Black Carbon Mitigation Strategies for the Transportation Sector in California

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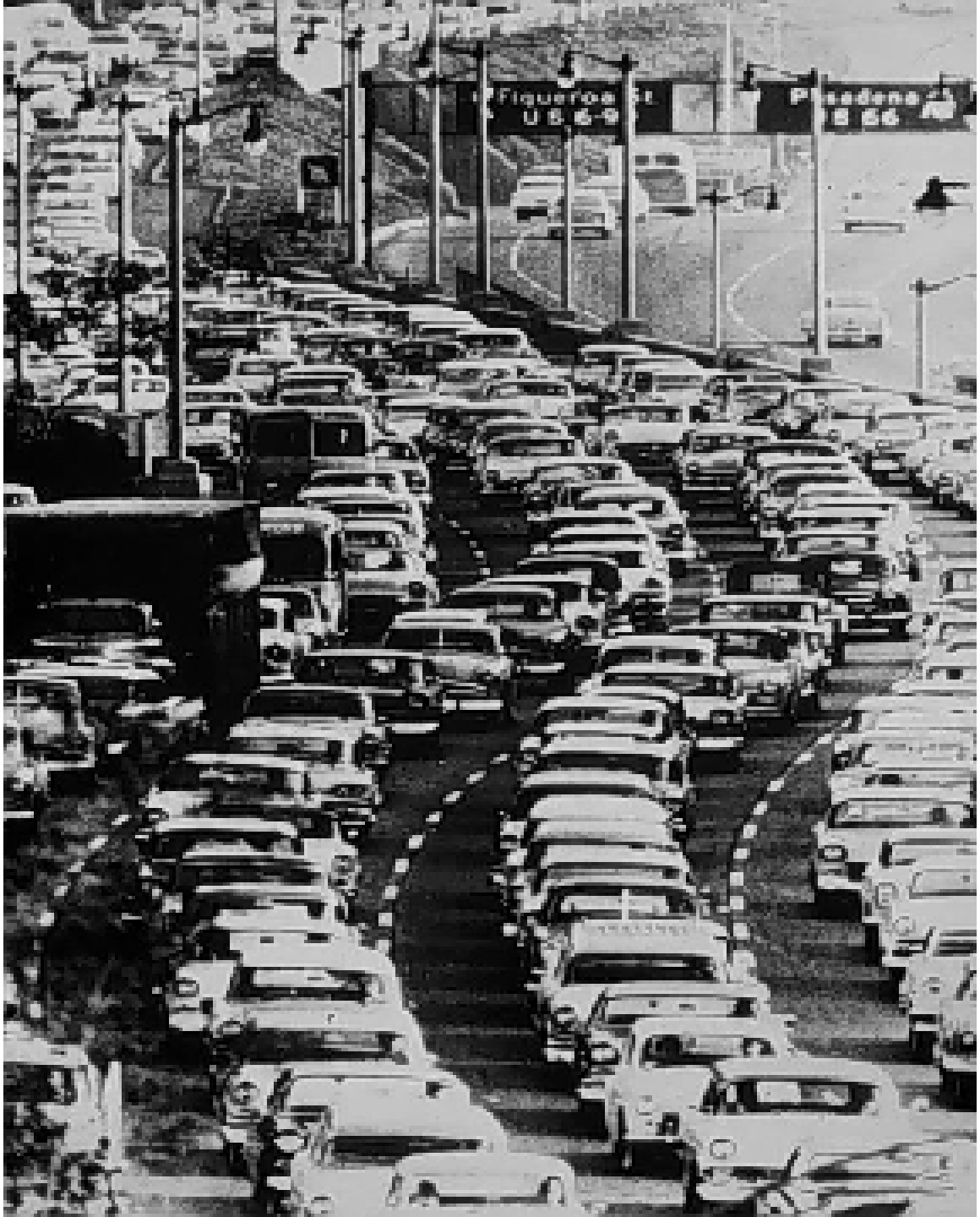
California Environmental Protection Agency

Air Resources Board

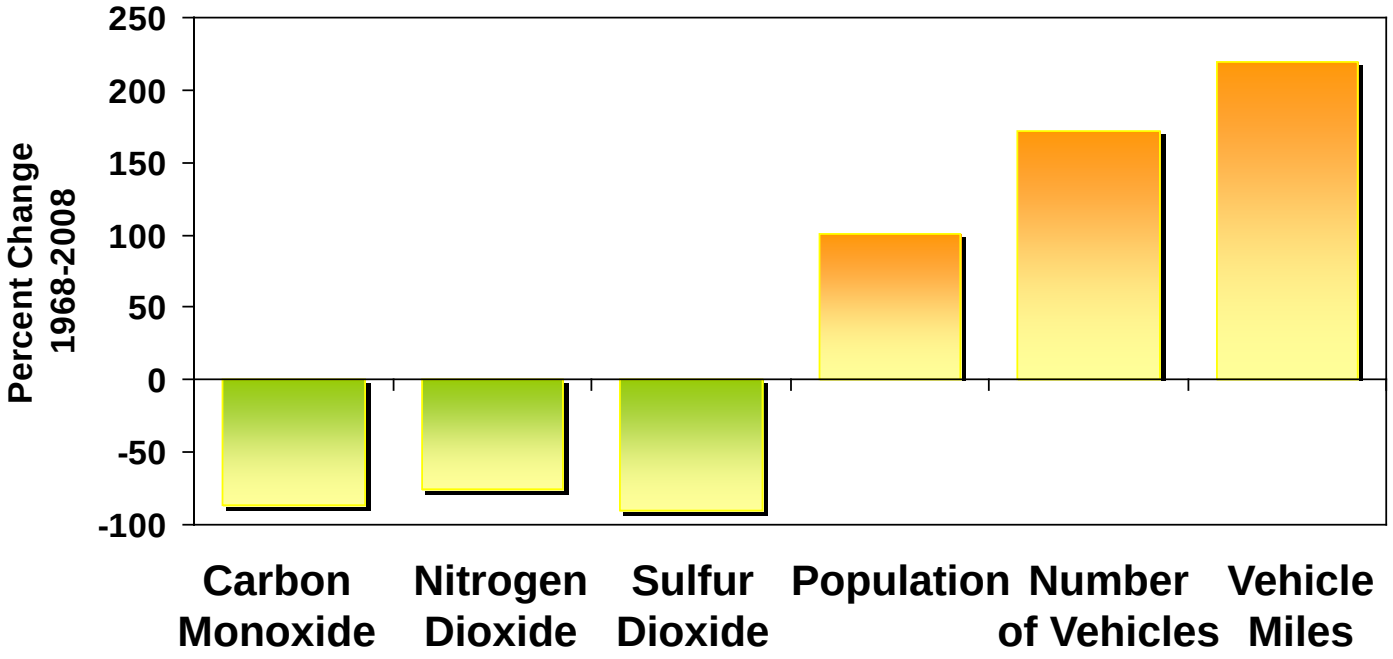


Air quality after World War II

- Unhealthy levels of lead, NO_2, SO_2, CO, ozone, particulate matter, and air toxics
- Poor visibility
- Difficulty breathing
- Extreme eye irritation
- In Los Angeles
  - Over 100 smog alerts annually
  - Over 300 days with unhealthy air annually

