Health Effects Institute Annual Conference 2026

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Brake-Wear and Tire-Wear Research Needs for Air Quality in California

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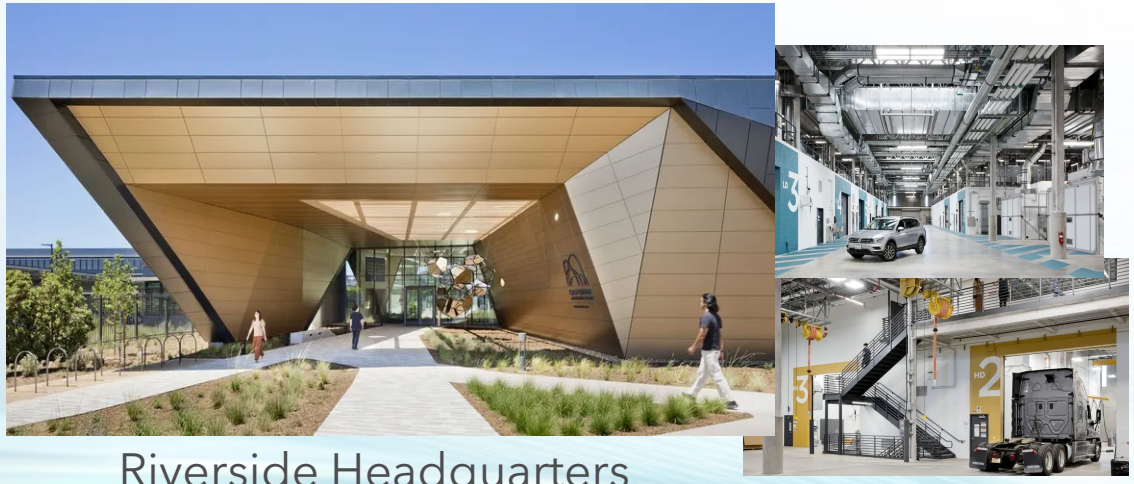
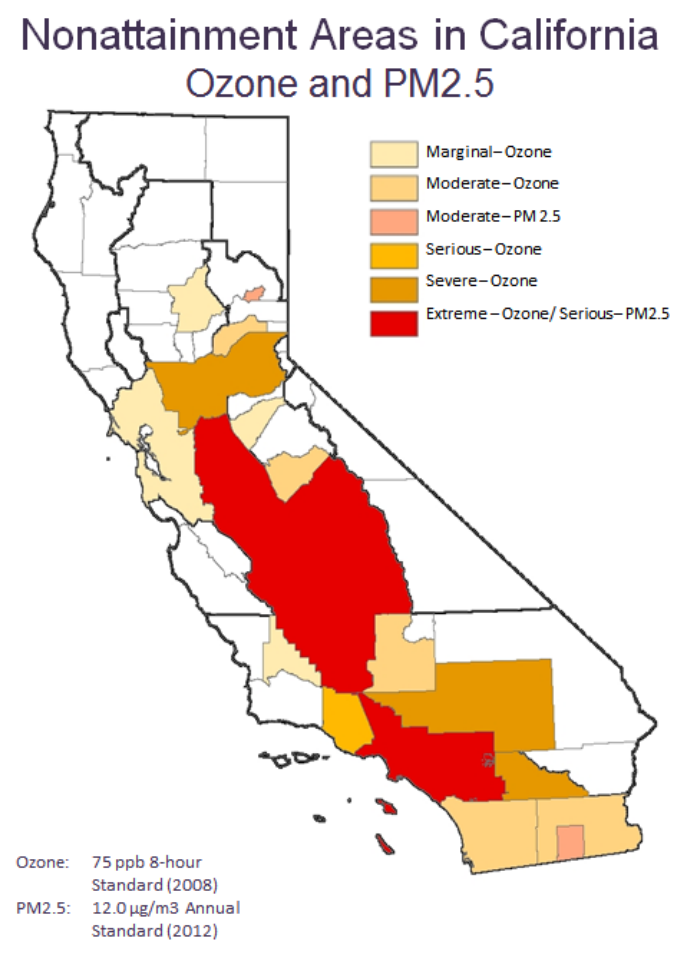
CARB leads California's fight against air pollution and climate change, protects public health, and promotes clean, energy-efficient fuels and technology.

