Controlling Fine Particulate Matter Under the Clean Air Act: *A Menu of Options*

STAPPA/ALAPCO

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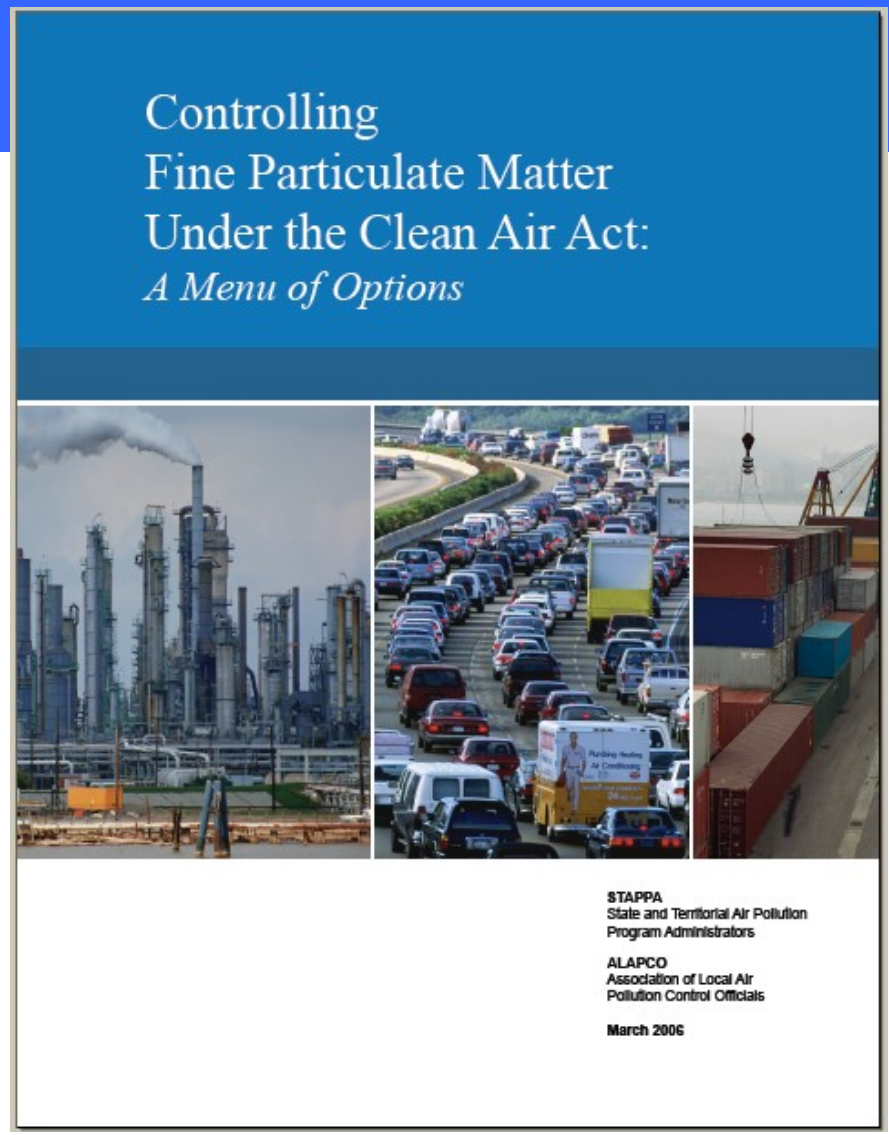


Chapter Structure

- Sector Profile
- Emissions Control Opportunities
  - $PM_{2.5}$, SO_2, NO_x
- Regulatory Authority
- State and Local Policy Measures