Los Angeles smog in 1948

Air pollution reduced 75-90% over 40 years despite growth



Ozone – Los Angeles peak reduced 70%, hours of exposure by 90%

PM10 – annual-average levels reduced 75%

Air toxics – lead eliminated, cancer risk reduced 80% (since 1989)

Black carbon – reduced 90% (95% by 2020)

Costs of Control

0.5% GDP (US 1990-2020)

Benefits of Control

$10-95 in health benefits for each $1 of control (US 1970-1990)

$30 in health benefits for each $1 of control (US 1990-2020)*

Air pollution control industry – 32,000 jobs and $6.2B (CA 2001)

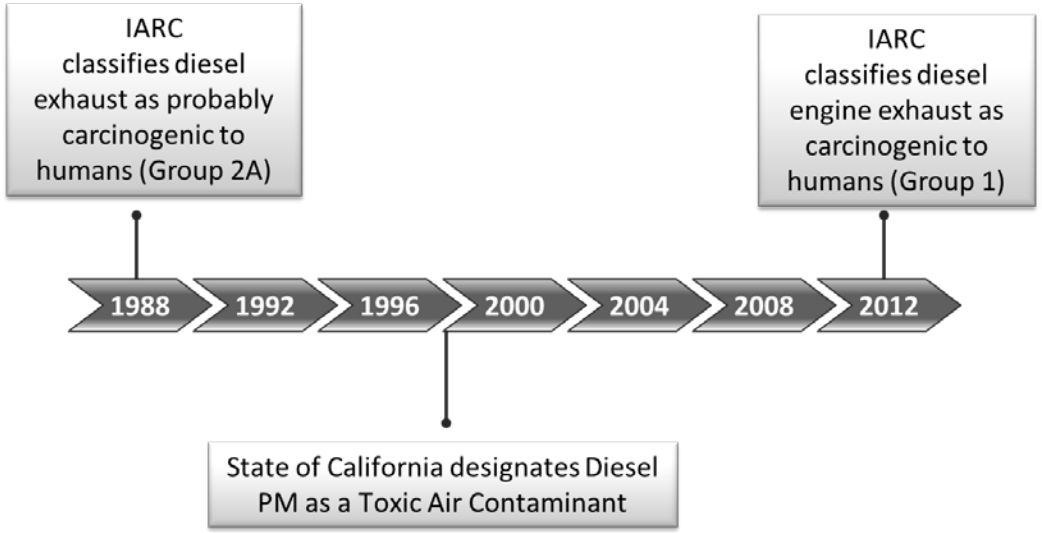
Clean energy industry – 123,000 jobs and $27B (CA 2009)

U.S. EPA Reports to Congress on The Benefits and Costs of the Clean Air Act (www.epa.gov/air/sect812/index.html)

* 1990-2020 uncertainty analysis under development

Major Drivers for Diesel Emission Reductions

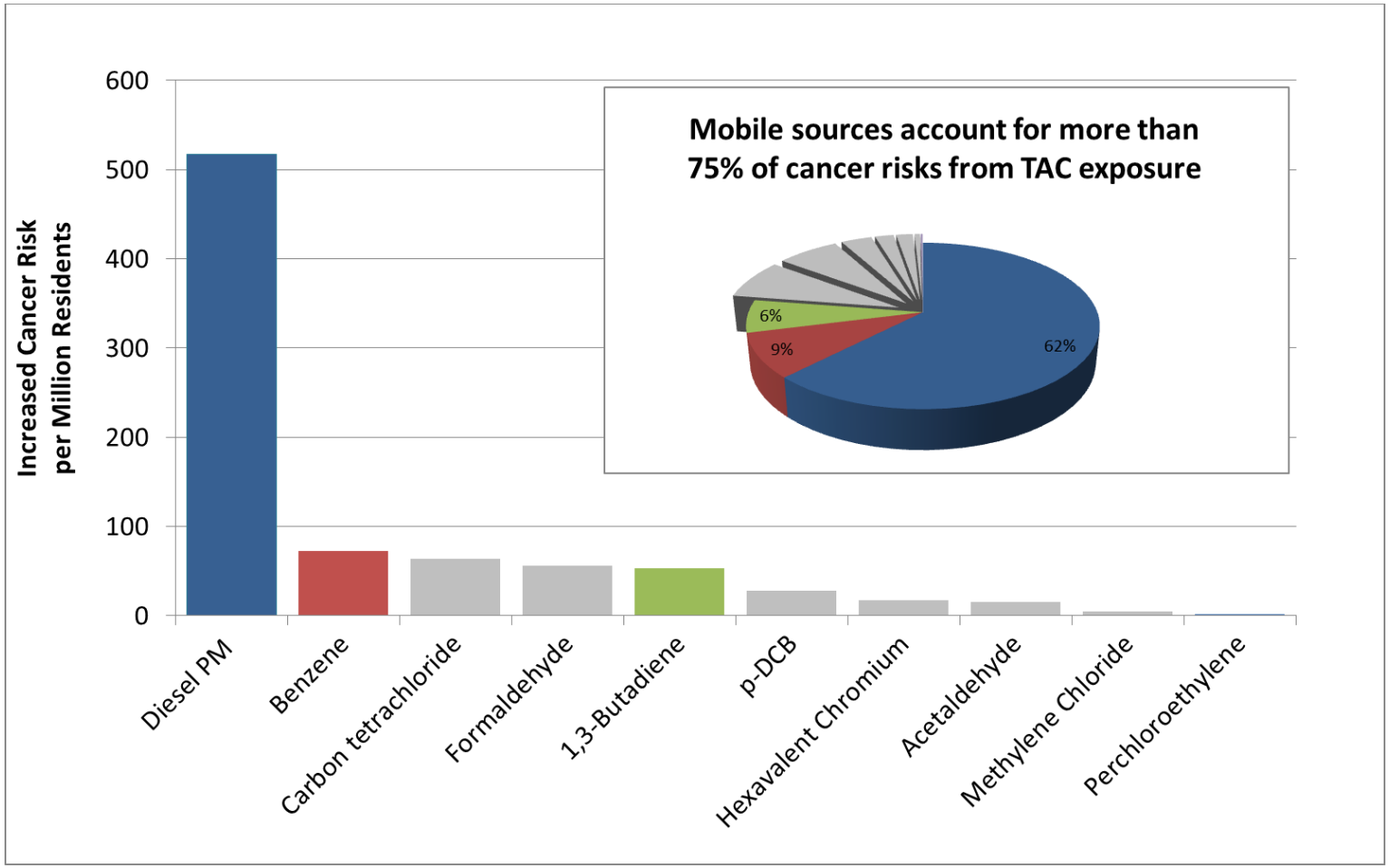
Diesel exhaust is toxic and carcinogenic