Sacramento Headquarters

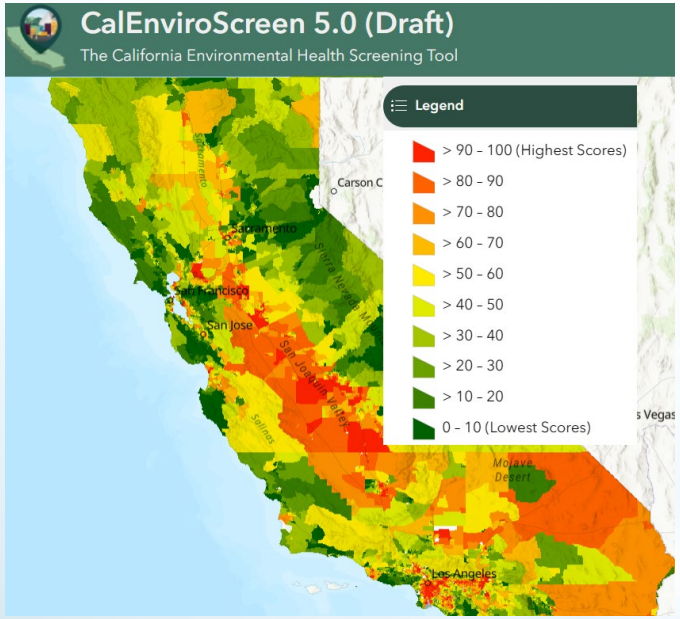


Riverside Headquarters

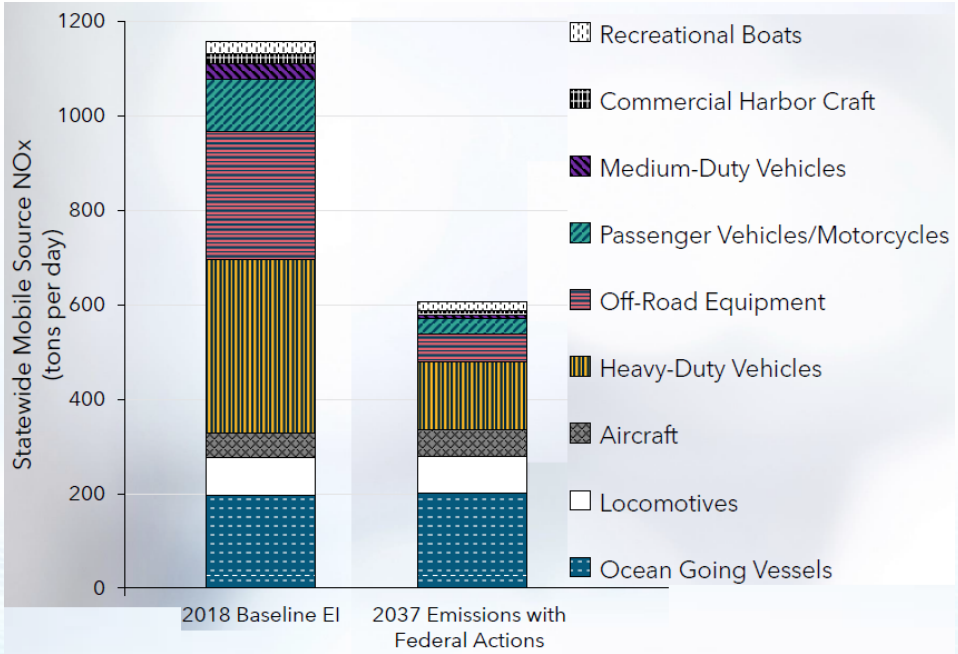
California needs to improve air quality regionally and locally



Disadvantaged Communities



(CalEnviroScreen 5.0)



(Drive Forward Workshop, Dec. 3, 2025)