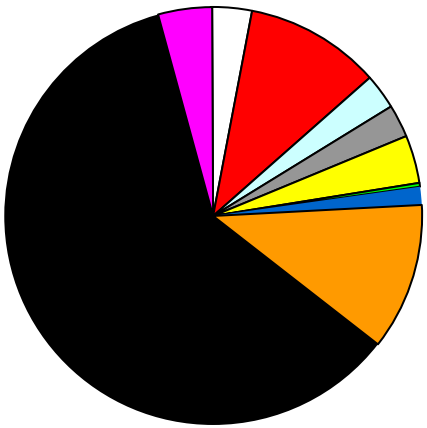
Ambient $PM_{2.5}$ Emissions

- Direct $PM_{2.5}$
- Precursors
  - SO_2 and NO_x included
  - Ammonia and volatile organic compounds not included
- But—source contribution and atmospheric chemistry are highly local

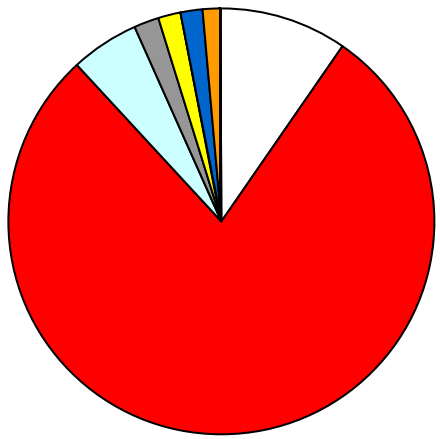
Pollution Contribution by Sector

- Industrial & Commercial Boilers
- Electric Generating Units
- Industrial Point Source (cement, refineries, iron/steel, paper -- no boilers)
- Onroad Vehicles
- Nonroad Equipment
- Airports
- Marine Ports
- Residential
- Fugitive Dust
- Other (commercial cooking, agricultural burning)

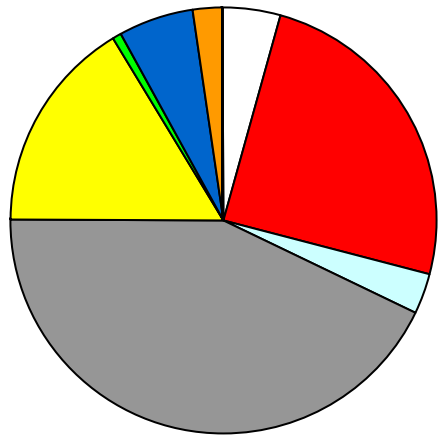
$PM_{2.5}$



SO_2



NO_x



Preemption—Stationary Sources

- For stationary sources, the Clean Air Act allows states and local areas to impose more stringent requirements (although some states have limited this authority)
- States can enact more stringent regulations or impose more stringent permit limits
- Other possibilities for further emissions reductions—limits on sulfur levels in fuel (Connecticut, New York); stringent requirements with an opportunity for source to demonstrate infeasibility; source caps

Cogeneration

- Conventional power plant loses two-thirds of the potential energy in the fuel to waste heat
- Petroleum refining, pulp and paper, cement manufacturing, iron and steel, and others—candidates for cogeneration
- CHP systems can achieve overall efficiencies of more than 80 percent
- Nine percent of U.S. electricity comes from cogeneration plants
- Denmark = 40 percent of country's electricity; Finland and the Netherlands = 30 percent each

Industrial and Commercial Boilers

- 40 percent of energy use in the industrial and commercial sectors
- Disparities between EGU and industrial/commercial boiler standards PM, SO_2, and NO_x—I/C boiler standards generally less stringent
- Wood-fired boilers = 4 percent of industrial boiler capacity and 20 percent of industrial boiler $PM_{2.5}$ emissions
- Recent BACT limit for PM for *existing* wood-fired EGU boiler is the same as the MACT standard for PM emissions for *new* wood-fired industrial/commercial boilers
- There are significant opportunities for additional reductions

Electric Generating Units

- STAPPA and ALAPCO have concluded that EGUs can achieve limits of 0.10 lb/MMBtu for SO_2 and 0.07-0.08 lb/MMBtu for NO_x
- Several states have requirements aimed at reducing EGU emissions beyond federal requirements—New Hampshire, Massachusetts, North Carolina
- Regional groups like OTC and LADCO are considering options that extend beyond CAIR, and include large industrial boilers
- Other opportunities for reducing sector emissions—limits on sulfur in fuel, efficiency, cogeneration, RPS (21 states plus D.C.)

