SOURCES OF AIR POLLUTION AND HOW THEY ARE REGULATED:

A Guide for New Yorkers

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I. What Is Air Pollution?

Air pollution consists of a mix of different chemicals, released into the atmosphere by both man-made and natural processes. Mobile sources (like cars, trucks, and airplanes), large industrial facilities, and power plants are the principal sources of air pollution associated with human activities. In many cases, the burning of fossil fuels is the primary culprit. Wildfires and volcanic eruptions also contribute to air pollution.

One way to think about air pollution is to group pollutants into the two broad categories that environmental scientists and regulators often use: "criteria" pollutants, and hazardous air pollutants (sometimes called "air toxics").

One way to think about air pollution is to group pollutants into the two broad categories that environmental scientists and regulators often use: *"criteria" pollutants*, and *hazardous air pollutants (sometimes called "air toxics")*. Criteria pollutants are so named because they are ones for which the Environmental Protection Agency (EPA), the chief federal environmental agency, is required to establish national air quality standards. They include ozone (which is the primary component of smog), particulate matter, and sulfur dioxide. Some of the criteria pollutants are emitted directly into the atmosphere; others are formed in reactions after they are emitted. Benzene and mercury are examples of hazardous air pollutants. EPA considers mercury to be among the most serious hazardous air pollutants. The federal Clean Air Act, as we shall see, regulates criteria pollutants and hazardous air pollutants differently.

It bears noting that ozone is not emitted directly; instead, it forms in the atmosphere in the presence of sunlight, in a reaction between oxides of nitrogen and other chemicals called "volatile organic compounds." Therefore, ozone is not regulated directly, but is regulated mainly through the regulation of oxides of nitrogen. For that reason, our discussion and figures refer to oxides of nitrogen rather than to ozone, even though ozone (and not oxides of nitrogen) is the criteria pollutant.

The criteria pollutant particulate matter has somewhat complicated origins. Some particulate matter is emitted directly (for example, from diesel trucks and buses). These are referred to as "primary" particles. In comparison, "secondary" particles (in large part from industrial sources, including power plants) form in the atmosphere. Secondary particulate matter includes sulfates formed from sulfur dioxide emissions, and nitrates formed from emissions of oxides of nitrogen.

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Neither of the categories (criteria pollutants or hazardous air pollutants) currently includes carbon dioxide, which is the most pervasive of the chemicals that contribute to the "greenhouse effect": a process in which gases in the air, like carbon dioxide, trap infrared light that would otherwise be radiated out to space, tending to raise temperatures on earth, otherwise known as global warming. There is no dispute that greenhouse gas concentrations have increased since industrialization began, and that this is due in part to human activities. The burning of fossil fuels and deforestation are largely responsible for the rising levels of carbon dioxide in the atmosphere. It is also clear that the global climate has warmed during the last century. Although the scientific community now believes that most of the observed warming over the last 50 years is likely due to the increase in greenhouse gas concentrations, there is still a dispute as to the exact extent to which human sources of carbon dioxide and other greenhouse gases contribute to the warming.

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This takes us to the effects of air pollution, which is a complex story.

II. What Are the Effects of Air Pollution?

We have touched briefly on the criteria pollutants ozone, particulate matter, sulfur dioxide, as well as on oxides of nitrogen, mercury, and carbon dioxide. Table 1 outlines the effects of these pollutants.

Table 1. The Impacts of Air Pollution
Particulate matter effects
Two other pollutants, oxides of nitrogen and the criteria pollutant sulfur dioxide, play a major role in the formation of another criteria pollutant, particulate matter. Particulate matter is currently believed to have the most widespread adverse health effects of all the criteria pollutants.
Acid deposition
Both oxides of nitrogen and sulfur dioxide cause acid deposition, more commonly known as “acid rain,” which damages ecosystems and can cause waterbodies to become too acidic to support life.
Ground-level ozone
In addition to their role in forming acid rain and particulate matter, oxides of nitrogen contribute to the formation of ground-level ozone—another criteria pollutant—which is the major component of smog. Ground-level ozone has impacts on human health and on natural ecosystems by attacking trees, crops and other plants.
Eutrophication
Deposition of oxides of nitrogen also cause eutrophication, which is the saturation of waterbodies with overly abundant growth of algae. This occurs mainly in the coastal waters of the eastern United States.