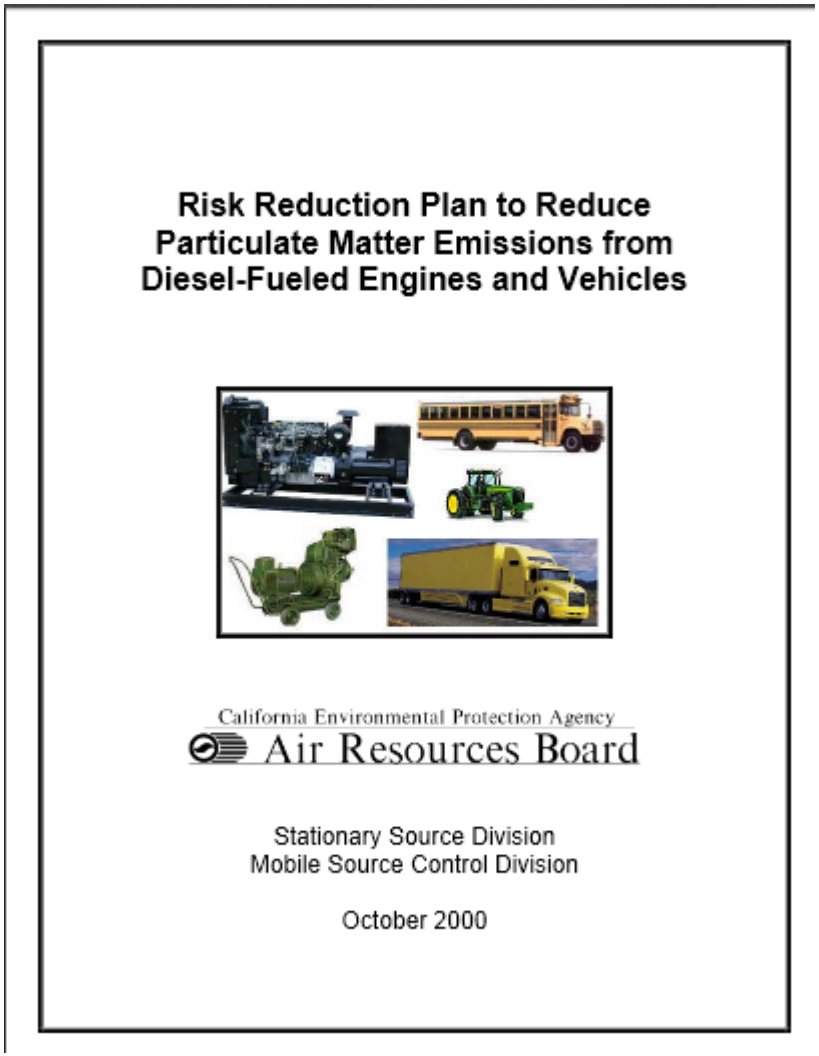
Diesel exhaust contributes to regional and local air pollution

- National Ambient Air Quality Standards for PM2.5 and ozone
- Reduce near-source health risk