Pulp and Paper

- Pulp making process accounts for over 75 percent of the sector's $PM_{2.5}$, SO_2 and NO_x emissions
- Power boilers dominate emissions from pulp mills
- Upgrades to electrostatic precipitators (ESPs) and replacement of wet scrubbers with ESPs can significantly reduce PM emissions
- Consider limits to SO_2 emissions from pulp mills as in Washington and Oregon
- Consider facility-wide emissions caps for PM, SO_2 and NO_x

Cement

- Cement kilns generate over 40 percent of sector PM emissions and more than 80 percent of sector SO_2 and NO_x emissions
- No NSPS for SO_2 and NO_x emissions from cement operations means significant opportunities to reduce these emissions from the sector
- SNCR advancements make it suitable for use on cement kilns
  - 32 SNCR systems installed on kilns in Germany; many more in rest of Europe
  - Included as part of BACT determinations in Florida
- Recent permits in Florida: SNCR, low-NO_x burners, and multi-staged combustion as BACT for NO_x

Cement

- Without add-on controls, use of low-sulfur raw materials is essential for control of SO_2
- FGD technology can provide an SO_2 control efficiency of 90–99 percent
- Recent MACT and NSPS standards for PM for kilns using hazardous waste as fuel are substantially more stringent than the MACT and NSPS standards for PM for fossil fuel-fired cement kilns
- South Coast AQMD control of fugitive emissions: enclosures, ventilation to a control system

Iron and Steel

- Coke Making
  - Limit amount of coke produced/employ coke substitutes
  - Avoid temperature fluctuations and incomplete coking
  - Staged charging
  - Desulfurize coke oven gas (only 11 of 16 byproduct recovery coke plants)
  - Careful maintenance and cleaning program
- Iron making
  - Control casthouse emissions with covered runners and capture hoods ducted to a baghouse (only about one-half of plants are controlled this way)
- Sinter plants
  - Control device for sinter cooler (only one of five)
  - Control oil and grease content of feedstocks

Iron and Steel

- Steel making
  - Oxygen blow—fabric filters
  - Upgrade old scrubbers and ESPs
  - Secondary collection systems for control of fugitive emissions
- Minimills
  - Baghouses for primary emissions from scrap melting
  - Hoods and baghouses for ladle metallurgy process and argon oxygen decarburization vessel
  - Opacity limits for fugitive emissions at least as stringent as NSPS

Petroleum Refineries

- Numerous sources of air pollution, including boilers, process heaters, catalytic cracking units, internal combustion engines, and flares
- Consider adopting facility-wide emissions standards
  - California's Bay Area AQMD limits NO_x emissions from boilers, steam generators, and process heaters to a refinery-wide NO_x standard
- Alternatively, a cap-and-trade approach that includes refineries allows sources flexibility to address a large number and variety of emissions sources (e.g., Houston-Galveston)

Petroleum Refineries

- Federal NSPS for catalytic cracking units and sulfur recovery plants are outdated
  - Consider adopting more stringent PM and SO_2 emissions standards for these units, and impose stringent NO_x standards (currently no NSPS for NO_x for these units)
  - Look to EPA consent decrees (with 83 refineries since 2000) for emissions limits and control options for PM, SO_2 and NO_x emissions
- Adopt rules to better manage PM, SO_2 and NO_x emissions from flaring activities (e.g., Bay Area AQMD, South Coast AQMD)

Preemption—Mobile Sources

- Mobile source preemption—or, you have more authority to regulate vehicles than you think you do
- Only EPA and California can set standards for *new* vehicles
- States can adopt EPA or California standards for *new* light-duty cars and trucks, onroad diesels (trucks and buses), and nonroad diesels (e.g., agricultural tractors and combines, construction equipment, airport ground-support equipment)