Table 1. The Impacts of Air Pollution, continued
Mercury health effects
Mercury is a potent neurotoxin that attacks the central nervous system of the fetus and of young children. Human exposures come mainly from eating fish contaminated with methylmercury.
Global warming
Greenhouse gases, the most significant of which is carbon dioxide, trap infrared light that would otherwise be radiated out to space, raising global surface temperatures. Temperature increases can severely disrupt natural ecosystems, impact the availability of water, and contribute to a rise in sea levels.

Particulate matter effects

Particulate matter comprises a broad class of substances, existing as tiny discrete particles rather than as gases. The particles include sulfates, nitrates, organic carbon or soot, and soil dust. In the eastern United States, sulfates are a major component of particulate matter. Sulfates are formed from sulfur dioxide emissions; nitrates, from emissions of oxides of nitrogen. Particulate matter has a serious adverse impact on human health, and also impairs visibility across the United States.

Particulate pollution is a continuing public health problem in metropolitan areas, where concentrations tend to be highest. The major sources of particulate matter in New York City include diesel and auto emissions, re-suspended road dust, and construction and demolition of building structures. Manhattan, which registers the highest concentration of particulate matter in the five boroughs, fails to meet national air quality standards for particulate pollution.

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Nationally, particulates are believed to contribute to more deaths each year than any other criteria pollutant. They also contribute to significant illness, from decreases in lung function to respiratory and cardiopulmonary symptoms sufficiently serious to require hospitalization. Children, people of all ages with asthma, and elderly persons with illnesses such as bronchitis, emphysema and pneumonia are at particular risk. The Health Effects Institute recently released two reports that corroborate the results of prior studies linking adverse human health effects to exposure to particulate matter.

Acid deposition

Both oxides of nitrogen and sulfur dioxide cause acid deposition, commonly known as “acid rain.” Acid deposition results when these pollutants react in the atmosphere to form sulfuric and nitric acids and then fall to earth as gases or particles (dry deposition), or as snow or rain (wet deposition).

Acid deposition causes serious problems for aquatic ecosystems, particularly in the East. New York's location directly downwind of huge fossil-fueled power plants, which are some of the biggest contributors to acid deposition in North America, puts it at particular risk.

Acidified water kills some insects and crustaceans (like clams and crayfish), thereby also affecting the animals that feed on them, like certain waterfowl. The effects on fish populations can be disastrous. A 1980 study identified 200 lakes in the Adirondacks and 200 in the province of Ontario where *all fish* had been killed by acidification of their habitats. Lake acidity levels in these areas have remained high since the 1980's. Acid precipitation also seriously affects tree foliage and soil chemistry. In metropolitan areas like New York City, acid deposition damages building materials, erodes ornamental facades and destroys statues and other vulnerable edifices.

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Ground-level ozone

As we have said, ground-level ozone, the major component of smog, is formed by the reaction of oxides of nitrogen and volatile organic compounds in the presence of sunlight. Ozone levels in the New York City metropolitan area have dropped over the past two decades, but over the past four years the area has registered exceedances of national air quality standards on an average of eleven days annually (down from an average 20 years ago of about 30 days annually).

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Both healthy people and individuals with impaired respiratory systems (like asthmatics) experience temporary respiratory symptoms from exposure to ozone. Symptoms include coughing, throat irritation, chest pain on deep breathing, nausea, and shortness of breath. A number of studies have reported excess hospital admissions and emergency room visits for respiratory causes, both for asthmatics and for healthy individuals, attributed primarily to ambient ozone exposures. Exposure to ozone also damages plants and trees, impairing their growth and reducing crop yields.

As this document goes to press, the U.S. Supreme Court is considering a case challenging EPA's new, more stringent standards for both ozone and particulates. It will likely be decided in the spring of 2001.

Eutrophication

Oxides of nitrogen, partially from atmospheric sources, are a major contributor to excess nitrogen in coastal waters, particularly in the eastern United States. This infusion, which causes oxygen levels in water to plummet and the abundant growth of plant life in water bodies, is known as "eutrophication." Eutrophication may be the most serious pollution issue facing U.S. coastal waters, with serious economic and ecological consequences. It results in fish kills, red and brown tides, toxic algae and plankton blooms that affect shellfish and coral communities.