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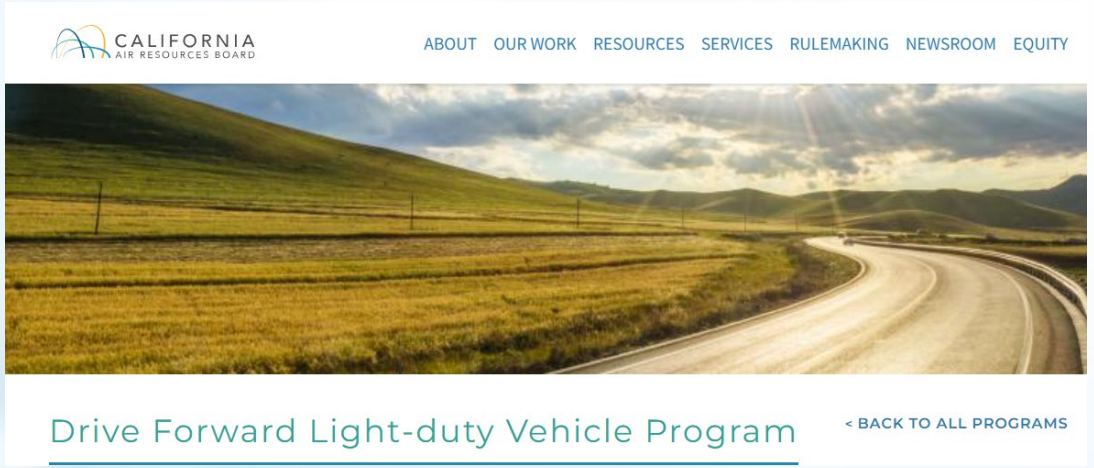
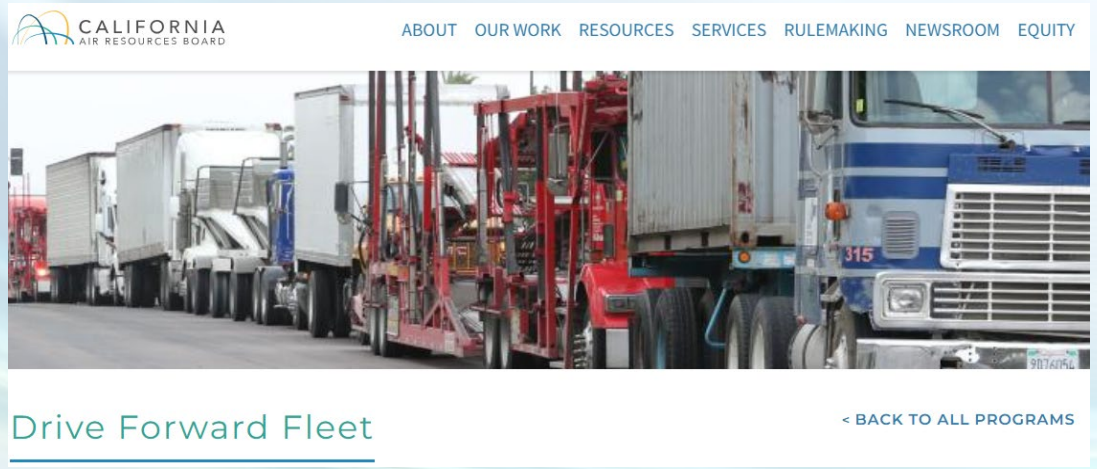
Drive Forward light-duty vehicle and fleet programs will help reduce emissions significantly





- Non-Exhaust Emissions (NEE), such as brake wear, tire wear, and wheel wear
- NEE could be more than 80% of the primary PM emission inventory by 2050
- Seeking input on reduction options that can be considered for regulatory or alternative measures

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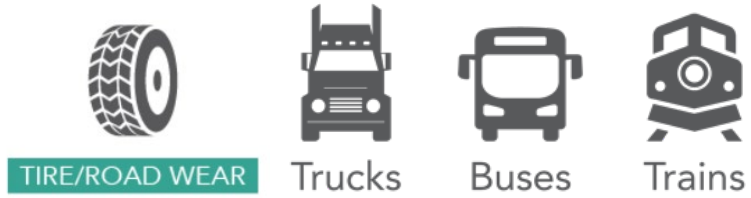
What are research needs for non-exhaust emissions?

