

# Air Quality and Energy Issues

## Trucks, Trains, Ships, and Planes: An Update on Goods Movement-Related Emissions

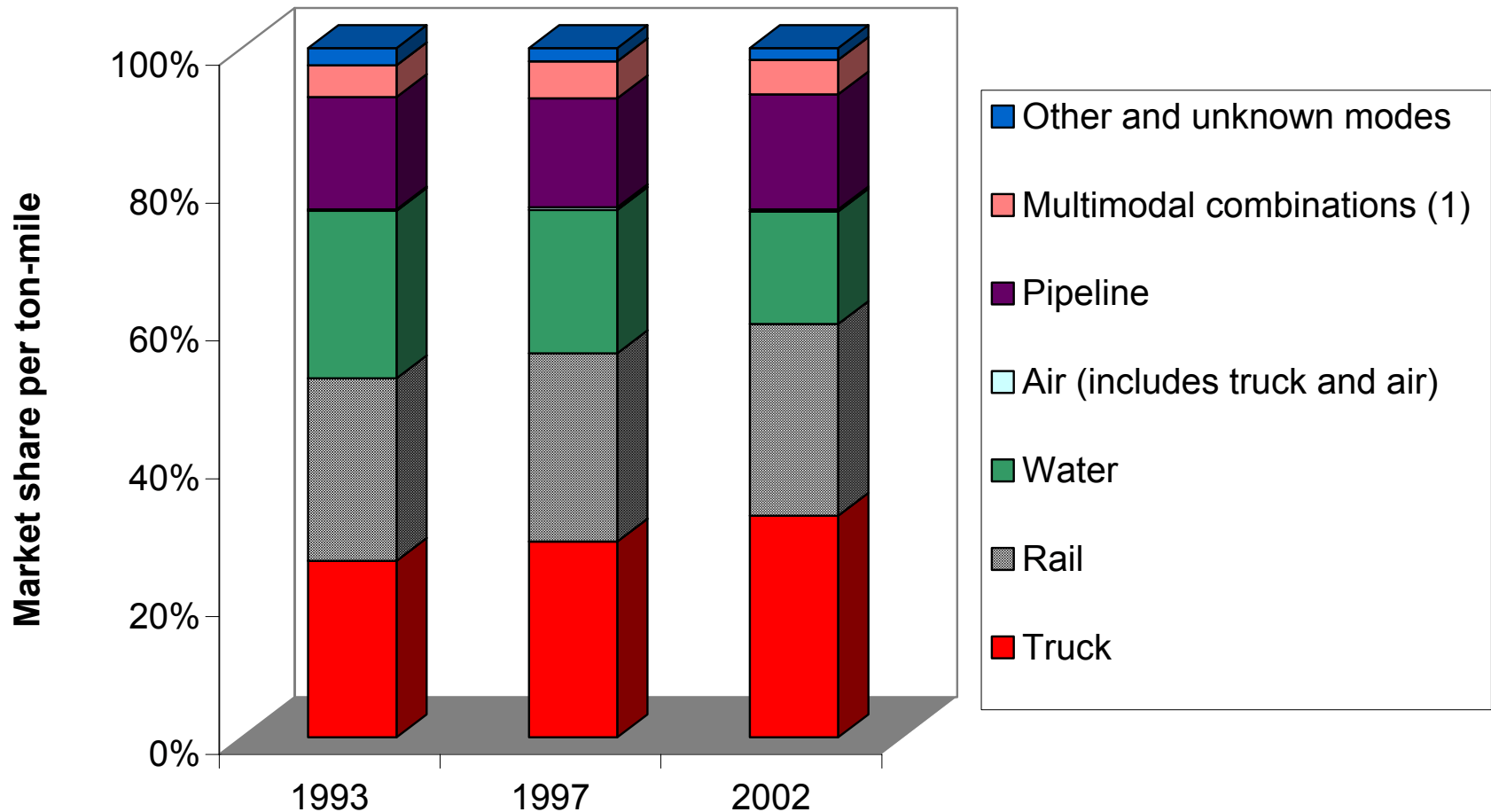
October 24-26, 2004

**Linking Good Movement to  
Economic Prosperity and  
Environmental Quality**  
UCLA Lake Arrowhead

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**ENVIRON**

# Freight Market Share by Mode





## Freight Choice

- Value/speed of freight
  - Truck - \$700/ton; at most 50-60 miles per hour
  - Rail - \$200/ton; <40 mph; ~20 mph average
  - Water - \$370/ton; <20 knots; ~10 knots average
  - Pipeline - \$200/ton; limited to gases and liquids
- Other considerations
  - Range/haul length, type and size of freight, point to point distribution