Mercury is a developmental neurotoxin that can damage the central nervous system of the developing fetus and of young children, even in low doses.

Over the past 15 years, every summer has seen a period of over a month in which the waters of Long Island Sound were severely depleted of oxygen. The fish and shellfish of the Sound and New York Harbor are heavily affected by eutrophication. Non-mobile species such as scallops and clams cannot escape to more oxygenated waters and are therefore at the highest risk. Harmful algae blooms can also choke off entire sections of New York's waters.

Mercury health effects

Mercury is a developmental neurotoxin that can damage the central nervous system of the developing fetus and of young children, even in low doses. Although it is less conclusive, there is also evidence that mercury has cardiovascular effects in adults, and that it can impair the adult immune and reproductive systems. Exposure to mercury comes mainly from eating contaminated fish.

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In New York Harbor, mercury levels in both fish and sediment sometimes exceed standards. An even more serious problem occurs in the numerous small lakes north of the city used for recreation and for sport and commercial fishing, where over 35 fish advisories have been issued (and remain active) in the last few years.

Global warming

Human activities, mainly the burning of fossil fuels and deforestation, have caused increases in carbon dioxide. Carbon dioxide in the atmosphere causes temperatures to rise on the surface of the earth. Therefore, most scientists believe that the current warming trend is attributable to human activities. Global warming is predicted to have serious consequences, including rises in sea levels (which will cause flooding of lowland areas and destroy large areas of coastal wetlands), the spread of malaria and certain other diseases (like yellow fever and viral encephalitis), and an increase in heat-related illness and death.

III. Where Does the Air Pollution in New York City Come from?

Most of the air pollution in New York City, as in the country as a whole, comes from four source categories:

- mobile sources, which include cars, trucks, airplanes, and trains;
- large industrial sources, including industrial, commercial and institutional coal- and oil-fired boilers, waste incineration, and chemical and asphalt manufacturing;
- power plants;
- other emissions sources, which refers mainly to smaller sized polluters, such as dry cleaners, gas stations, and residential and commercial heating systems.

In New York City about two-thirds of local sulfur dioxide emissions come from large industrial sources (this does not include power plants), and three-quarters of local oxides of nitrogen come from mobile sources.

The amount of pollution from each of these categories varies depending on the pollutant in question. *For example, in New York City about two-thirds of local sulfur dioxide emissions come from large industrial sources (these include industrial, commercial and institutional coal- and oil-fired boilers, waste incineration, and chemical and asphalt manufacturing, but exclude power plants), and three-quarters of local oxides of nitrogen come from mobile sources.* (Remember that when we talk about emissions, we talk about oxides of nitrogen rather than about the criteria pollutant ground-level ozone. That is because, as we have discussed, ground-level ozone is not emitted directly, but is formed by oxides of nitrogen reacting with other pollutants in the atmosphere.)

In more than one sense, New York is not an island. The prevailing winds blow from southwest to northeast, bringing with them a load of pollutants. This phenomenon is known as "transport." EPA estimates that almost half of New York City's ozone problem is a result of ozone transported from upwind states.

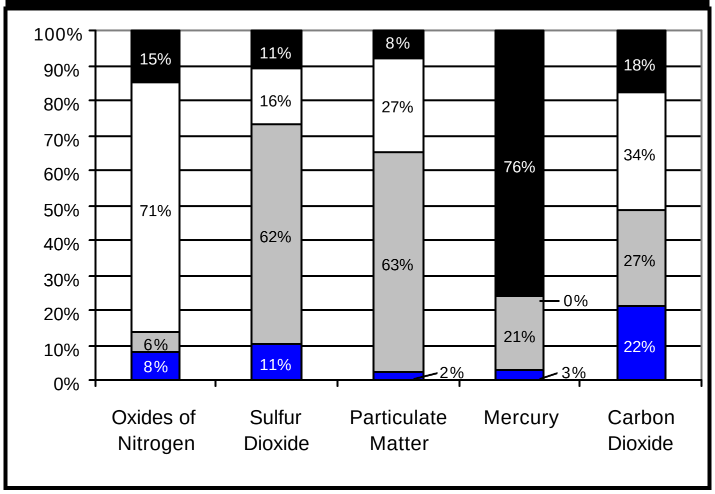
In more than one sense, however, New York is not an island. The prevailing winds blow from southwest to northeast, bringing with them a load of pollutants. This phenomenon is known as "transport." EPA estimates that almost half of New York City's ozone problem is a result of ozone transported from upwind states. Similarly, much of the acid deposition in the Adirondacks is carried east from older power plants located in the Ohio River Valley, home to some of the country's largest electric power plants. In turn, pollution from New York continues northeastward, to destinations like the coast of Maine.

