



Cleaning Up Diesel Engines

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Overview

- **Why it matters**
- **California's strategy**
- **A bit about light-duty diesels**
- **Other greenhouse gas strategies**
- **Future prospects**

Diesel Health Effects

- **Diesel NO_x, ROG contribute to ozone and particulate matter formation**
- **Diesel PM identified as toxic air contaminant in 1998**

Significant Health Impacts Attributed to Diesel PM

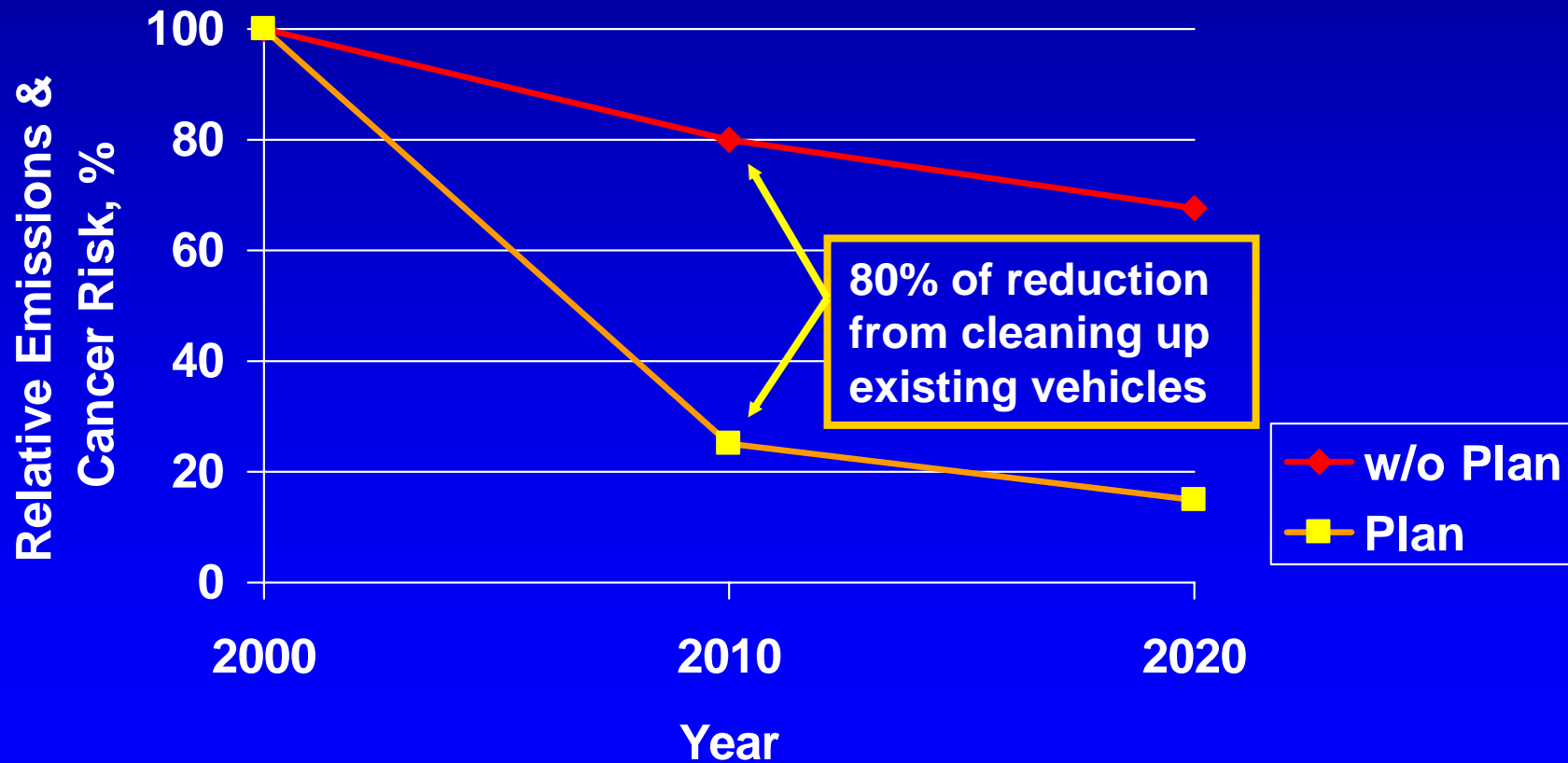


- 2,900 premature deaths
- 2,500 cases bronchitis
- 600,000 lost work days
- 3.2 million minor restricted activity days
- 540/million cancer risk