Emissions Inventory Updates

Characterize tire-wear, train wheel and rail, off-road emissions and validating laboratory vs real-world testing



Air Quality Impacts

Investigate the significance of volatile organic gases and their contribution to Ozone and secondary $PM_{2.5}$ formation in the atmosphere

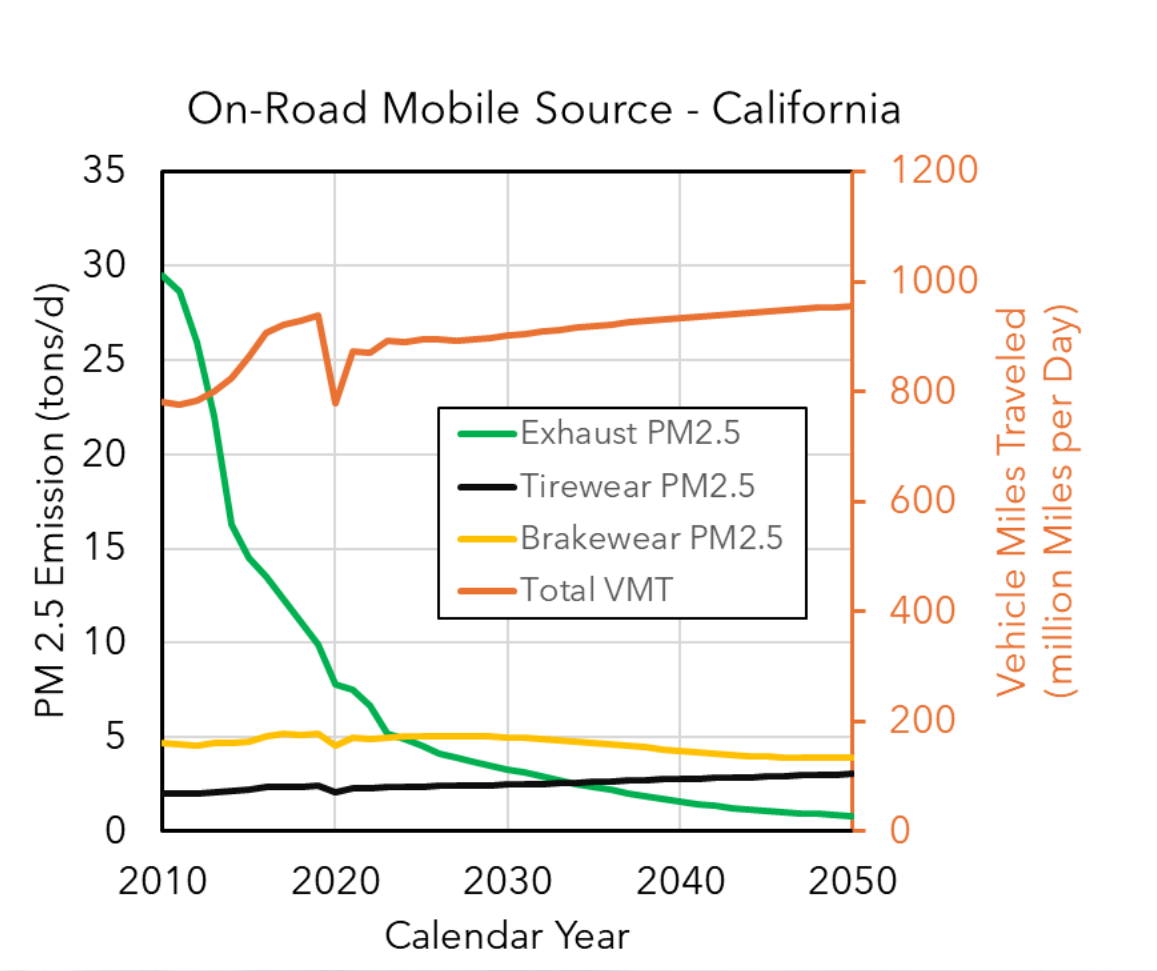
Impact of Clean Transportation Technologies