Cancer Risks from Airborne Toxics



California Diesel Risk Reduction Plan



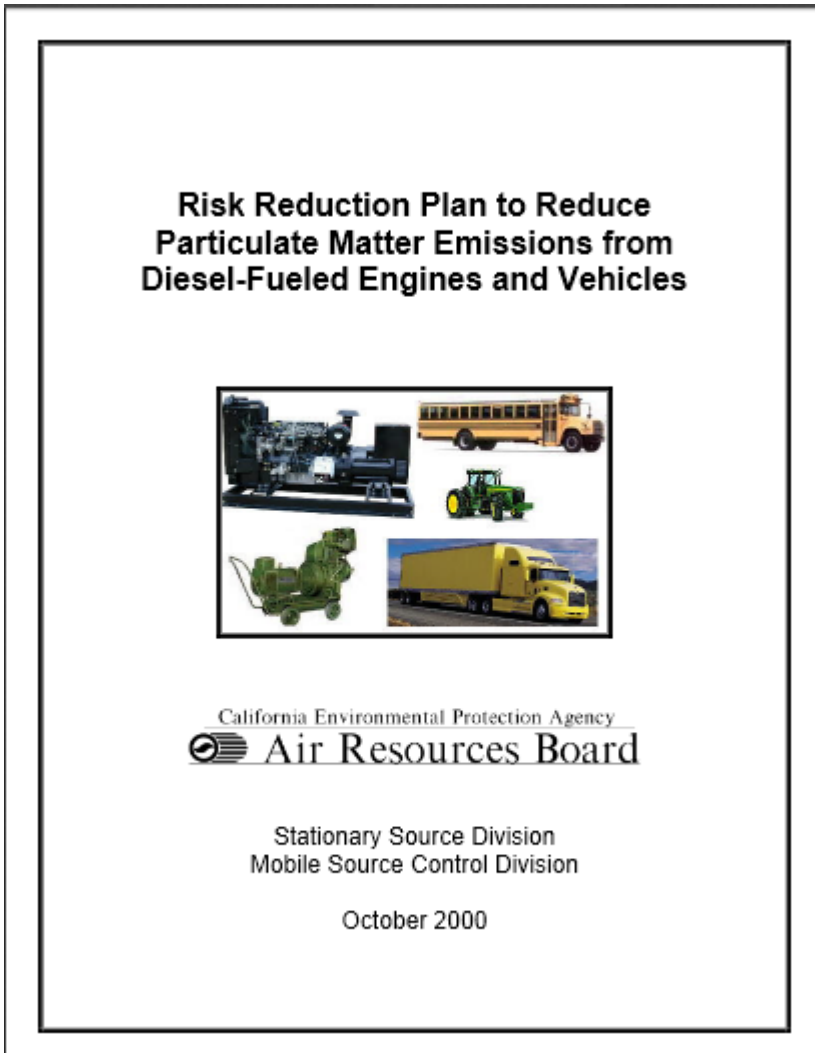
Goal

Reduce diesel PM 85% from 2000 to 2020

How

1. New engine emissions standards
2. Ultra-low-sulfur diesel (15 ppm)
3. In-Use Fleet Rules
   - Transit agency fleet rule (2000)
   - School bus idling (2002)
   - Solid waste collection vehicles (2003)
   - Stationary compression ignition engines (2004)
   - Portable engines (2004)
   - Transport refrigeration units (2004)
   - Commercial vehicle idling (2004)
   - Locomotives/harborcraft fuel (2004)
   - Transit fleet vehicles (2005)
   - Public agency/utility on-road fleets (2005)
   - Port/rail cargo handling equipment (2005)
   - Ship auxiliary engine fuel (2005)
   - Drayage Truck Rule (2007)
   - Off-Road Rule (2007)
   - Truck and Bus Rule (2008)+

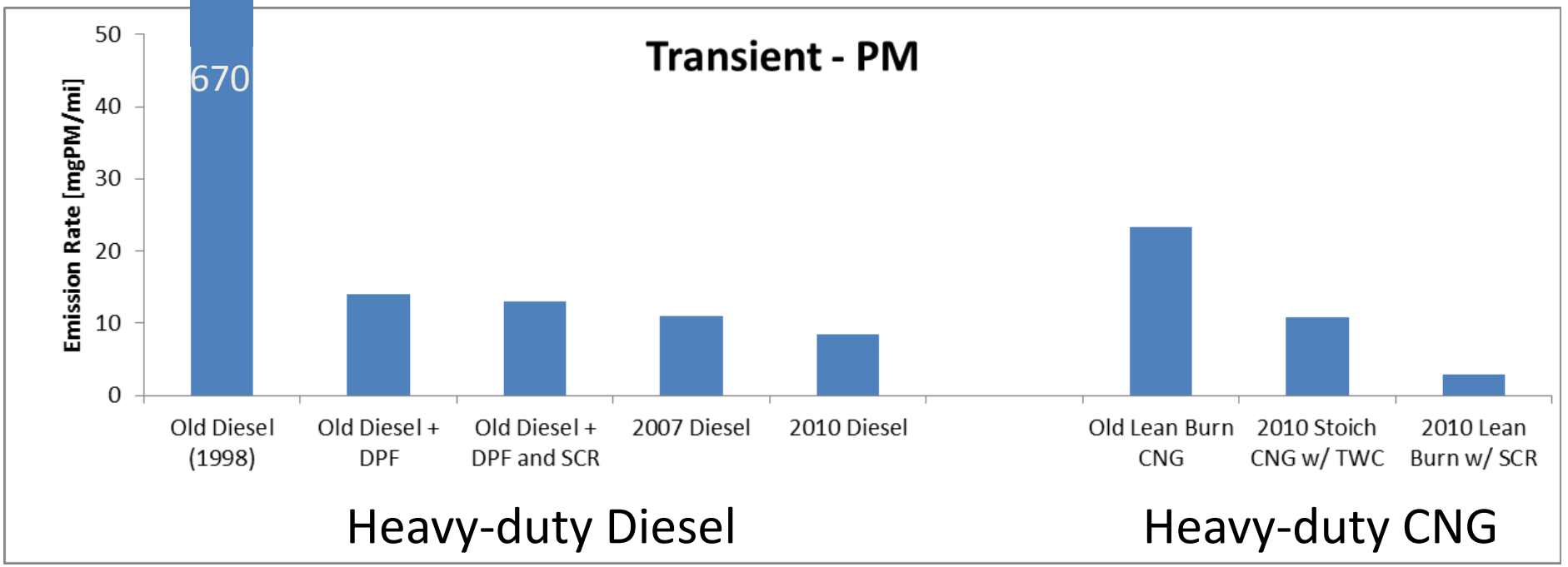
California Diesel Risk Reduction Plan



Keys To Success

- Flexibility in regulatory path
- Outreach to affected businesses
- Incentive funding
- Enforcement
- Willingness to adjust
- Research