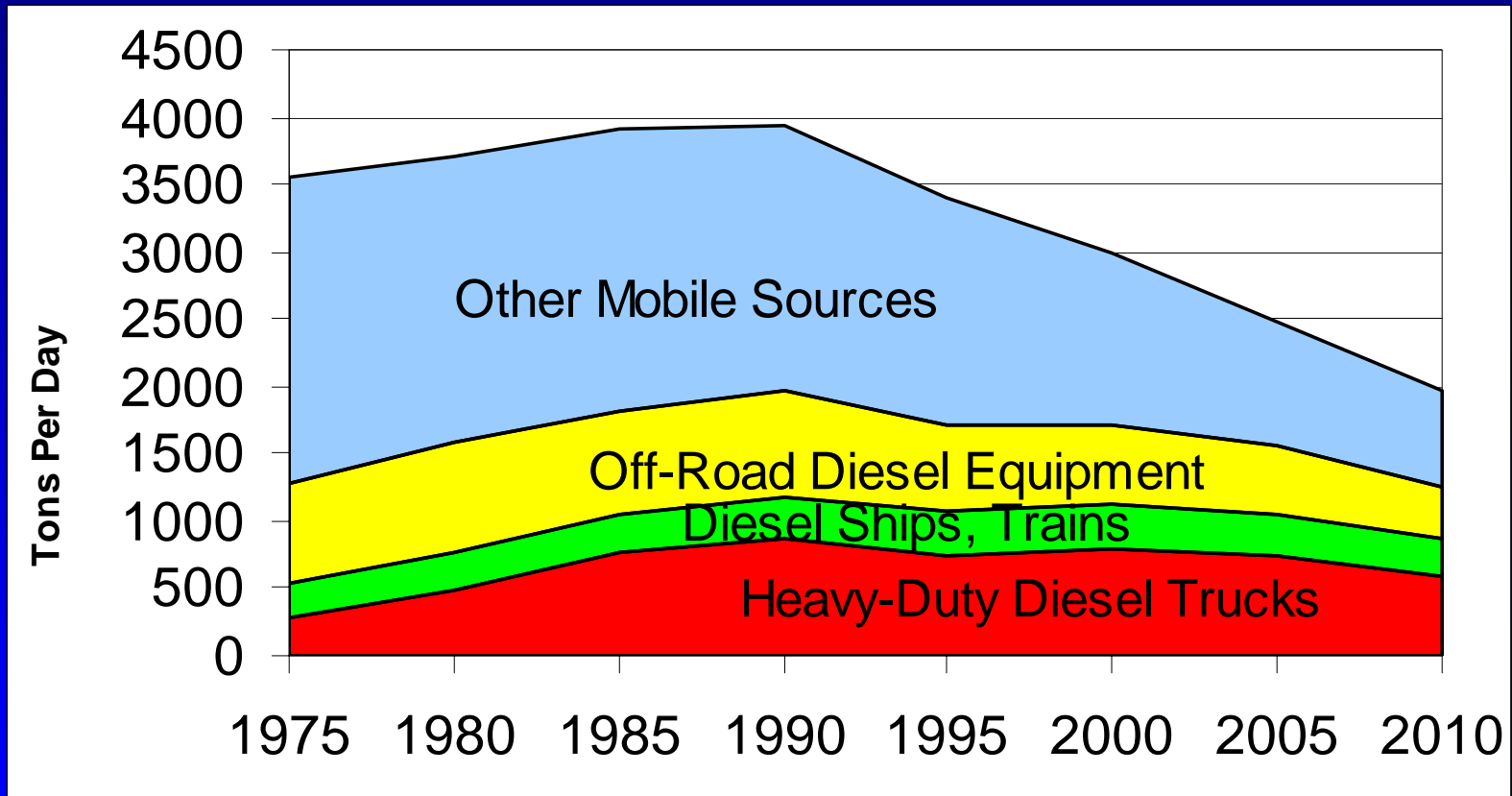
Diesel Risk Reduction Plan

- Adopted 2000
 - 75 percent risk reduction by 2010
 - 85 percent risk reduction by 2020
- Multiple Strategies:
 - Cleaner fuel
 - Stringent new engine standards
 - Ensure in-use performance
 - Retrofit / retire existing engines