Understand impact of clean transportation on non-exhaust emissions

Health Effects & Community Exposure

Identify toxic compounds, health effects, and impacts in communities

Emissions Inventory Updates

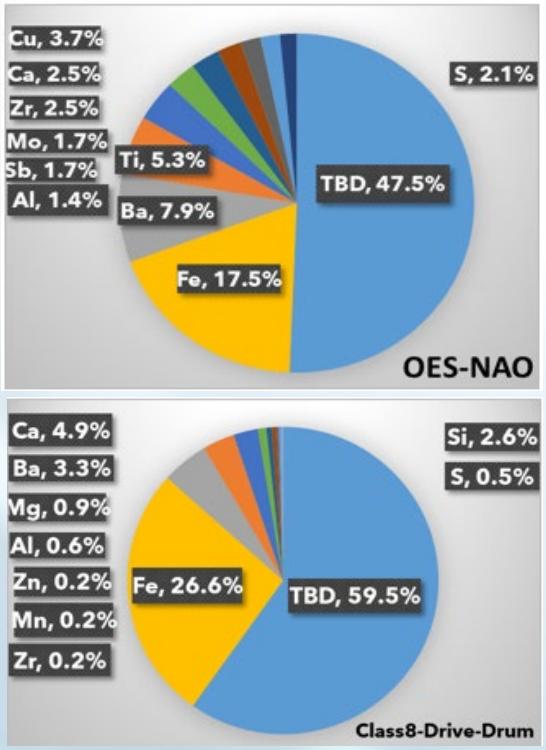


(EMFAC2025 Projections)

- Characterize NEE PM and gaseous emissions along with cleaner vehicle technology advancements
  - Emission factors for mobile source emission inventory and regional air quality modeling
- Assess the significance of the impact of NEE on the air quality

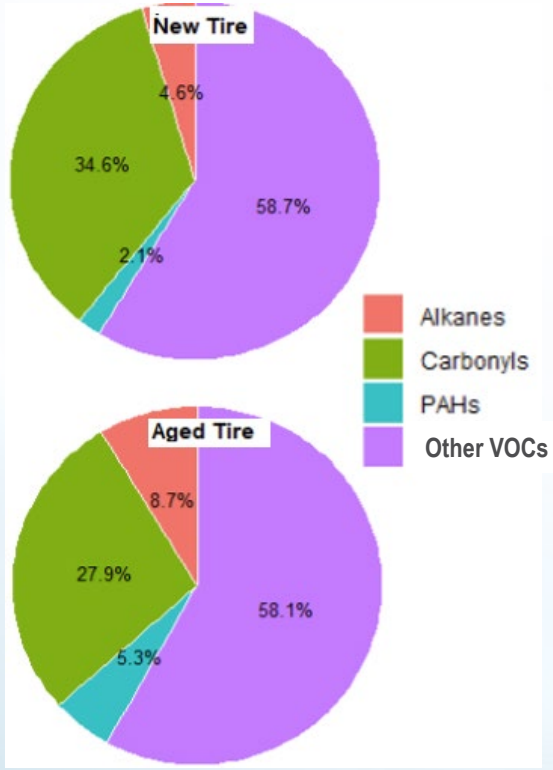
Air Quality Impacts

Brake Wear PM



(Yao, et al., Presentation for 2024 CRC Mobile Source Air Toxics Workshop)