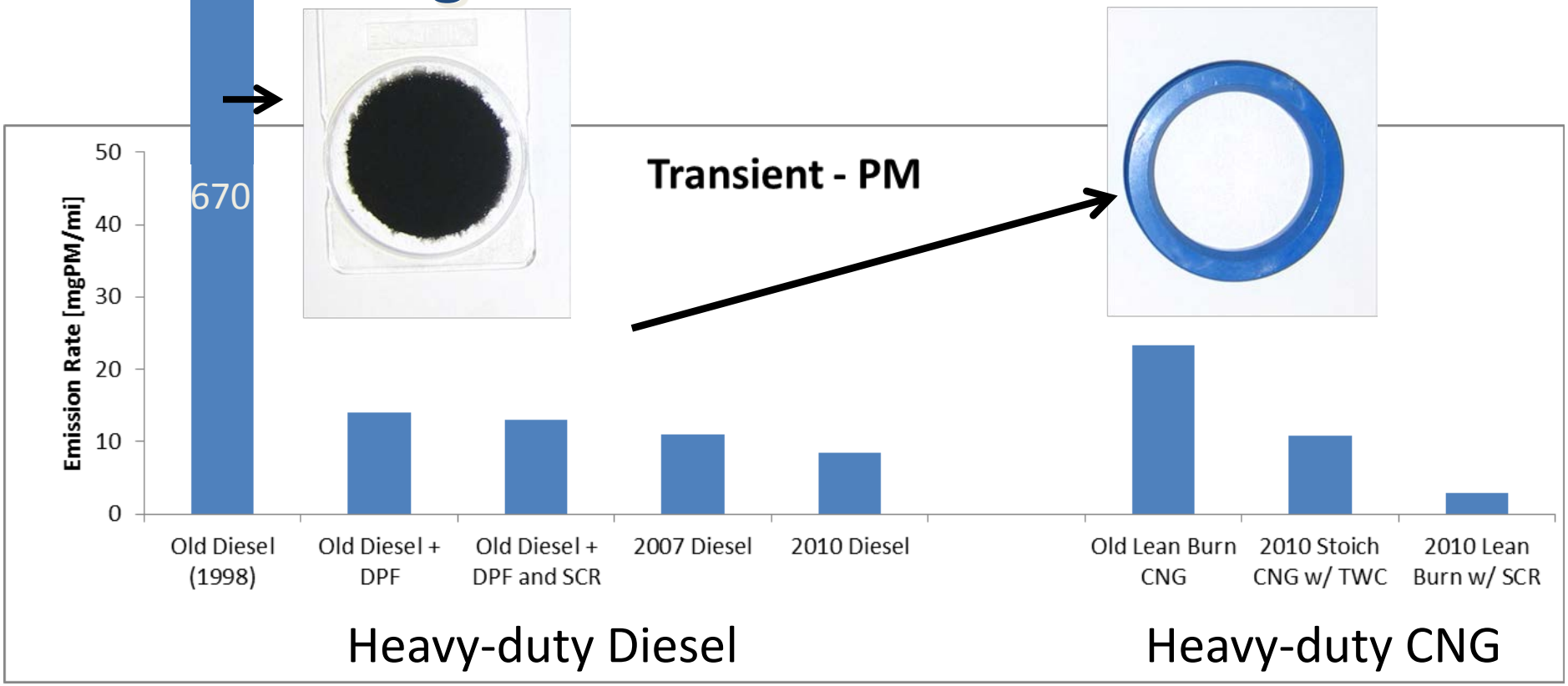
Progression of PM Emissions



99% PM reduction for diesel and 90% for CNG in 2010

"Old" diesel and CNG number from chassis dynamometer studies, while 2007 and 2010 are average certification values in mg/mi, using 2.9 bhp-hr/mi

Progression of PM Emissions



99% PM reduction for diesel and 90% for CNG in 2010

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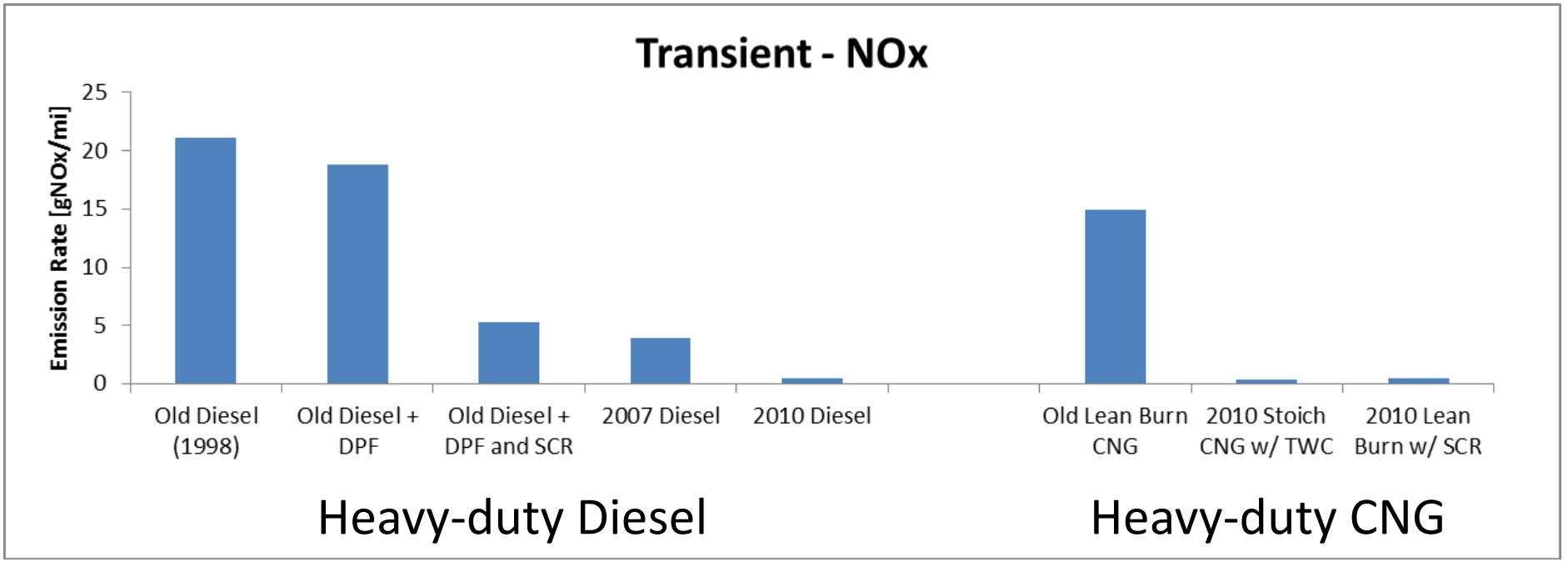
Progression of NO_X Emissions



98% PM reduction for diesel and 97% for CNG in 2010

California needs further 90% reduction to meet ozone and PM2.5 standards

"Old" diesel and CNG number from chassis dynamometer studies, while 2007 and 2010 are average certification values in mg/mi, using 2.9 bhp-hr/mi