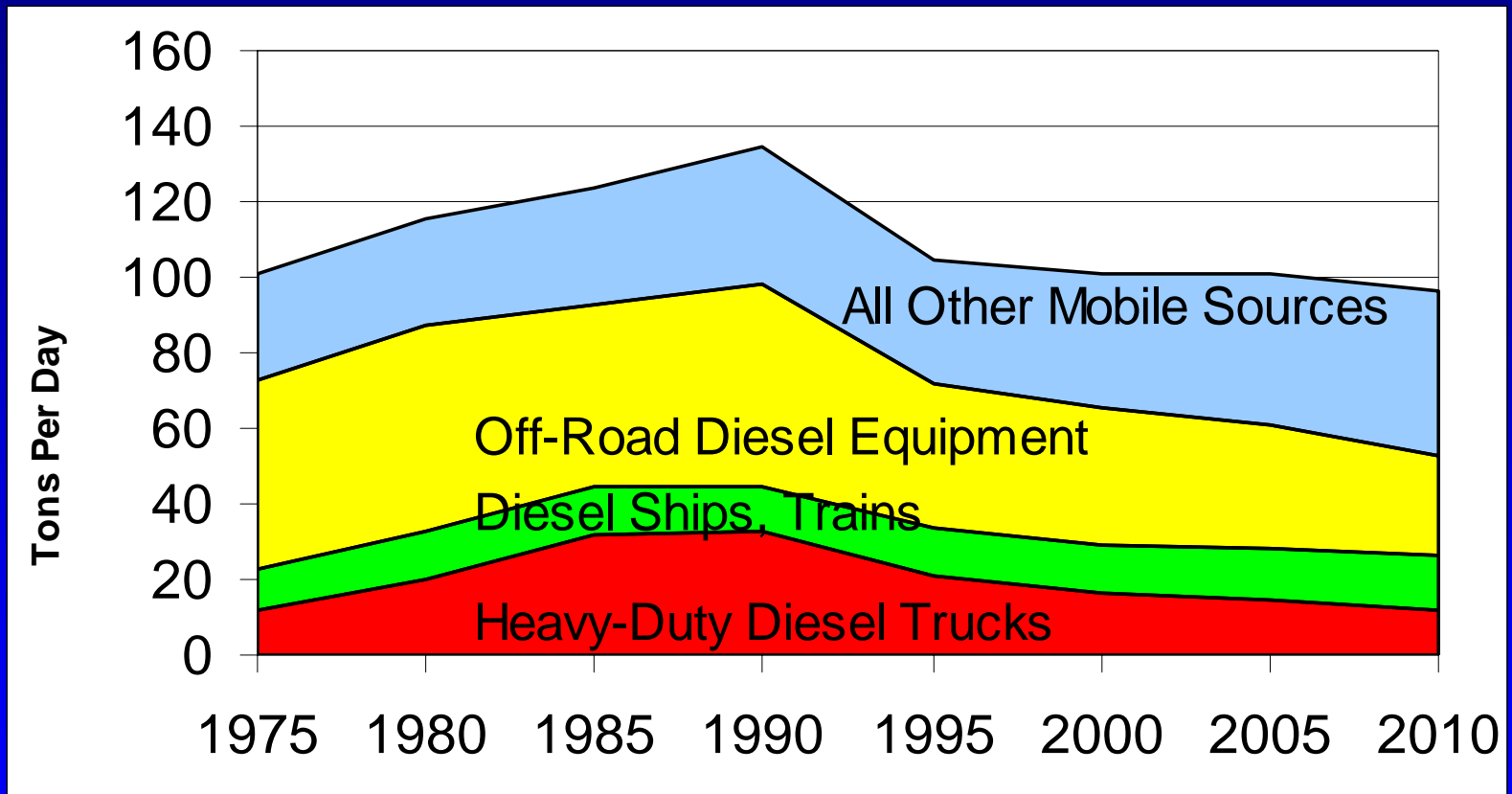
California Reduction Targets



NOx Emissions Trend



PM_{2.5} Emissions Trend



Rules Adopted to Date

- Transit buses 2000
- Trash trucks 2003
- TRUs “reefers” 2004
- Portable engines 2004
- Bus/truck idling (2) 2002/04
- Loco/harbor craft fuel 2004
- Stationary engines 2003

Upcoming Regulations

- **Late 2005**
 - **Public & utility on-road fleets**
 - **Cargo handling equipment**
 - **Ship auxiliary engine fuel**



Upcoming Regulations

- **2006/07**
 - On-road private fleets
 - Off-road public/private fleets
 - Harbor craft
 - Stationary agricultural engines
 - Agricultural off-road engines



Voluntary Agreements

- **Railroads**

- **MOU for Los Angeles (1998)**

- By 2010, meet EPA 2005 stds in LA
- Retrofit existing engines to Tier 0

- **MOU for Statewide Railyards (2005)**

- Idle shutoff devices installed
- Smoke inspections and repair
- Use low sulfur diesel when refueling in CA
- Risk assessments, local mitigation