To get a better sense, then, of the source categories that New York City's air pollution comes from, we must include the national scene. *In the U.S, the contribution mix looks quite different from New York's: three-quarters of sulfur dioxide comes from power plants, and one-half of the oxides of nitrogen* *from mobile sources.* Figures 1 and 2, "New York City Emissions by Source Category (based on 1993, 1997 and 1998 data)," and "U.S. Emissions by Source Category (based on 1995, 1997 and 1998 reports)," give a more complete picture.

Key

- Other Sources
- Mobile Sources
- Large Industrial Sources
- Power Plants

Figure 1: New York City Emissions by Source Category (based on 1993, 1997 and 1998 reports)



Key

- Other Sources
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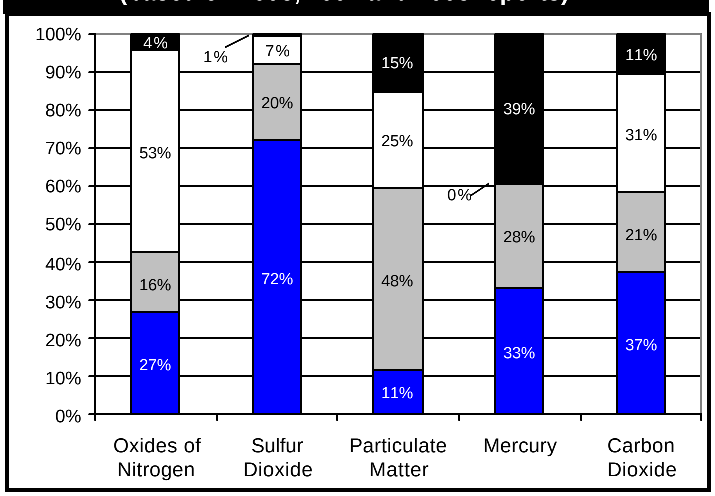
Figure 2: U.S. Emissions by Source Category (based on 1993, 1997 and 1998 reports)



IV. Power Generation and Air Pollution: a Closer Look

Section III examined the relative contribution that various sectors of the economy (mobile sources, industrial sources, power plants) make to air pollution. We look more closely now at one of those sectors—power generation—with a focus on the fuel sources of electric power and the air emissions from the fossil fuel (coal, oil, natural gas) sources.

A. The Fuel Sources of Electric Power

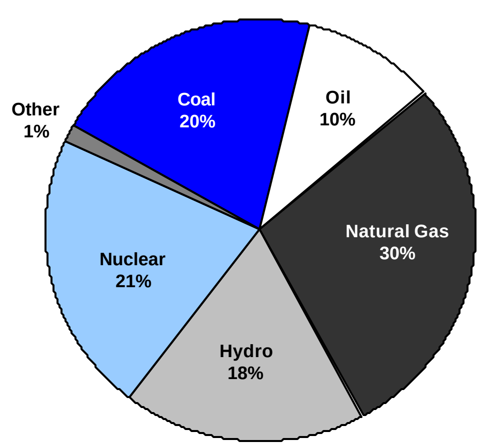
New York City gets electric power from inside and outside the City. The plants located outside the City, in New York State, New Jersey, Pennsylvania, and Connecticut, are connected by a network of power lines. These power lines form a transmission system known as the New York power grid, which the New York Independent System Operator manages. *Across the New York power grid*, power is generated by a mix of sources:

Across the New York power grid, power is generated by a mix of sources.

