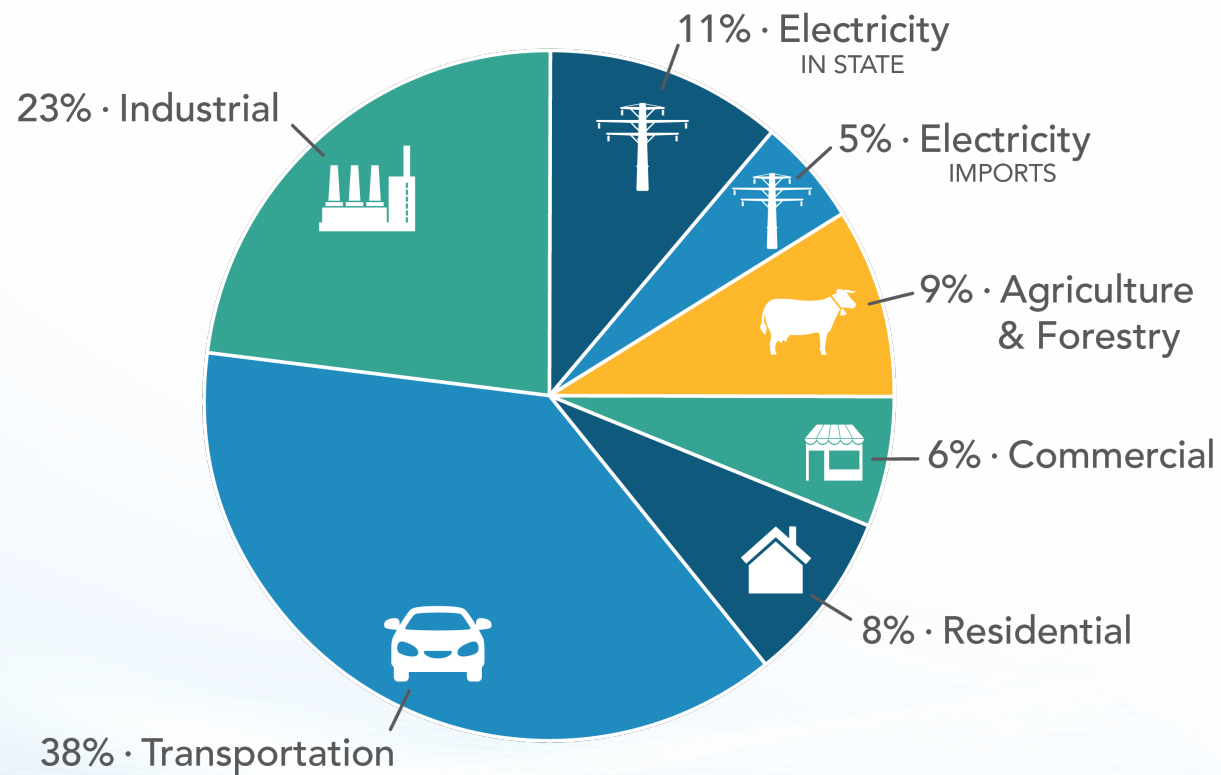


# Baseline and Attainment NOx Emissions for the South Coast



# California's Climate Targets

- Greenhouse gas (GHG) goals
  - 40% reduction by 2030
  - 85% reduction by 2045
  - Carbon neutrality by 2045
- Clean electricity
  - 60% renewable by 2030
  - Carbon-free by 2045



369.2 MMT CO<sub>2</sub>e  
2020 TOTAL CA EMISSIONS





# **Existing Regulations Summary**

# Hydrogen in CA's Climate Plan



Blending in Pipelines



Aviation Fuel



Ocean-Going Vessel Fuel



Industrial High Heat Uses



Transportation Fueling



Focus on Low-carbon Sources, e.g. Biomass or Electrolytic



Capitalizing on Federal Funding for Hydrogen Hubs and Low-CI Hydrogen



Significant Reduction in Overall GHG Emissions by Replacing Methane End-Uses with Hydrogen