Preemption—Mobile Sources

- For *existing* vehicles—
  - States can adopt their own standards for light-duty cars and trucks, and for trucks and buses
  - States can adopt California or federal standards for nonroad equipment, but *cannot* adopt their own standards
- All states (including California) are preempted from regulating some sources—e.g., new engines used in locomotives, new construction equipment, new farm equipment, aircraft, ocean-going ships
- Fuel—voluntary vs. mandatory issues

Light-Duty Cars and Trucks

- Contribute 16 percent of NO_x emissions from *all* sources; $PM_{2.5}$ emissions fall dramatically beginning in 2006
- *But* stricter federal and California standards starting with 2004 model year will have an effect in short term because of fast turnover rates—66 percent NO_x reduction by 2020
- Adopt California LEV II standards, as about ten states have done

Light-Duty Cars and Trucks

- Don’t think retrofits
- Instead, in addition to California standards, consider strategies that—
  - increase vehicle turnover rate
  - encourage purchase of cleanest vehicles
  - monetary incentives to make clean choices—e.g., scrappage programs, tax rebates, tax exemptions, reduction in registration fees
  - non-monetary strategies—e.g., permission to use HOV lanes, exemption from state emissions tests, parking perks

Light-Duty Cars and Trucks

- Also, strategies to reduce vehicle miles traveled and otherwise reduce fuel use—increasing public transportation, bicycle paths, enhanced traffic management, keeping maximum highway speeds down
- I & M—one of the most cost-effective strategies for reducing vehicle emissions, according to National Academy of Sciences (but EPA is giving less and less SIP credit for these programs)

Diesel Trucks and Buses

- About 20 percent of all NO_x emissions, and almost all of the PM emissions are $PM_{2.5}$
- More stringent federal standards for PM, NO_x, and onroad diesel fuel—soon
- But *do* think retrofits—because of long vehicle lifetimes, lag in effective regulation
- Three kinds of state and local programs imposing emissions standards on existing trucks and buses—(1) voluntary (consider loans where short payback period from, e.g. fuel savings), (2) mandatory for all vehicles of a type, (3) mandatory for government vehicles or government contracted vehicles

Diesel Trucks and Buses

- Idling limitations
  - Long-haul truckers are a special case—the biggest benefit from reducing idling (with EPA guidance for SIP credit); fuel savings suggest feasibility of loan programs
- Programs that encourage proper tire inflation
- Lower/enforce speed limits

Nonroad Equipment

- About the same emissions contribution as trucks and buses
- New York City inventory for 1999: 45 percent of PM emissions and 26 percent of NO_x emissions from all mobile sources in NYC from construction equipment
- EPA emissions standards becoming more stringent, but at a slower pace than for trucks/buses
- Again, think retrofits—an even better target than trucks and buses for retirements/retrofits

Nonroad Equipment

- Same three kinds of state and local programs imposing emissions standards as for trucks/buses
- Mandatory—more difficult for nonroad equipment, but California standards are a possiblity for portable diesel engines used in a lot of equipment
- Reduced sulfur fuels—important opportunity in short term (2012), and required for effective retrofit program
- Idling—limited feasibility, except for switcher yard locomotives (EPA guidance for SIP credit)—again, good for loan programs

Airports

- States have numerous opportunities to reduce emissions from airport ground service equipment and ground transportation vehicles, but no authority over aircraft engines
- Airport ground service equipment (baggage tugs, belt loaders and aircraft pushback tractors) are candidates for nonroad equipment emissions reductions strategies
- Ground transportation fleets are candidates for usual vehicle emissions reduction strategies—enforcement of anti-idling rules is important

Airports

- Airports are good candidates for programs that cap their overall emissions (e.g., Dallas/Fort Worth International Airport and Boston's Logan Airport NO_x caps)
- The Federal Aviation Administration's Voluntary Airport Low Emissions (VALE) Program provides funding for various airport air quality improvement measures at commercial service airports in nonattainment and maintenance areas