- 20 percent from coal;
- 30 percent from natural gas;
- 10 percent from oil;
- 21 percent nuclear;
- 18 percent hydroelectric;
- 1 percent other sources.

See Figure 3, "Generation fuel Mix: New York Power Grid (1999)."

Figure 3: Generation Fuel Mix: New York Power Grid (1999)

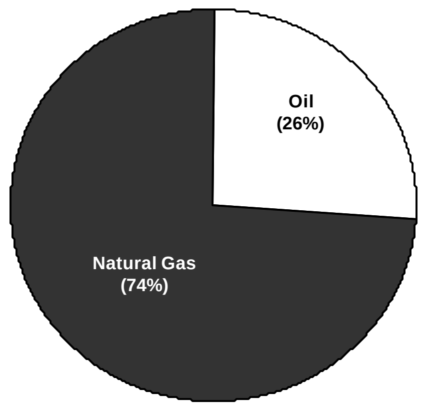


Power plants located within New York City are fueled exclusively by oil and natural gas. As shown in Figure 4, "Generation Fuel Mix: New York City Power Plants (1999)," these plants get

- 74 percent of their electricity from natural gas;
- 26 percent from oil.

Power plants located within New York City are fueled exclusively by oil and natural gas.

Figure 4: Generation Fuel Mix: New York City Power Plants (1999)



The grid's and the City's fuel mix vary markedly from the national mix. *Nationally*,

- *slightly more than half of our electricity comes from coal*;
- 15 percent from natural gas;
- four percent from oil;
- 19 percent from nuclear generation;
- nine percent from hydroelectric power;
- two percent from non-hydroelectric renewable sources.

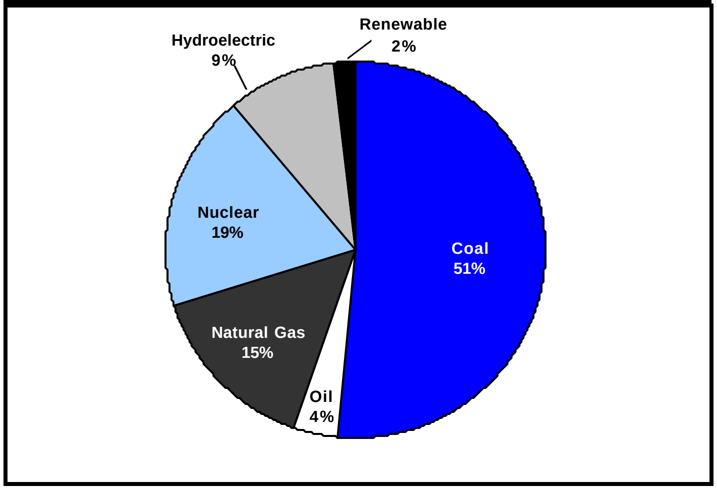
The grid's and the City's fuel mix vary markedly from the national mix. Nationally, slightly more than half of our electricity comes from coal.

See Figure 5, "Electric Power Generation in the U.S. by Fuel Source (1999)," on page 11.

B. The Air Emissions from the Fuel Sources Used to Generate Electric Power

Although fossil fuels are the principal sources of electricity that pollute the air, they emit dramatically different amounts of pollution:

Figure 5: Electric Power Generation in the U.S. by Fuel Source (1999)



- With coal accounting for about half of all fuel used for electric power generation nationally, *coal-generated electric power contributes approximately 90 percent of electric power emissions of nitrogen oxides, sulfur dioxide, and carbon dioxide. Coal-generation accounts for virtually all of the electric power emissions of particulate matter and mercury.*

- *The contribution of oil-fired power plants to air pollution is approximately proportional to the four percent of our power that comes from oil nationwide.* For example, four percent of oxides of nitrogen emissions and three percent of particulate matter emissions come from oil generation of power.

- *Natural gas makes the least contribution to pollution. Natural gas-generated power emits virtually no sulfur dioxide, mercury, or particulate pollution. It accounts for six percent of oxides of nitrogen emissions, and nine percent of carbon dioxide emissions.*

See Figure 6, "Emissions from Electric Generation, by Fuel Source (based on 1995, 1997 and 1998 reports)," on page 12.