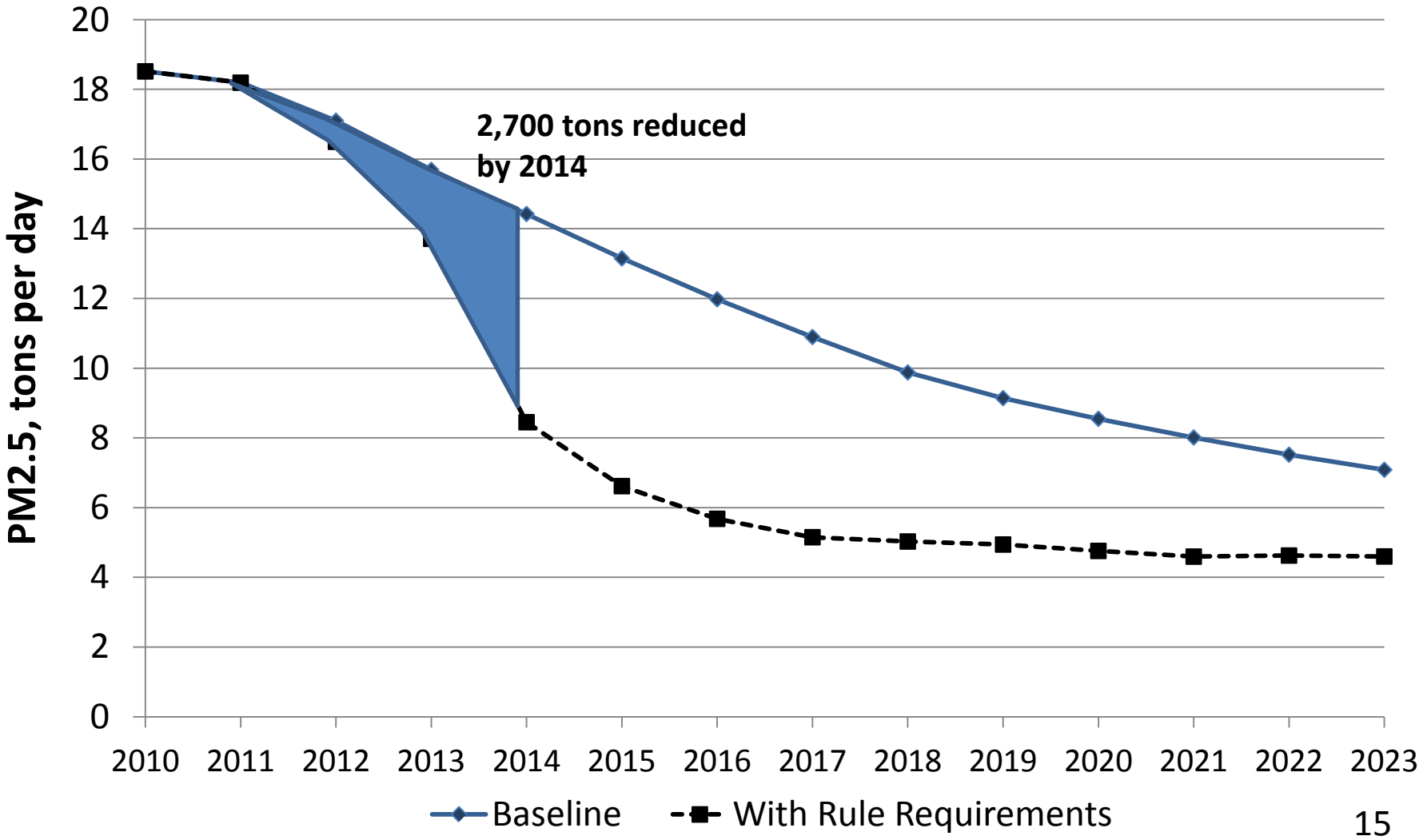
Financial Incentive Programs

- Grant programs and vouchers
  - Funding primarily for surplus (early) actions
  - $150M per year for diesel engines
  - $1B for port trucks and equipment
- Loan assistance programs
- Funding available for the following:
  - Vehicle replacements
  - Exhaust retrofits
  - Hybrid trucks
  - Engine repowers

Diesel Emission Control Verification

- Verified for PM or NO_X reduction
- Quantifies system performance to determine if emission reductions are real and durable
  - Based on engine model year and engine family
  - Unique for on-road, off-road, stationary, etc.
- Provides a warranty for the device and installation
  - Up to 5 years/150,000 miles for filter
- Remote sensing and other on-road studies