Marine Ports

- Over 30 of the largest U.S. ports are in areas that are in nonattainment for $PM_{2.5}$, ozone, or both
- Most of the PM and NO_x emissions from ports come from marine vessels: ocean-going ships (which states cannot regulate), auxiliary engines on these ships, and commercial harbor craft
- Sector is a candidate for the same emissions reduction strategies that apply to trucks, buses, and nonroad equipment
- Some port vehicles (e.g., tugboats) are particularly good candidates for repowering because of the greater fuel efficiency of replacement engines

Marine Ports

- Electrification opportunities—“cold ironing” to deal with hotel loads, replacement of diesel-powered cranes with electric cranes
- Other options for reducing emissions:
  - programs that encourage ships to operate at lower speeds near the coast (e.g., programs at the Port of Long Beach and the Port of Los Angeles);
  - operational changes that reduce truck queuing and idling (e.g., measures at the Georgia Ports Authority and the Port of Virginia)
- Sector is an excellent candidates for programs that cap overall emissions
- Governance structure of ports makes mandatory programs more feasible

Commercial Cooking

- $PM_{2.5}$ emissions from the sector account for 6 percent of the total direct $PM_{2.5}$ emissions from all point source categories
- Charbroiling generates over 80 percent of total $PM_{2.5}$ from commercial cooking
- Two types of charbroilers, with 74 percent of emissions from the use of underfired charbroilers
  - But--expensive to regulate; further investigation warranted
- PM emissions from new and existing chain-driven charbroilers can be regulated
  - The South Coast AQMD requires operators of new and existing chain-driven charbroilers to install a catalytic oxidizer (but allows equally effective alternatives); PM emissions reductions of over 80 percent; cost-effective ($1,680–$2,800 per ton of PM and VOCs reduced)

Fugitive Dust

- Fugitive dust refers to particles, mostly derived from soil, that are lifted into the air by agricultural tilling, motor vehicle use, wind
- Programs must be targeted to maximize effectiveness
  - Agricultural strategies include reduced tillage and limiting tilling during windy weather (e.g., South Coast AQMD)
  - Road strategies include paving or enforcing a low speed limit on heavily traveled unpaved roads
- “Trackout” controls are effective on large construction projects (e.g., South Coast AQMD)

Mobile Source: Cost-Effectiveness

- The $PM_{2.5}$ Menu of Options contains a good deal of cost and cost-effectiveness information; however, for some source categories information is scarce, and the report does not deal systematically with these issues
- For a project MJB&A is doing for NESCAUM, we are making efforts to derive cost-effectiveness numbers:
  - five retrofit technologies
  - four fuel options
  - three diesel vehicle types
  - also—six idle reduction technologies
- Caveats: preliminary, heavily dependent on assumptions, useful directionally and in a relative sense

Mobile Source: Cost-Effectiveness

Vehicle Type	Duty Cycle	Age/ Emission Standards
Onroad Truck	Highway	1990
		1998
	Urban	1990
		1998
Construction Equipment	High Usage	Tier 0
		Tier 2
	Average Usage	Tier 0
		Tier 2
Locomotive	Line-Haul	Tier 0
	Switchyard	

Mobile Source: Cost-Effectiveness

- The relative ranking of available reductions by vehicle type, age, and duty cycle is similar for all technologies and fuel options:
  - locomotives
  - construction equipment
  - onroad trucks—highway
  - onroad trucks—urban
- In all cases, per vehicle reductions are 2-10 times larger from construction equipment than from onroad trucks of similar age
- Reductions from locomotives are 5-50 times larger than reductions from even the oldest pieces of construction equipment
- Reductions from locomotives are 10-500 times larger than from onroad trucks

Mobile Source: Cost-Effectiveness

- The higher reductions available from locomotives are based on their much larger engine size, higher baseline emissions, and higher annual usage
- The reductions available from urban onroad trucks are lower than from highway trucks because of their much lower annual usage
- For retrofit devices, cost-effectiveness is improved with greater annual usage; but fuel options work differently: they are more cost-effective the higher the baseline, but cost-effectiveness does not depend on greater use
- Every locomotive and sleeper cab truck should have an idle reduction technology; every idle reduction technology has a payback period of less than two years—think revolving loans