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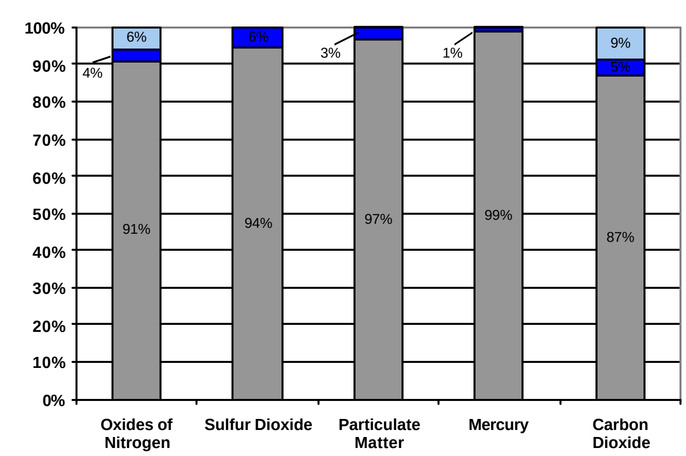
Figure 6: Emissions from Electric Generation, by Fuel Source (based on 1995, 1997 and 1998 reports)



Key

- Coal Plant
- Natural Gas Combined Cycle Power Plant
- Oil Plant

Another way of comparing the pollution impact of fuels is to compare their emission rates for various pollutants, which is the mass of a particular pollutant that the fuel emits per unit of energy content. This approach is informative because it allows us to compare the relative air pollution impact that coal, oil, and gas would have if they were used in equal amounts. For the average plant, the fuels stack up as follows:

For *oxides of nitrogen*,

- *the emission rate of oil is slightly more than one-half the emission rate of coal;*
- *the emission rate of natural gas is less than half that of coal.*

For *sulfur dioxide*,

- *the emission rate of oil is approximately three-fourths that of coal;*
- *the emission rate of natural gas is a tiny fraction of the rate of coal.*

For *particulate matter*,

- *the emission rate of oil is half that of coal;*
- *the emission rate of natural gas is negligible.*

For *mercury*,

- *only coal has significant emissions.*

For *carbon dioxide*,

- *the emission rate of oil is approximately three-fourths that of coal;*
- *the emission rate of natural gas is approximately half that of coal.*

Figure 7, "Relative Average Emission Rates for Coal-, Oil-, and Gas-Fired Power Plants (1998)," presents this information graphically.

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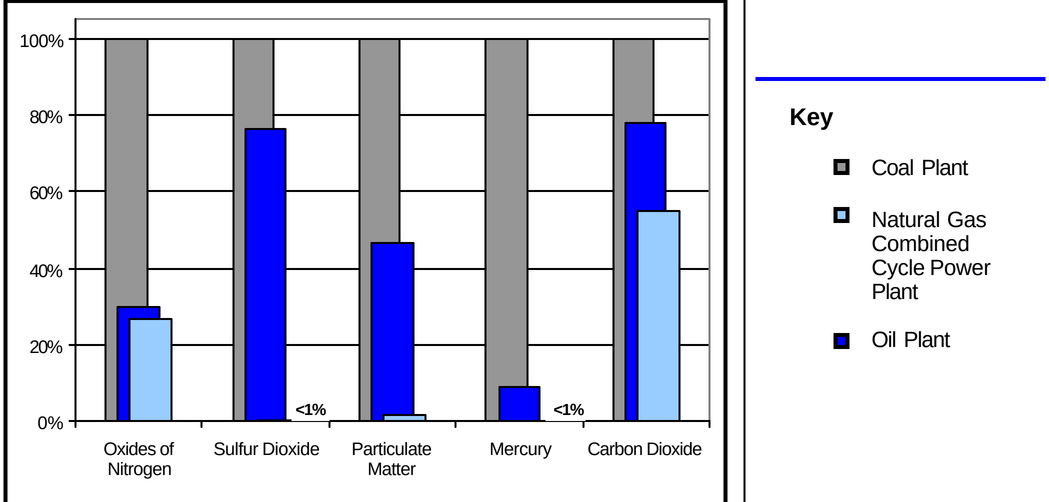
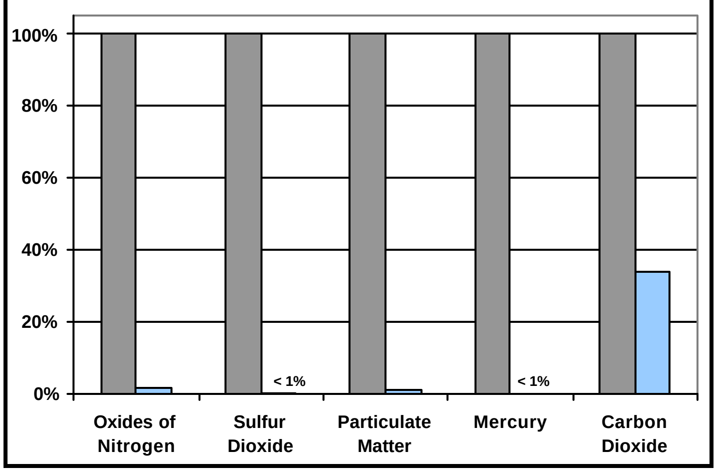