Prioritize non-combustion options

# Measures to Clean Up Heavy-Duty Vehicles



2018  
Innovative Clean  
Transit



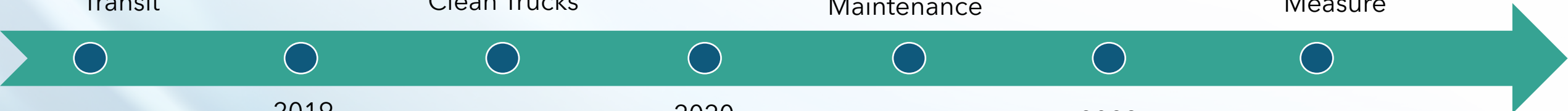
2020  
Advanced  
Clean Trucks



2021  
Heavy-Duty  
Inspection and  
Maintenance



2028  
Zero-Emission Truck  
Measure



2019  
Zero Emission Airport  
Shuttle



2020  
Heavy-Duty  
Omnibus



2023  
Advanced  
Clean Fleets

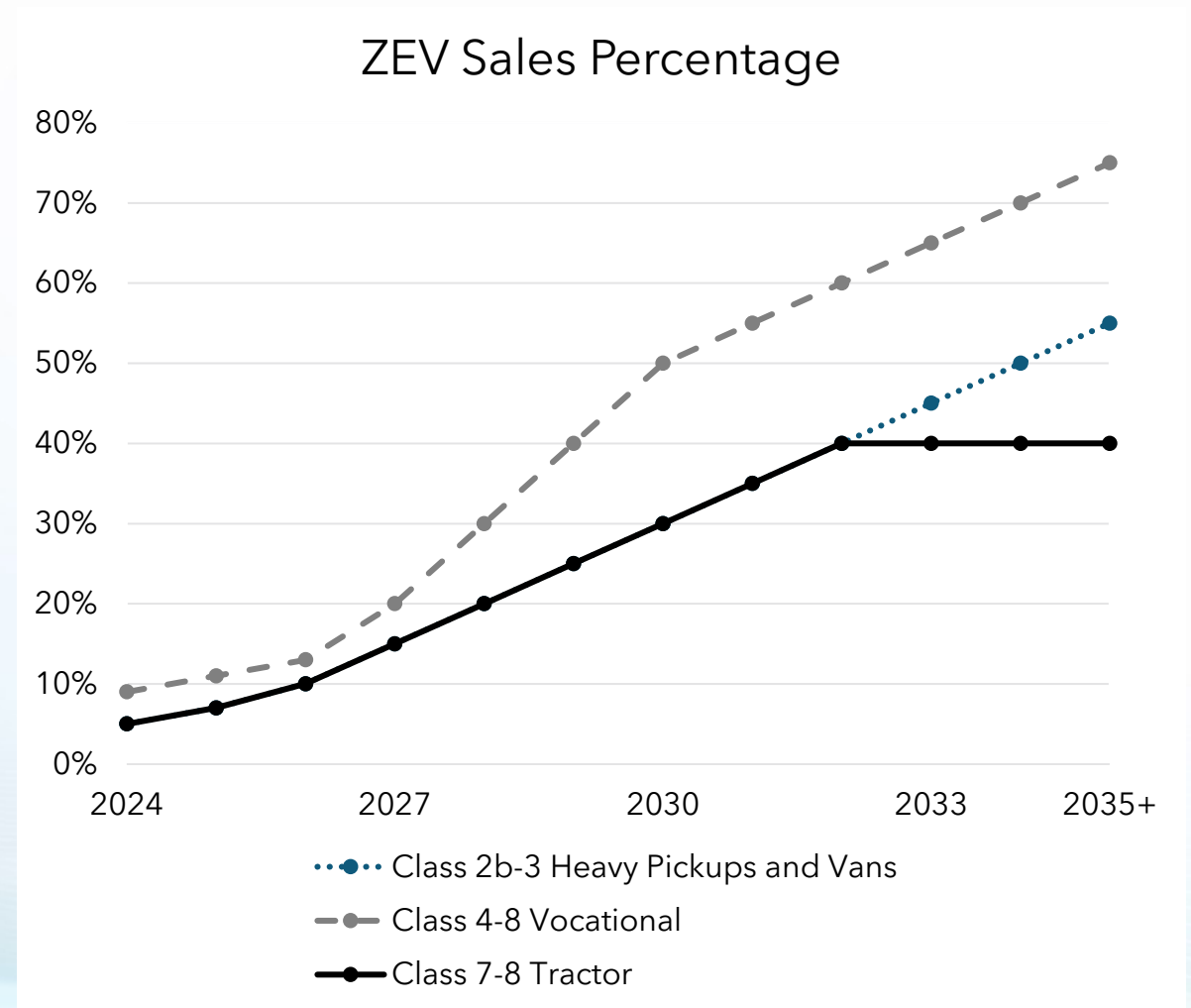


# Heavy-Duty Omnibus Regulation

- Adopted by the Board on August 2020
- Critical 2016 State Implementation Plan measure for achieving air quality goals
- Established more stringent NO<sub>x</sub> and PM emissions standards for 2024 and subsequent model year (MY) HD engines
- Limited exemptions for HD trucks over 525 hp and transit buses