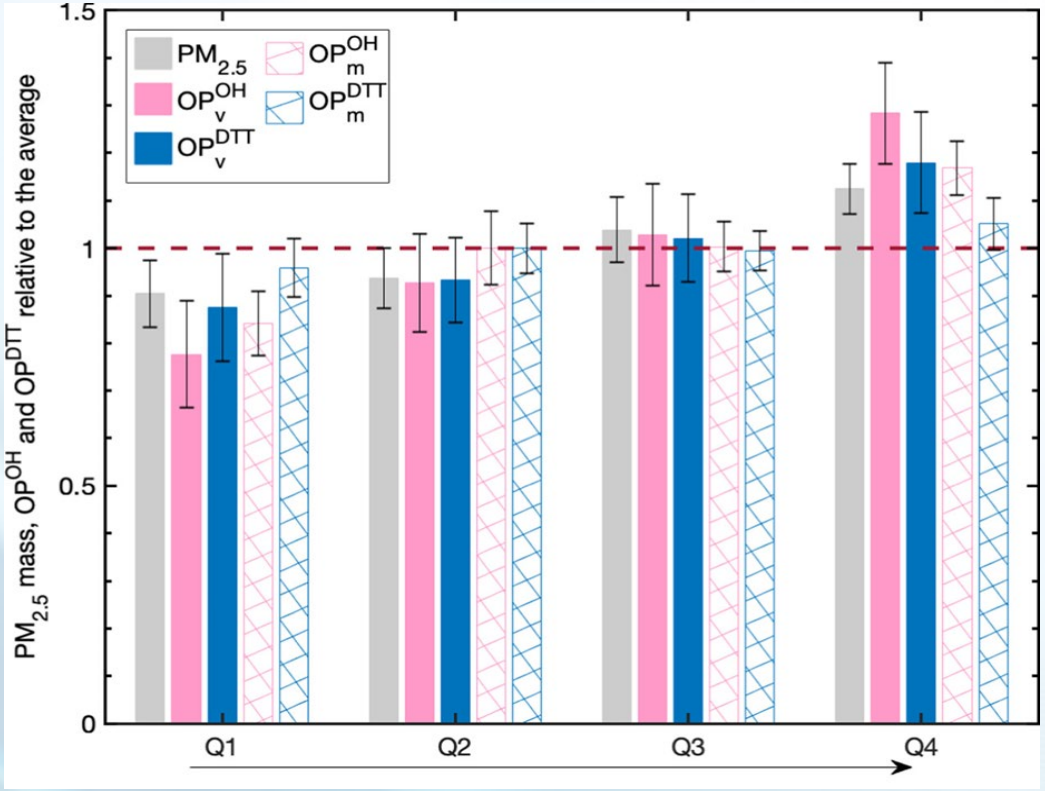
Gaseous Tire Wear



(Preliminary findings from Gaseous tire-wear study – CARB Contract # 23RD008)

- Characterize chemical speciation profiles for regional air quality modeling
- Investigate Ozone and secondary PM formation of NEE gaseous emissions
- Assess the significance of the impact of NEE emissions on regional air quality

Health Effects & Community Exposure



(NEE health effect study - CARB Contract # 17RD012)

- Assess the significance of exposure to NEE near source communities
- Examine potential reduction opportunities of NEE exposure through clean transportation and community air protection programs