## Fuel Efficiency

- National system-wide average (net revenue freight)
  - Truck ~ 40 to 50 ton-mile/gallon
  - Rail ~ 400 ton-mile/gallon
  - Water ~ 350 ton-mile/gallon
- Best Case
  - Truck ~ 125 ton-mile/gallon (loaded multi-trailers)
  - Rail (unknown likely similar to water)
  - Water ~ 800 ton-mile/gallon (over some current routes)





## Factors Affecting Efficiency

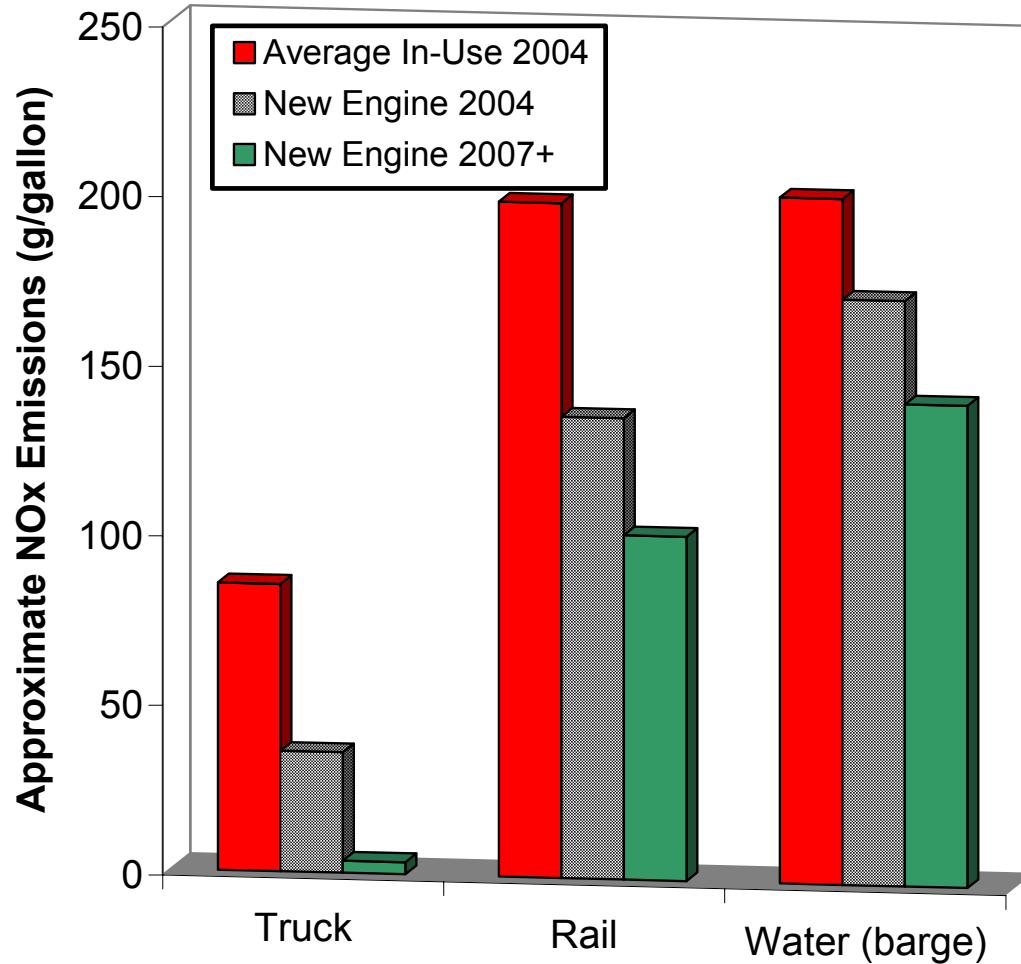
- Empties (less than full load) ~ 50 - 100% effect (improving the ton-mile per gallon)
- Duty cycle (idle, speed/congestion) ~ 5 – 50% effect
- Technology (aero/hydrodynamics – faring, train/truck size, ship design; engine/transmission efficiency)  
~ up to 25% effect
- Maintenance/other (good working order, proper lubrication) ~ up to 10% effect