- Compliance flexibilities during the transition years in 2024-2026 MYs - legacy engine provisions

# Advanced Clean Trucks Regulation

- Board approved in 2020
- Manufacturers to sell ZEVs in all vehicle classes as a percentage of total sales
  - Partial credit for near-ZEVs with minimum all electric range
- ZEV sales are already two years ahead of schedule



# Clean Truck Check (HD I/M) Overview

- **What is it?**

- Adopted December 2021
- Smog Check for Trucks

- **Who is regulated?**

- Diesel and alternative fuel HD vehicles over 14,000 lbs. operating in California, including out-of-state vehicles



# Advanced Clean Fleets Regulation

- **What is it?**

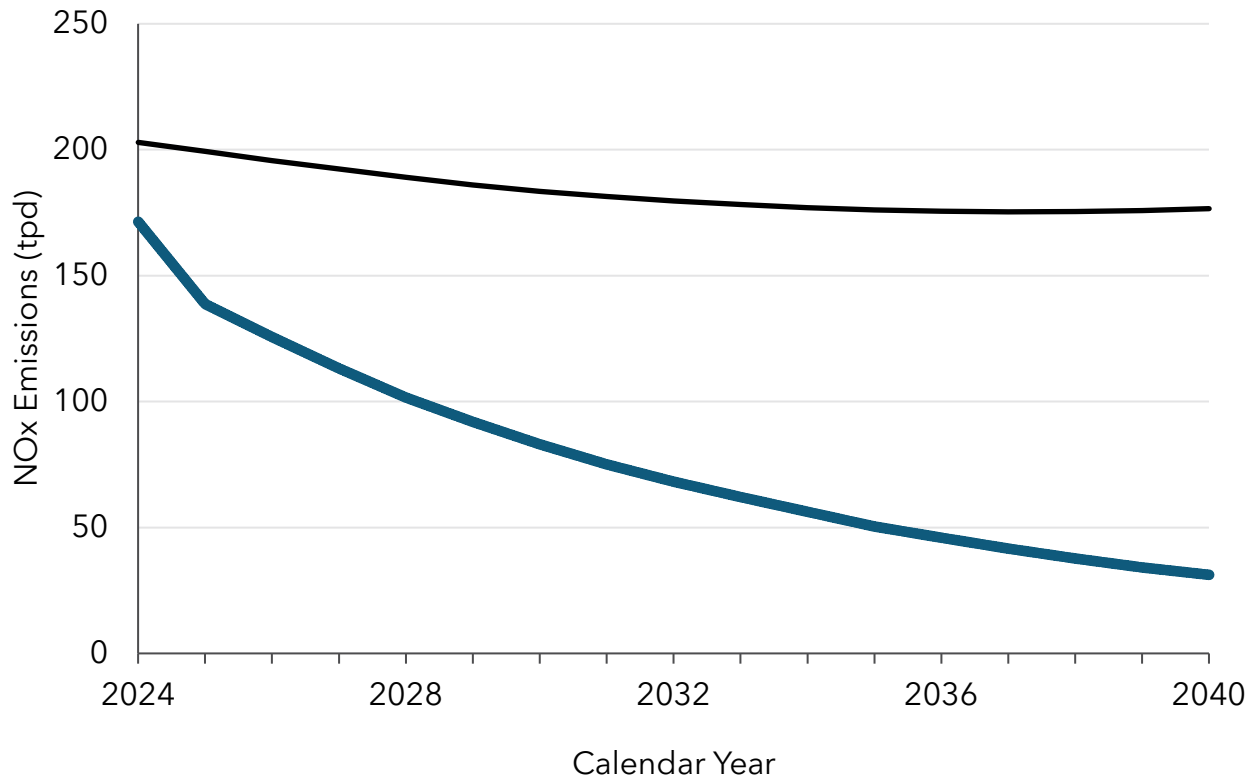
- Fleets must start phasing in ZE trucks starting in 2024
- Manufacturers must sell only ZE trucks starting in 2036 MY