New Power Generation in New York

Virtually all power plants currently proposed for construction in New York State will employ natural gas-fired combined cycle technology. Traditionally, electricity has been generated at fossil-fuel power plants in a conventional steam cycle. Fuel is burned to turn water into steam, and the steam in turn provides the mechanical energy necessary to drive a turbine and generate electricity. A combined cycle power plant uses fossil-fuel combustion to drive a turbine and generate electricity, but also uses waste heat from the combustion process to generate steam, which in turn is used to generate electricity. The end result is more electricity for every unit of fuel combusted. This combination of efficient technology and clean fuel results in very low emissions. See Figure 8, Relative Emission Rates (lbs/MWh) for Coal Plant vs. Natural Gas Combined Cycle Power Plant (based on 1996 and 1999 reports), on page 14.

Figure 8: Relative Emission Rates (lbs/MWh) for Coal Plant vs. Natural Gas Combined Cycle Power Plant (based on 1996 and 1999 reports)



Key

- Coal Plant
- Natural Gas Combined Cycle Power Plant

V. How Does the Federal Clean Air Act Regulate Power Plants?

A. Introduction

The federal Clean Air Act is one of the country's most complicated pieces of legislation. It is not so difficult to understand, however, if we break it up into pieces.

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The Clean Air Act also deals differently with different types of pollutants. So-called "criteria" pollutants are regulated separately from "hazardous air pollutants," or "air toxics." Recall that the "criteria pollutants" got that name because they are the ones for which EPA is required to establish air quality standards, or criteria. Carbon dioxide and the other greenhouse gases are still unregulated.

The legislation is so complicated not just because the sources and types of air pollution are so varied, but also because it has to address the fact that air pollution does not stay in one place. Prevailing winds blow from southwest to northeast. This means that New York City creates some of its own polluted air but, as we have discussed, also inherits some air pollution from other parts of the country, and sends some downwind.

Furthermore, in writing the Act, Congress divided responsibility for various types of sources and air pollutants between the states and the federal government. For the most part, the states and the federal government share responsibility for regulating criteria pollutants from stationary sources like power plants. The federal government has the lion's share of the burden for regulating air toxics and also for regulating mobile sources, although the states are free to adopt California's strict standards for mobile source emissions (as some have done), instead of following federal standards.

B. The Drivers: the National Ambient Air Quality Standards, or NAAQS

States, and often smaller areas, get classified in terms of how they stand in achieving the national standards for each criteria pollutant.

The whole scheme of air pollution regulation rides on the National Ambient Air Quality Standards, or NAAQS (pronounced *"nax"*).

EPA sets National Ambient Air Quality Standards, or NAAQS, for the six air pollutants that in its judgment pose especially serious problems for public health or welfare. These so-called "criteria" pollutants are ground-level ozone (regulated mainly through the regulation of oxides of nitrogen), nitrogen dioxide, carbon monoxide, particulate matter, sulfur dioxide, and lead.