PM2.5 Benefits Already Realized



Enforcement Activities

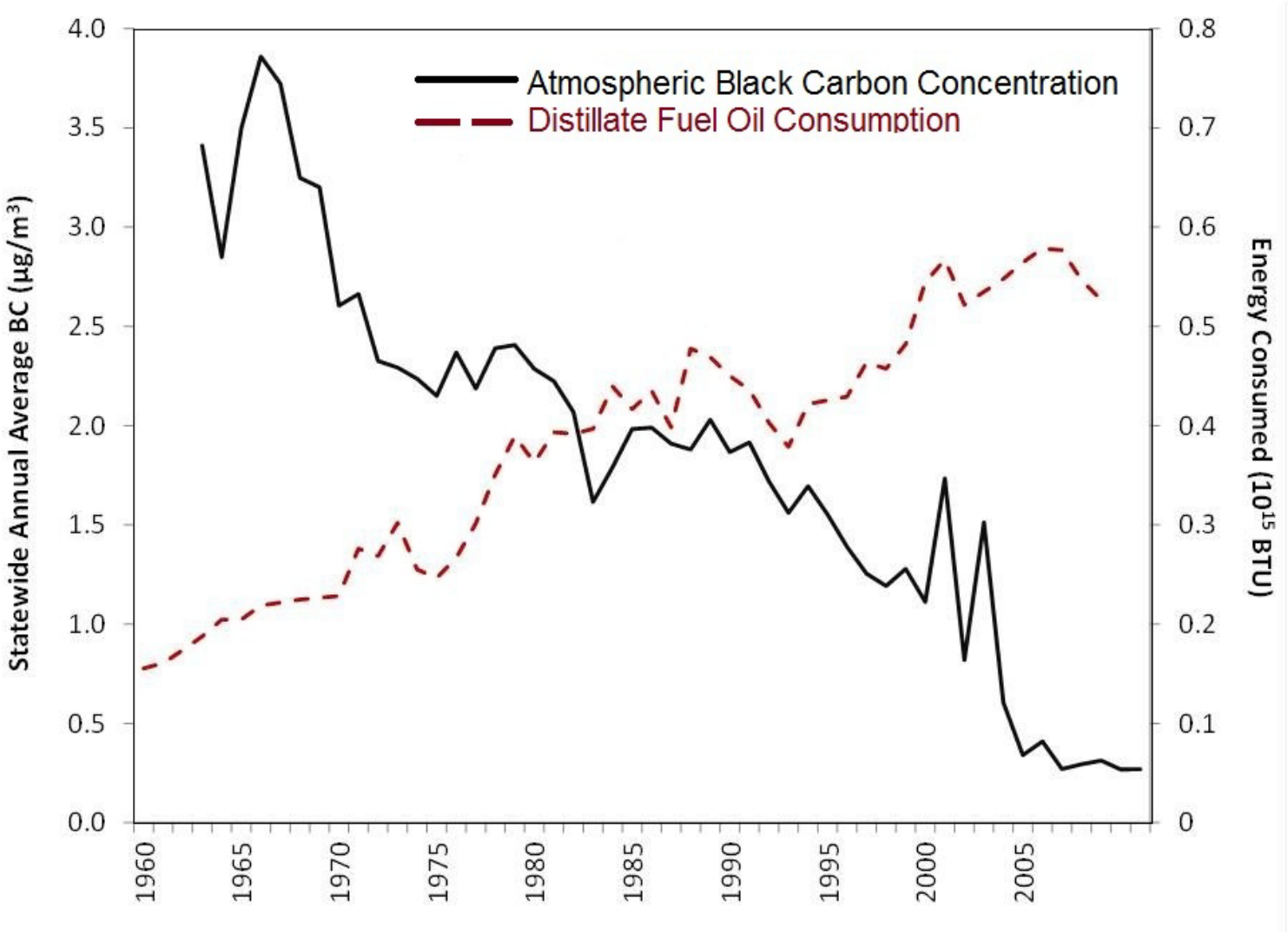
2010 Inspections

15,000 Trucks

2,700 Locomotives

300 Ships

45 Years of Progress on Black Carbon



Ramanathan, Kirchstetter, et al. (2013) Black Carbon and the Regional Climate of California, CARB Contract No. 08-323

Black Carbon Reduction Benefits

- Premature death
  - 6% reduction in cardiovascular deaths (3% of all-cause deaths)
- Lung cancer risk
  - 6,000 in a million lifetime exposure to 500
- Visibility
  - 10-75% of light extinction in urban areas is from diesel black carbon
- Climate
  - 10% reduction in overall carbon footprint

Conclusions

- Control technologies drastically reduce emissions from diesel and CNG engines
- Significant emissions reductions are possible but holistic approach is needed
  - Flexibility in regulatory path
  - Outreach to affected businesses
  - Incentive funding
  - Enforcement
  - Willingness to adjust
  - Research
- In-use fleet rules accelerate benefits

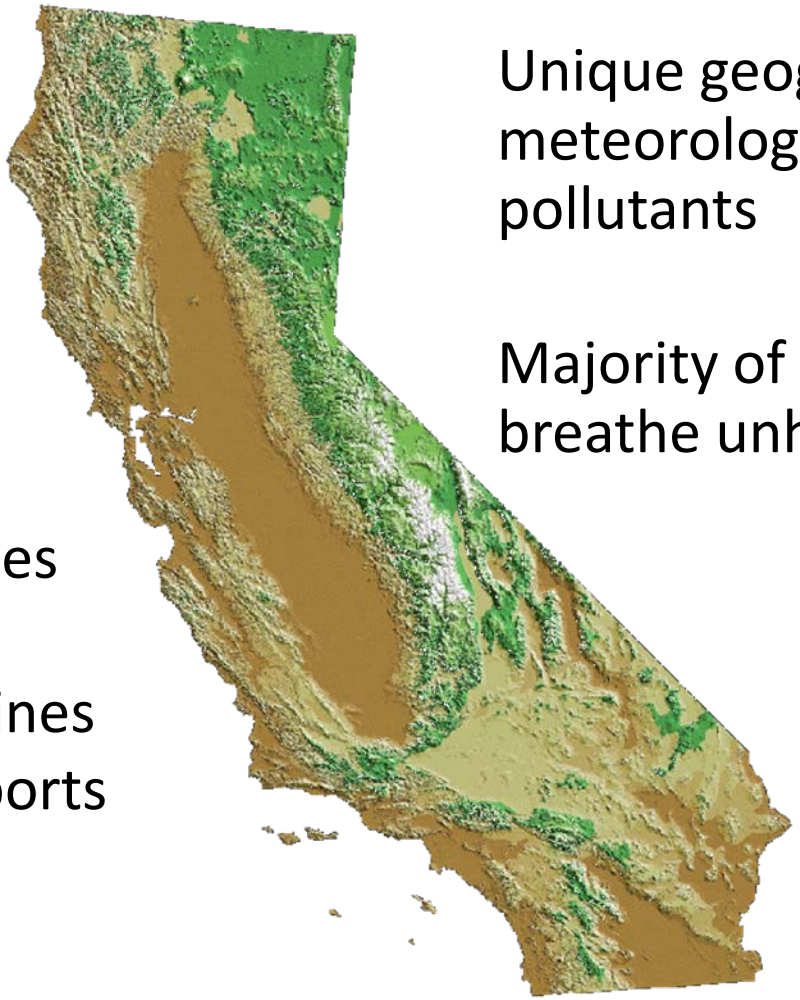
Next Steps

- In-use heavy-duty rules implemented through 2023
- Continued need for large NO_X reductions from heavy-duty engines beyond what will be achieved with the 2010 standard
- Reduce fossil fuels usage 50% by 2030
  - U.S. EPA Phase 2 rulemaking on heavy-duty fuel efficiency
  - 10% reduction in life-cycle carbon intensity of fuels by 2020
- Short-lived climate pollutant plan in 2015
- Sustainable (zero emissions) freight by 2050 (plan in 2015)

extra

California's air pollution problem

38 M people
90 people per km^2
24 M gasoline cars
1.3 M diesel vehicles
1.4 B km per day
18 M off-road engines
3 large container ports