- **Who is regulated?**

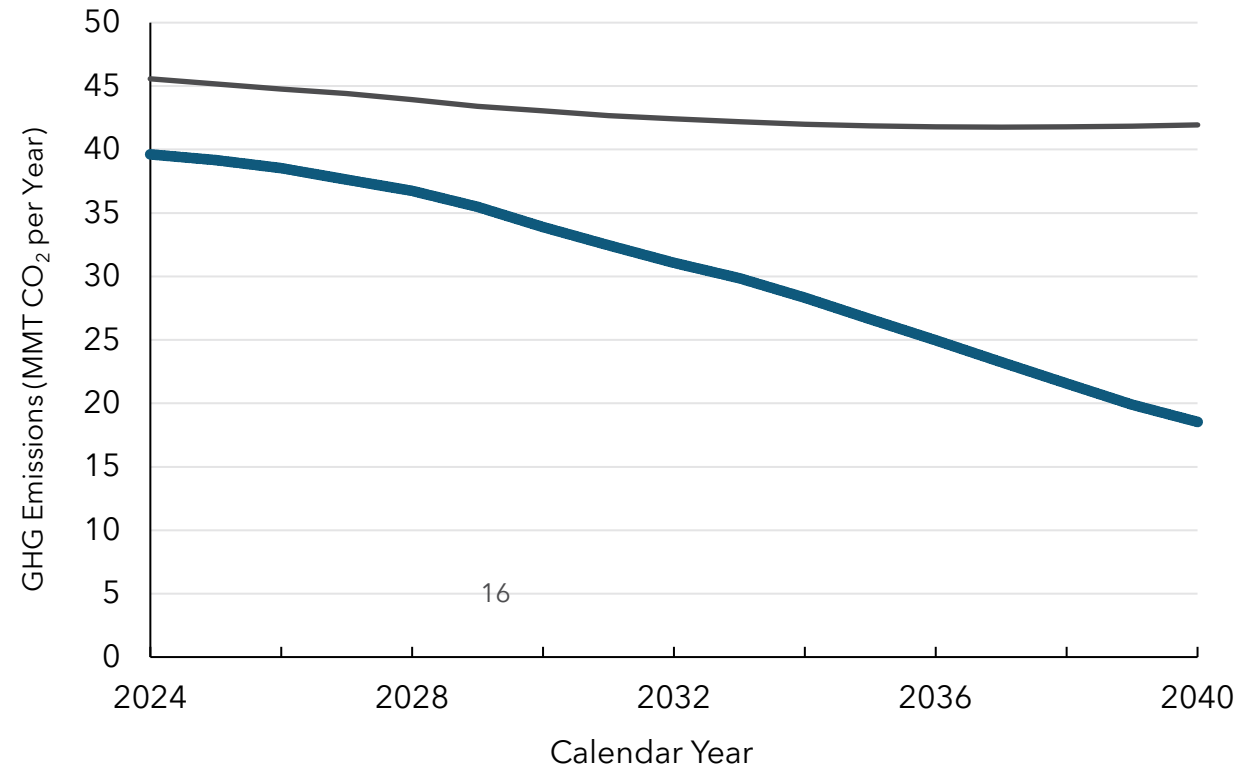
- High Priority Fleets, Government Fleets & Drayage Trucks
- Any manufacturer that certifies on-road vehicles over 8,500 lbs. gross vehicle weight rating for sale in California