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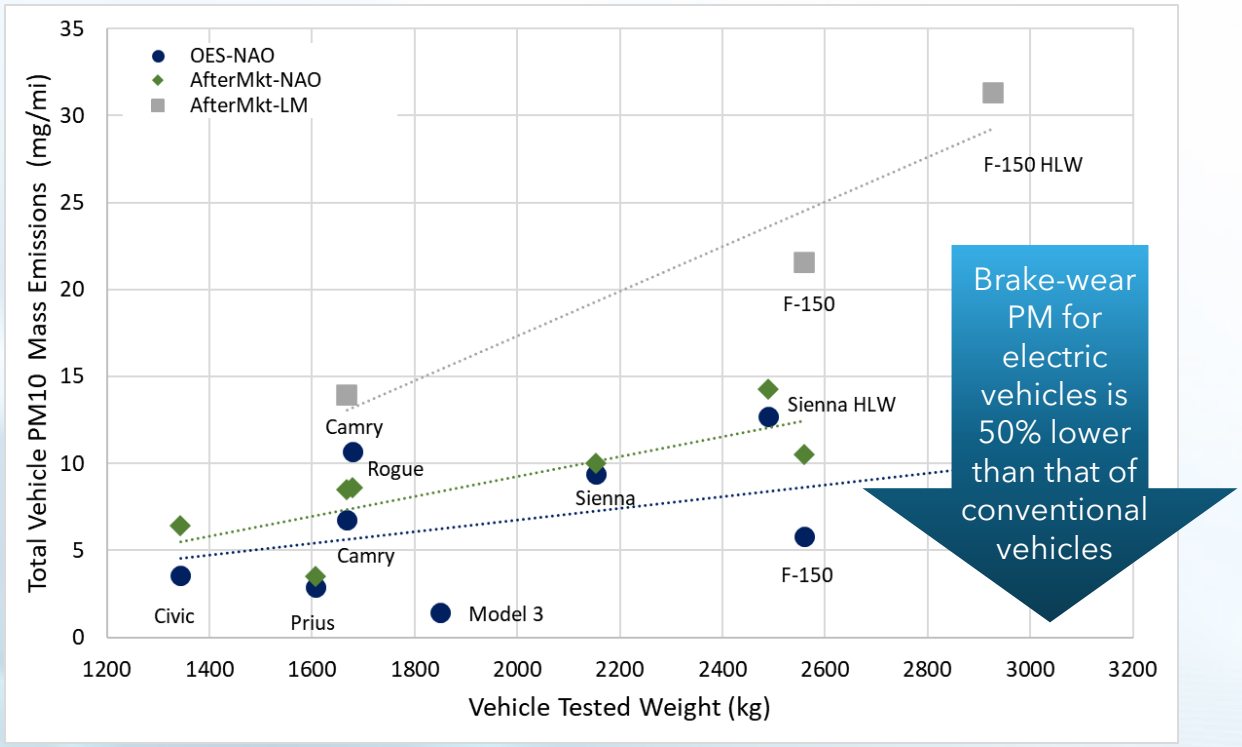
Impact of Clean Transportation Technologies



(Light-duty vehicle brake wear test report - CARB Contract # 17RD016)

- Characterize NEE PM and gaseous emissions along with cleaner vehicle technology advancements
- Promote the advancement of innovative transportation technologies
  - Maximize recuperation of braking energy
  - Lighter vehicle weight
  - Higher energy density batteries
  - Less/non-toxic friction materials
  - Energy and emission-efficient tire design

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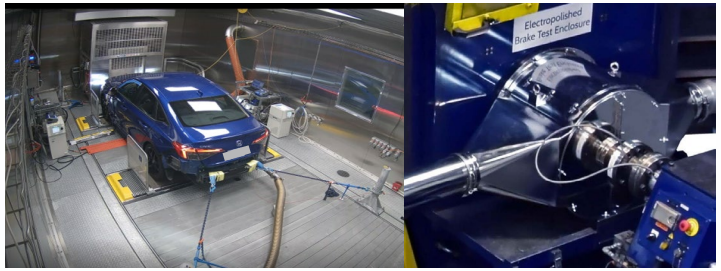
Current Research Efforts

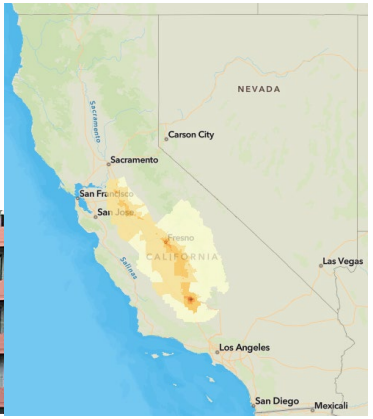
Brake-Wear and Tire-Wear

On-road measurements for heavy- and light-duty vehicles



Zero-Emission Vehicle Brake-Wear Emissions Reduction

Laboratory testing comparing emissions from gasoline and electric vehicles



Exposure/Health Study

Exposure and health effects of NEE in San Joaquin Valley

Wheel-Wear and Rail- Wear

Laboratory rail- and wheel-wear emissions measurement

Off-Road Brake-Wear

Laboratory dynamometer emissions measurement

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NEE Research Needs

- California's strict tailpipe standards and zero-emission mandates have reduced exhaust emissions substantially; Hence, non-exhaust emissions are a greater fraction of the remaining vehicular PM emissions.

- Prioritized NEE research needs are:
  1. Emissions Inventory Updates
  2. Air Quality Impacts
  3. Health Effects & Community Exposure
  4. Impact of Clean Transportation Technologies

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