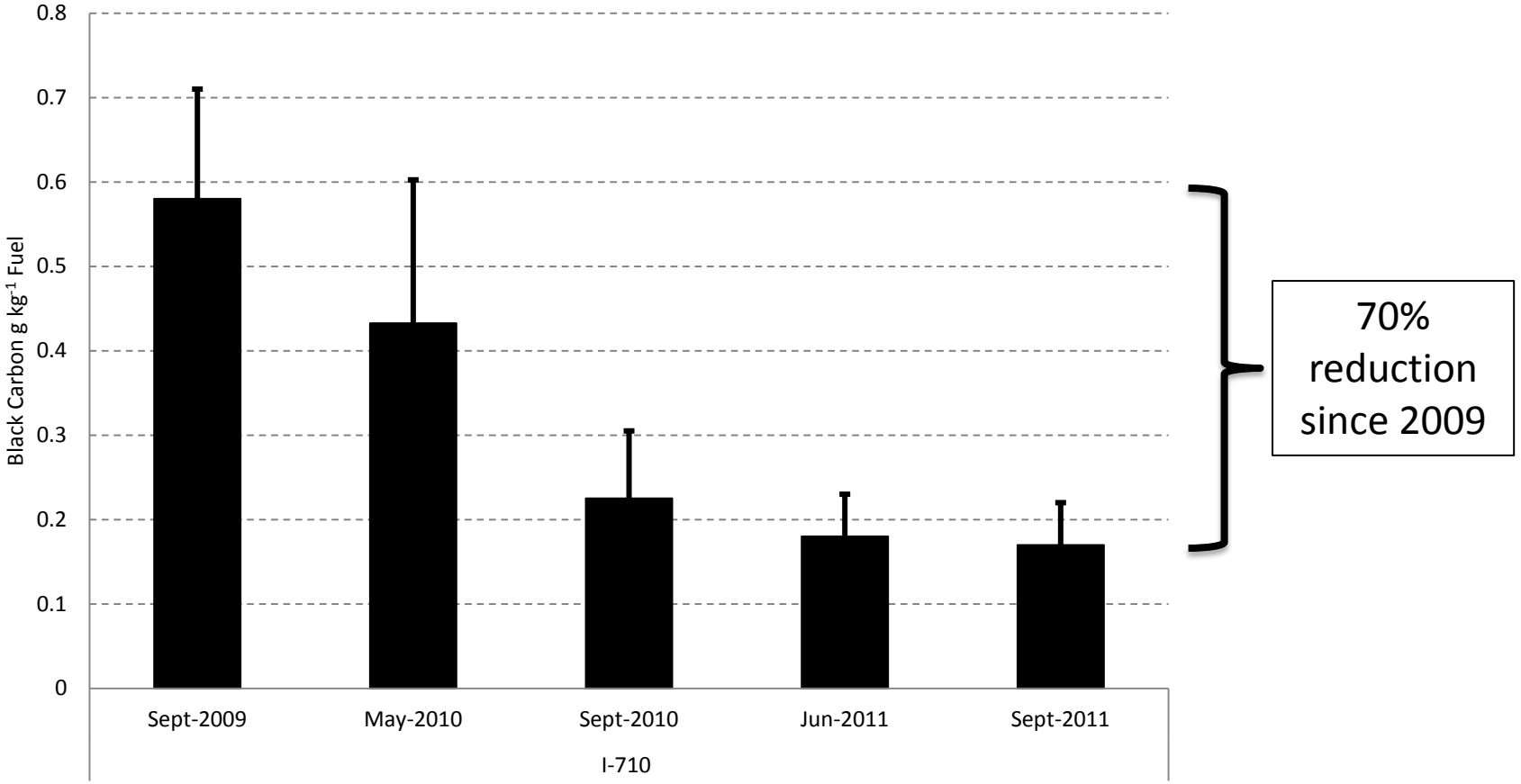
Unique geography and meteorology confine air pollutants

Majority of Californians breathe unhealthy air

California Controls on Black Carbon Sources

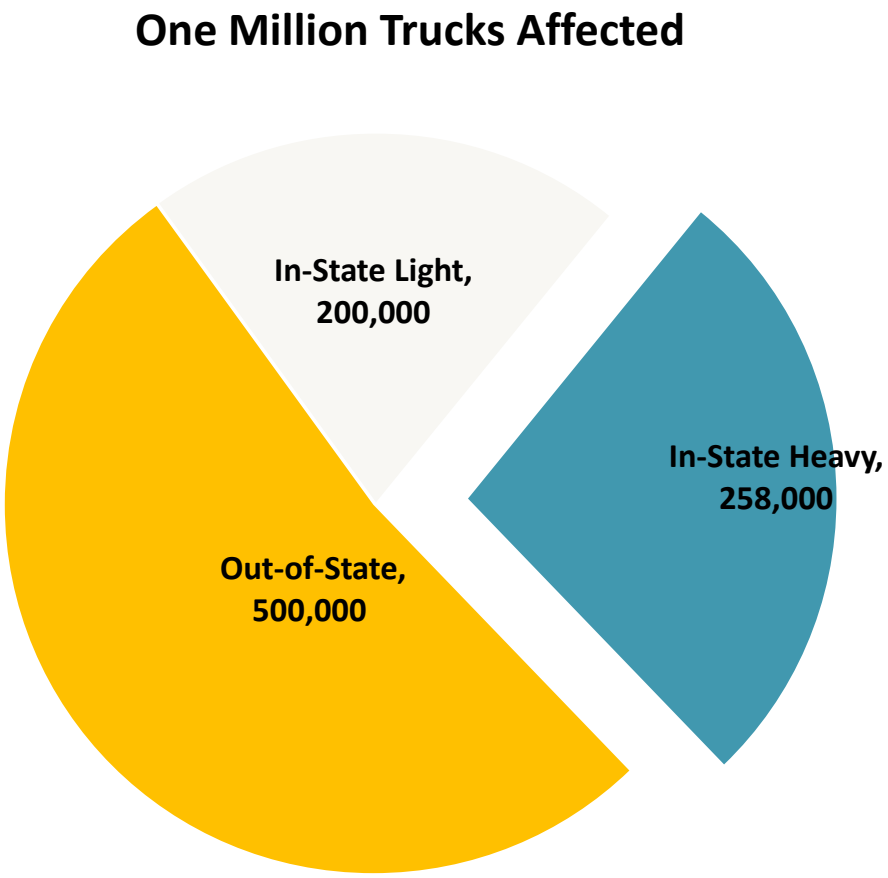
- Trash burning ban
- Agricultural burning reduced 80-90%
  - Restricted to favorable weather conditions
- Residential burning restrictions
- Smoking gasoline vehicle programs
- Heavy-duty vehicle controls
  - Smoke limits
  - New engine standards
  - Cleaner fuels
  - Retrofits

Black Carbon Emission Reductions from Trucks Operating on I-710 Freeway



Kozawa et al. (2014) Verifying Emissions Reductions from Heavy-Duty Diesel Trucks Operating on Southern California Freeways, *Environmental Science and Technology,* 48(3), 1475-1483.

Truck and Bus In-Use Regulation



Truck and Bus In-Use Regulation

- Basic Requirements
  - Lighter Vehicles
    - Upgrade to 2010+ engine 2015-2023
  - Heavier Vehicles
    - PM filters 2012-2014, then
    - Upgrade to 2010+ engine 2020-2023
- Small fleet options
- Phase-in for large fleets

Significant Flexibility in Regulation

Low-Use Agriculture

- Compliance 2017 or 2023

Log Truck Phase-In

- Upgrade to 2010 engines 2014-2023

NO_X Exempt Areas

- Filter <u>only</u> phase-in 2014-2016

Low-Mileage Construction

- Phase-in 2014 to 2016

Low-Use Exemption

- 1,000 miles per year
- 100 hours per year if stationary work

BC reduced throughout California