# ACF, ACT, and Heavy-Duty Omnibus Get Substantial Emission Reductions

## NOx Emissions Drop 82% by 2040



## GHG Emissions Drop 56% by 2040



— 2020 Baseline — ACT, HD Omnibus, Clean Truck Check, and ACF Regulations

— Baseline — ACT and ACF Regulations





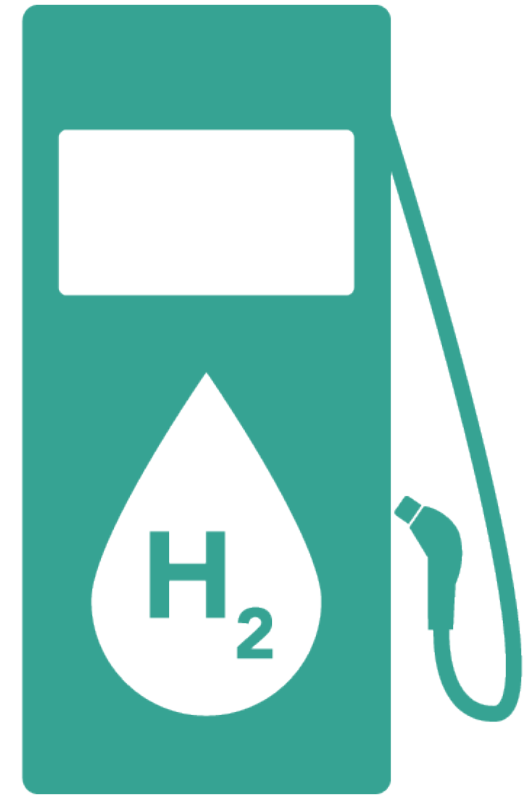
# **Planning for Medium-and Heavy-Duty Hydrogen Fueling Infrastructure**

# Low Carbon Fuel Standard (LCFS) Regulation

- LCFS program provides credits for hydrogen dispensed to ZEVs
- In 2018, the Board adopted the hydrogen refueling infrastructure credits for public light-duty ZEVs
- CARB is considering a similar infrastructure crediting provision for HD ZEVs