## Emissions Rates

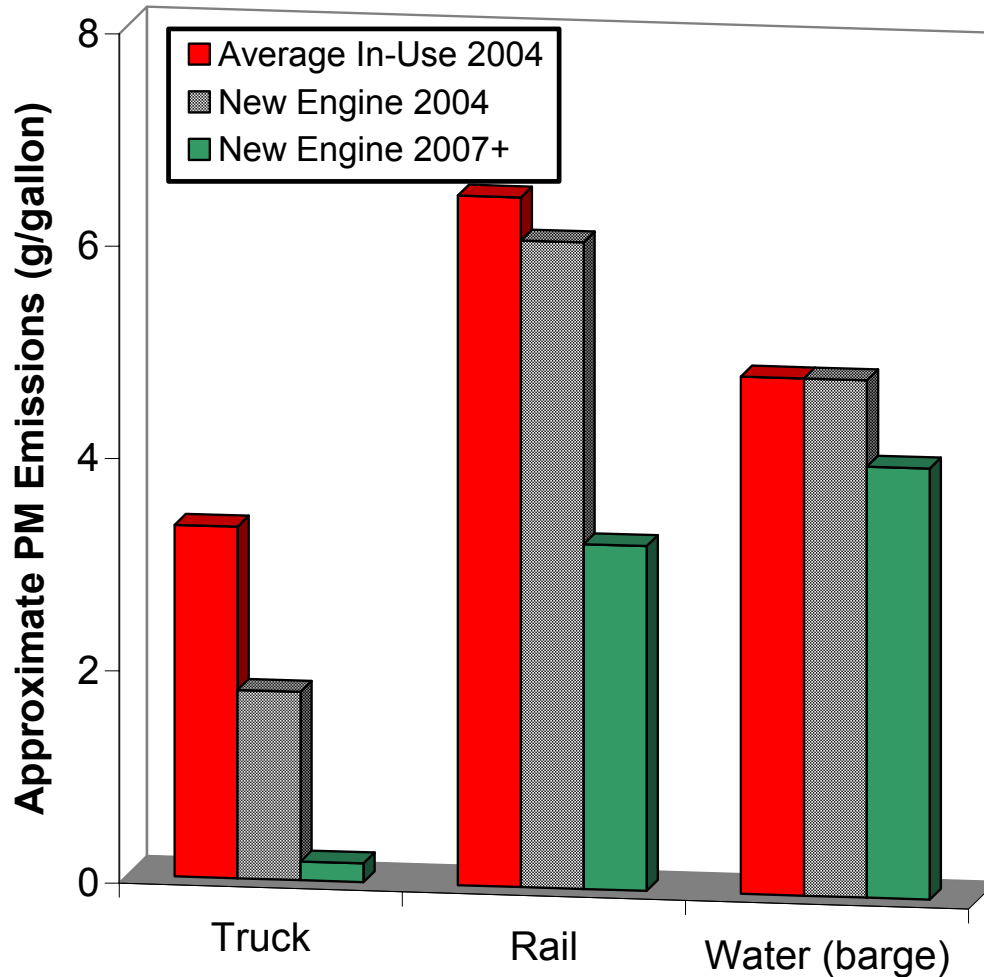
- Per engine emissions
  - Average in-use accounting for fleet turnover
  - Emission standards; current and future
    - Truck engine standards very strict especially after 2007
    - Locomotive and marine similar to each other
- Per ton-mile
  - Includes freight efficiency