Agreements, continued

- **Marine Vessels**
 - Voluntary speed reduction within 5 miles of California coastline
 - Cuts NOx 5%
 - Additional measures under discussion

Regulatory Detail

Fleet Rule for Transit Agencies

- Stringent New “Urban Bus” Standard
- Fleet Requirements
 - Fuel Path Choice
 - Fleet NOx Average
 - Fleet PM Reductions
 - 85% of 2002 baseline
 - by 2007 (diesel) or 2009 (alt-fuel)
- Zero-emission Bus Demos



Refuse Vehicle Rule

- Cuts 2.2 tons PM, 15.3 tons NO_x+HC
- Costs \$1/household per year
- Phased in over 6 years
- Requires BACT
 - Diesel at 2007 PM standard or
 - Current standard w/retrofit
 - Alternative-fuel
 - Pilot ignition engine



Municipal or Utility Owned Truck Rule (proposed)

- Requires BACT:
 - repower to 2007 PM standard
 - retrofit with highest level verified DECS
 - alternative-fuel
 - heavy-duty pilot ignition engine
- Staged compliance through 2013

Off-Road Equipment (Proposed)

- Largest source of mobile PM
- Construction, mining and industrial equipment
- BACT concept
 - Tier 4 PM standard or
 - Current PM standard w/
 - Alternative-fuel engine
 - Overall fleet reduction in PM and NOx



On-Road Trucks (Proposed)

- Largest source of on-road PM
- Medium thru heavy-heavy
- May require DECS



- Encourage shift to alt fuels
- Accelerated 2007 turnover
- Capture NOx reductions

Clean Diesel Fuel



- **June 1, 2006**
 - 15 ppm Sulfur
 - Low aromatics
 - On- and off-road sources
- **January 1, 2007**
 - Applies to intrastate locomotives and harbor craft

The Economics

Impact of Adopted Programs

Fleet	Affected Population	Cost (million \$)	% of all Diesels
Urban buses	10,300	103	2%
Other Transit	4,050	18.7	
Refuse trucks	11,900	155	
School buses	3,500	76	
TRUs	38,500	87-158	3%
Stationary	21,000	47	5%
Portable	33,000	350-420	
Other	3,600	39	
TOTALS	127,350	\$ 959-1029	10%

Incentive Programs

- Carl Moyer Program (\$140M/year)
- School Bus Program (\$25M)
- Light-Duty Scrappage (\$5-10M/year)
- West Coast Diesel Collaborative
- Pending Federal funds (\$200M/year)

Benefit to Cost Ratios

- California SIP: \$3 to \$1
- Clean Air Act: \$4 to \$1
- Carl Moyer program: \$10 to \$1
- ARB diesel retrofit rules: \$10-20 to \$1
- US EPA new diesel rules: \$24 to \$1

A Bit About Light Duty Diesels

Light-Duty Diesels

- **Significant technological progress**
- **50-80% NO_x reductions over a wide range of operating conditions**
- **Toyota Avensis D-CAT available in Europe**
- **Challenges are emissions durability, desulfurization and US06 standard**

Diesel vs. Gasoline

- **Benefits**

- More efficient
- More durable
- Higher torque
- Less evaporative and tailpipe ROG
- Less GHG emissions

- **Drawbacks**

- Higher purchase price
- Higher NOx and PM emissions
- Emits air toxics
- Consumer acceptance

Greenhouse Gas Regulation

- **22% reduction by 2012**
- **30% reduction by 2016**
- **Features of rule**
 - **All GHG emissions from vehicle**
 - **CO₂-equivalent per global warming potential**
 - **Fleet average standard**
 - **Preserves model choice**

Relative Compliance Costs

	Technology	CO ₂ reduction	Price increase	Payback in years
Mid-term	Gasoline ¹ (GDI-S, camless valve)	24%	\$742	3
	Diesel ¹ (HSDI)	24%	\$1141	3
Long-term	Diesel ¹ (HCCI)	18%	\$469	2
	Gasoline HEV (Prius-like)	48%	\$3186	7

¹ Includes automated manual transmission, electric power steering, improved. alternator

Other Diesel Related Greenhouse Gas Strategies

Biodiesel Fuel

- **New California targets for GHG reductions**
- **Action plan due January 2006**
- **Initial strategies include looking at requiring 1-4% biodiesel content in statewide diesel fuel**

Conclusion

- On track to meet 85% reduction goal
- Economics biggest challenge
- Offroad engines, nat'l & internat'l sources need attention
- Light-duty diesel likely future compliance strategy
- Diesel fuel also in play