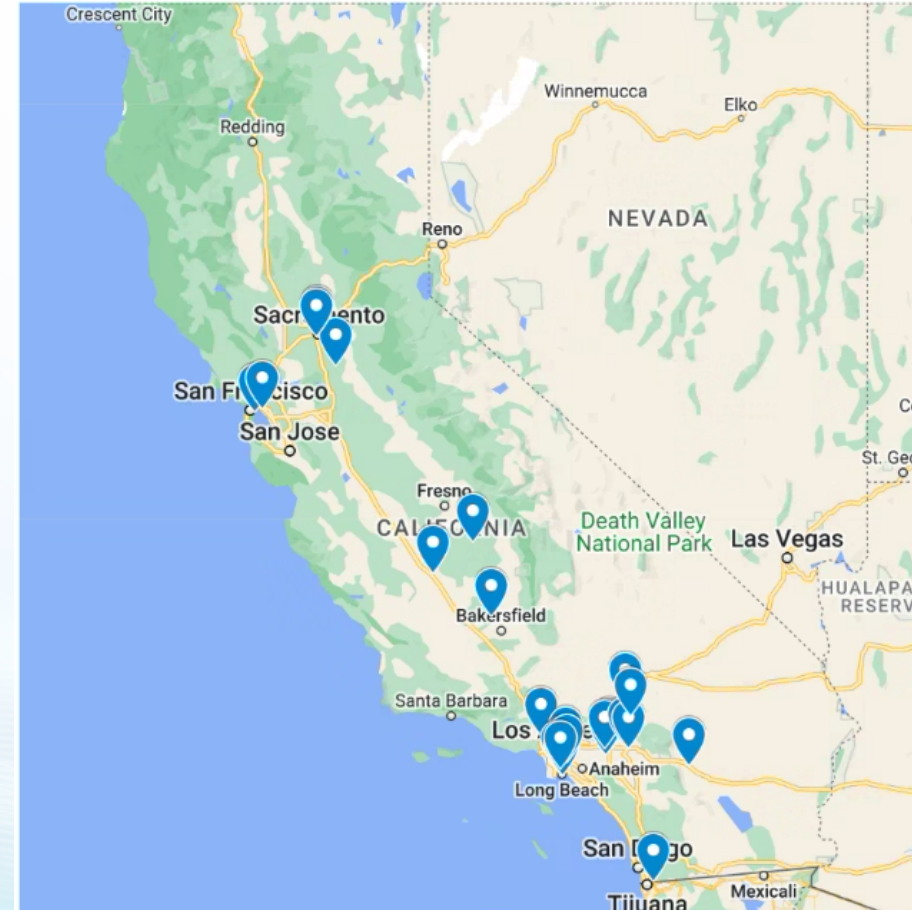
For more information see the LCFS website, <https://ww2.arb.ca.gov/our-work/programs/low-carbon-fuel-standard>

And for more information on Capacity Crediting, see the webpage, <https://ww2.arb.ca.gov/resources/documents/lcfs-zev-infrastructure-crediting>



# Medium- and Heavy-Duty Hydrogen Stations: Those Already Built and Those Underway

- Several at the Ports of Oakland and LA-Long Beach, and Ontario
- Several new station projects announced
- Once built out there will be a backbone enabling deliveries from Redding to the Mexican Border
- More hydrogen stations are available for FCEV at public transit agencies, see the [Innovative Clean Transit website](#)



# Incentives Available for Medium- and Heavy-Duty ZEV Infrastructure

## California:

- CEC's EnerGIIZE commercial vehicles \$17 M & transit/drayage fleets \$29.7 M \*
- CEC's Critical Paths \$20 M
- CEC's Blueprints \$20 M
- CTC's Trade Corridor Enhancement Program \$400 M per year
- Carl Moyer and Community Air Protection Program \$200 M this year

## Federal:

- DoE's ZEV charging and fueling corridor plans \$7.4 M
- IRA tax credits up to \$10 B
- IRA Pollution Reduction Grants \$5 B
- EPA's Clean Heavy-Duty Vehicles and Clean Ports \$4 B

# Panelists

- Dr. Aleš Srna, Sandia Heavy-Duty Optical Engine Lab
- Ram Vijayagopal, Argonne National Laboratory
- Dr. Terry Alger, Southwest Research Institute
- Carl Hergart and Mike Gerty, PACCAR
- Admir Kreso, Daimler Trucks
- John Bartel, Volvo
- Jacquelyn Birdsall, Toyota
- Jerome Gregeois, Hyundai

# Closing Remarks

More Information available on our websites

Clean Truck Partnership (<https://ww2.arb.ca.gov/clean-truck-partnership>)

Advanced Clean Trucks (<https://ww2.arb.ca.gov/our-work/programs/advanced-clean-trucks>)

Heavy-Duty Low NOx (<https://ww2.arb.ca.gov/our-work/programs/heavy-duty-low-nox>)

Advanced Clean Fleets (<https://ww2.arb.ca.gov/our-work/programs/advanced-clean-fleets>)