# Per Engine NOx Emissions Rates



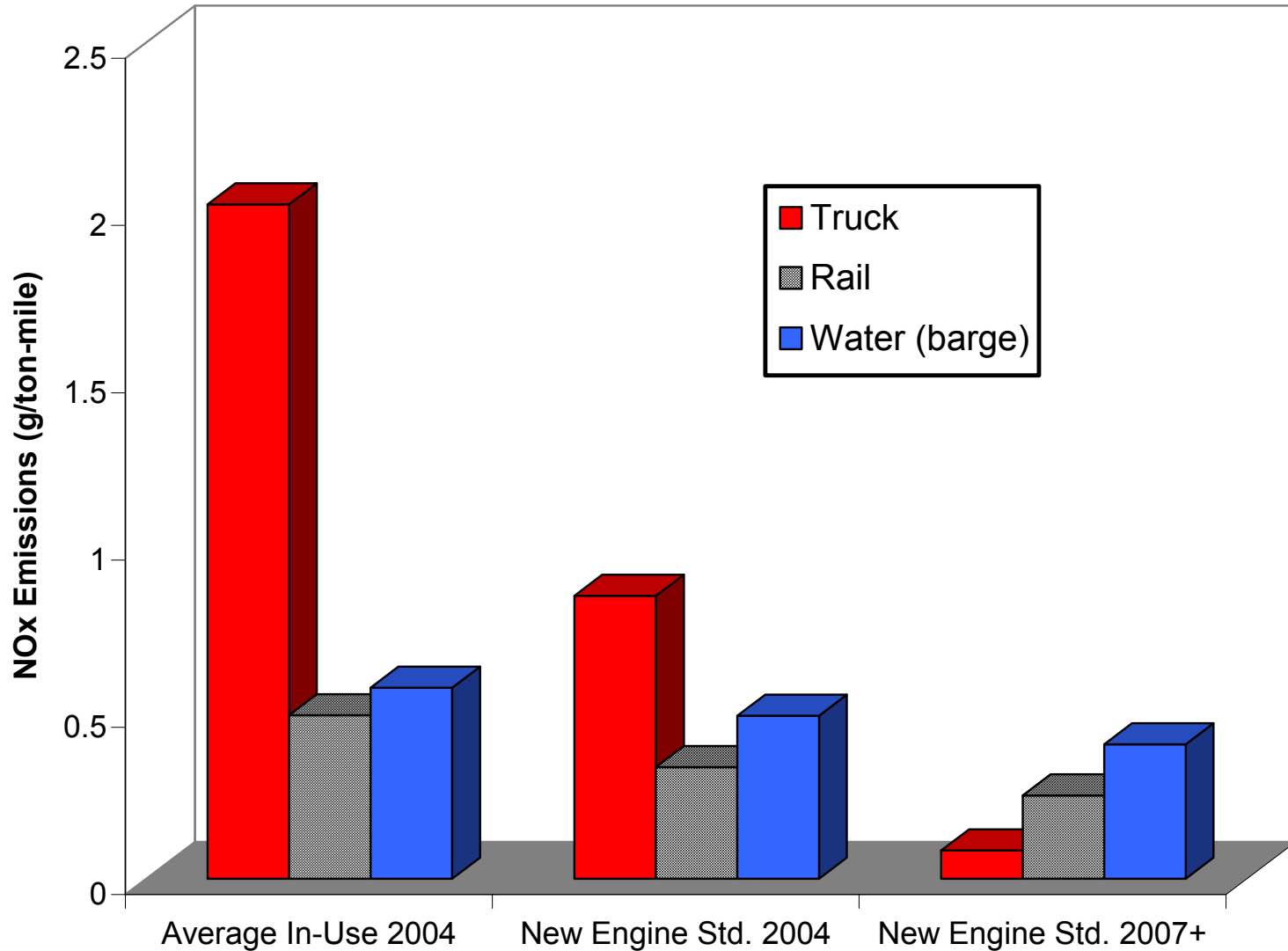


# Per Engine PM Emission Rates

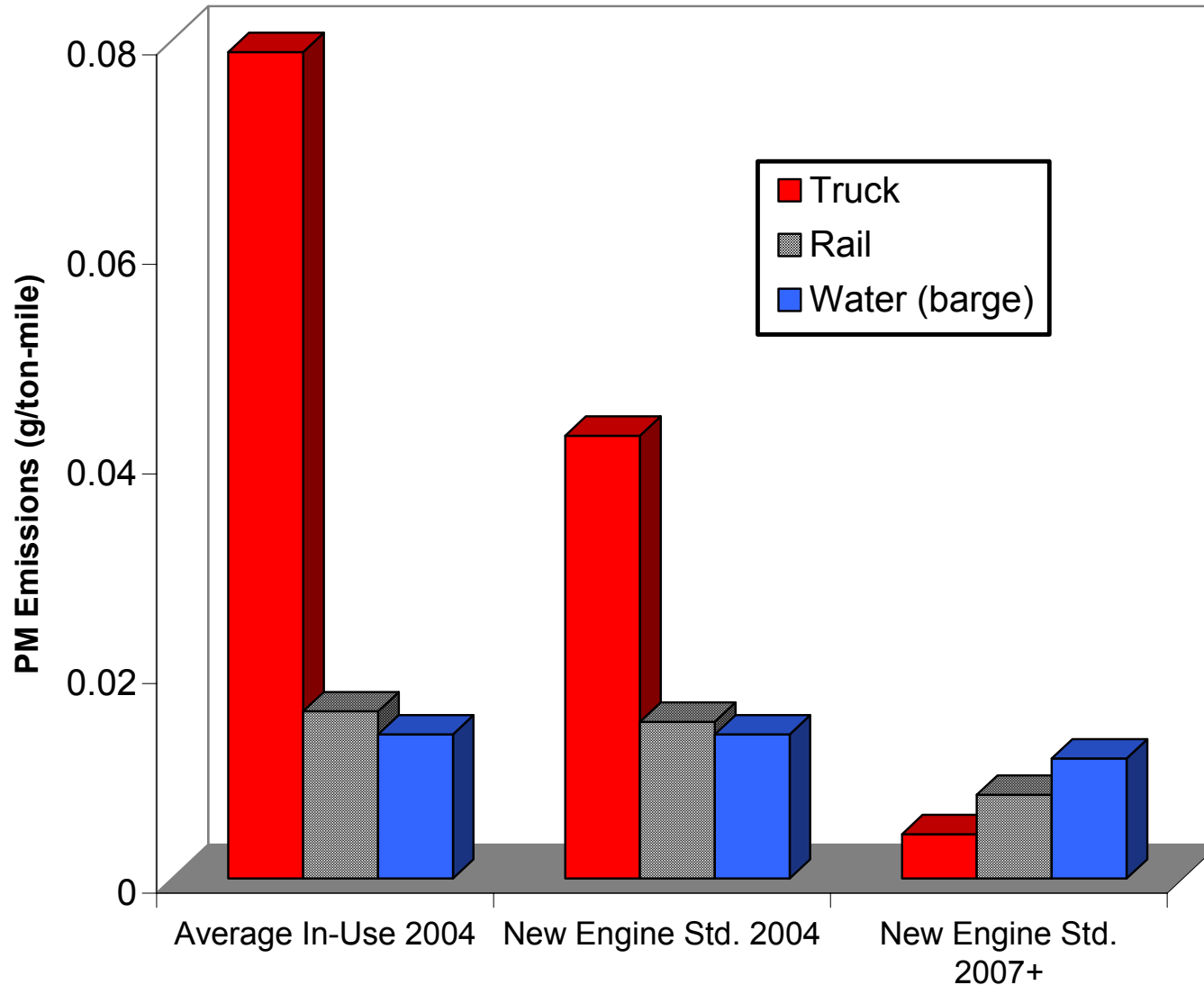




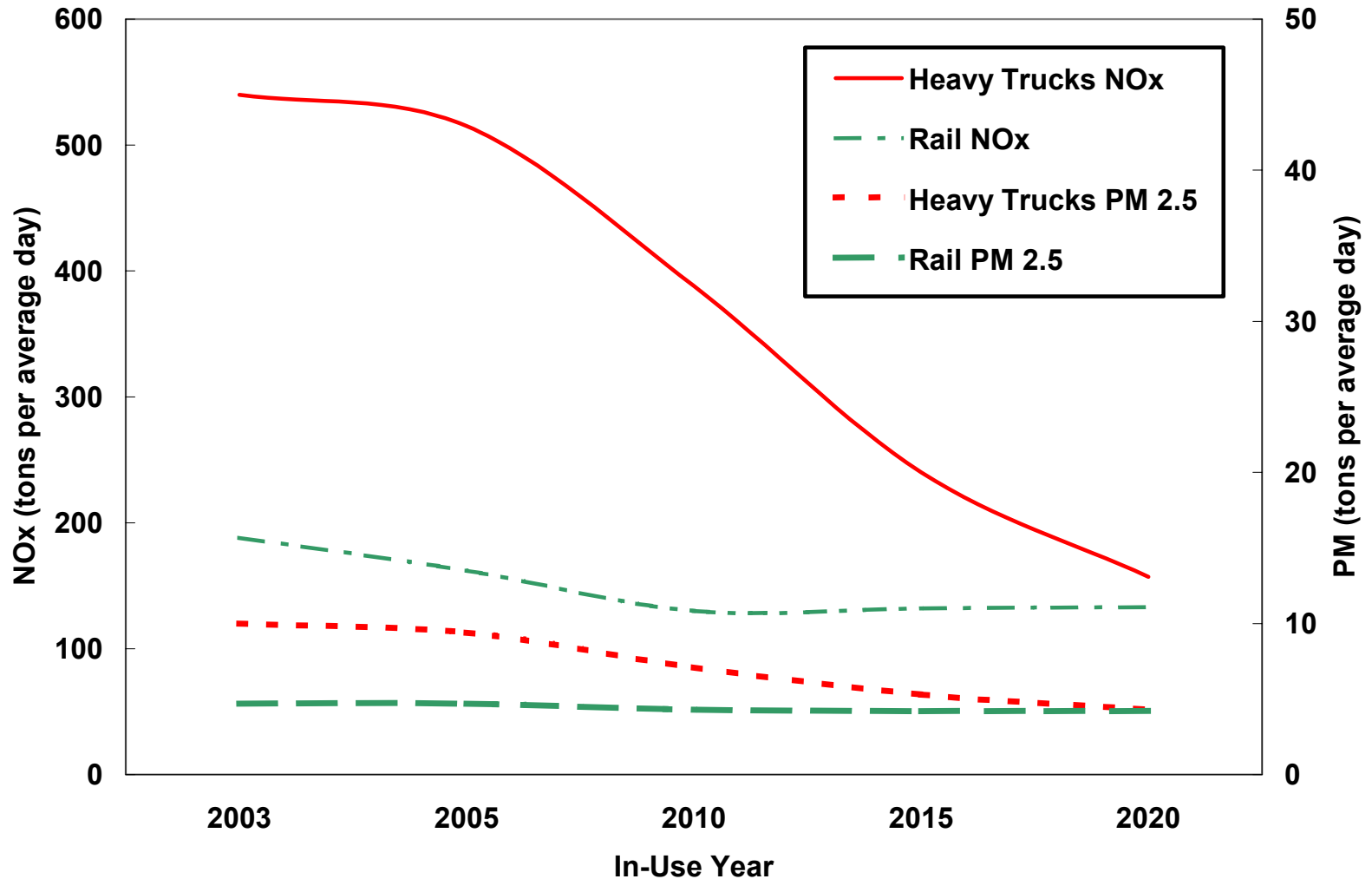
# Freight Movement NOx Emissions



# Freight Movement PM Emissions



# California State Emissions





## Future Emission Issues



- New truck engine and fuel standards are more strict than those for rail and marine
- Truck and rail in-use emissions rates equal about 2020
- Can or will rail & marine engines meet truck-like engine standards? And do they need to?
  - Different (larger) engines
  - Ultralow sulfur fuel to enable aftertreatment devices
  - Packaging difficult for locomotive
  - Accounting for the freight efficiency of rail and water transport in setting emission standards?