States, and often smaller areas, get classified in terms of how they stand in achieving the national standards for each criteria pollutant. (Recall that as of winter 2001 the U.S. Supreme Court currently has before it a case challenging EPA's tightened national standards for both ozone and particulates.)

Areas are designated as "nonattainment" (they fail to meet the standards), "attainment" (they meet the standards), or "unclassifiable" (not enough information to tell).

Monitors throughout the country measure the concentrations of these pollutants in the air, to determine if the area complies with the standard. Areas are designated as "nonattainment" (they fail to meet the standards), "attainment" (they meet the standards), or "unclassifiable" (not enough information to tell). The classification scheme has additional levels of complexity. For example, areas that are in nonattainment for ozone are classified as marginal, moderate, serious, severe, or extreme. As the classification increases in severity, a more stringent set of air pollution controls is required of local sources, but with more time provided to meet the standard.

C. The NAAQS Made Real: State Implementation Plans

The Clean Air Act requires states to write plans, called State

Implementation Plans, or SIPs, that indicate how they will achieve each of the National Ambient Air Quality Standards. The stringency of air pollution controls that states have to impose in their Plans depends, as we have noted, on whether the area in question is classified as nonattainment or attainment and, for nonattainment areas, the degree of nonattainment.

State Implementation Plans must also contain provisions limiting "transport." SIPs must contain provisions prohibiting their own local sources from emitting so much air pollution downwind that *other* states are unable to meet or maintain national air pollution standards.

EPA, which is the chief federal environmental agency, sets the standards for the criteria pollutants. The state's Implementation Plan is adopted as state regulations.

D. Further Implementation: Permits

Individual *stationary* sources of air pollution, like factories and power plants, implement the State Implementation Plans through operating permits, issued by the state. A permit sets specific emission limits for the source, for various pollutants. Permits last for five years. They are intended to collect in one document all of the pollution control, operating, emission, monitoring, reporting and certification requirements for a facility.

E. The Division of Responsibility: State v*ersus* Federal

EPA, which is the chief federal environmental agency, sets the standards for the criteria pollutants. The state's Implementation Plan is adopted as state regulations; however, once EPA approves the Plan, it also becomes enforceable as federal regulations. If a state fails to submit a Plan, or submits one that is insufficient in some way, EPA can impose sanctions on the state (like loss of federal highway subsidies), or write its own plan (known as a Federal Implementation Plan, or FIP).

State Implementation Plans mainly address how the states will regulate their *stationary* sources, through measures like emissions limitations. In contrast, the federal government writes most of the rules governing *mobile* sources.

The Clean Air Act also provides that the governor of each state makes the attainment/nonattainment determinations in the first instance, but EPA can change them, or make them if the governor fails to do so. Similarly, states develop operating permit programs, but EPA approves or disapproves them. States issue the operating permits, subject to their approval by EPA.

State Implementation Plans mainly address how the states will regulate their *stationary* sources, through measures like emissions limitations. In contrast, the federal government writes most of the rules governing *mobile* sources, in order to avoid automobile and truck manufactures having to make different products for different states.

F. A Separate Regulatory Scheme: Hazardous Air Pollutants or Air Toxics

So far we have discussed the regulatory apparatus for criteria air pollutants. The Clean Air Act regulates hazardous air pollutants, or air toxics, separately. The Act specifies 188 of such chemicals that are known to present or suspected of presenting a threat of adverse human health or environmental effects. It directs EPA to identify the categories of sources that emit these pollutants, and then to develop technology-based *national emissions standards* for each of the categories. These standards are based on the maximum reduction of emissions possible through application of technologies or work practices. Note that this is an entirely different approach to regulation from that embodied in the National Ambient Air Quality/State Implementation Plan approach to criteria air pollutants. The approach to criteria pollutants combines the state/federal role, and is based on the degree of protection needed rather than on the technologies that are available.

Although this is the Act's general approach to air toxics, it takes a different course with respect to air toxics from electric generators. Instead, Congress required EPA to study the potential hazards from utility air toxics, and to determine whether it is necessary to pass regulations. EPA has conducted this study, as well as another required study on mercury from all sources, and has concluded that mercury is the air toxic of most serious concern. The National Academy of Sciences has endorsed EPA's view. (As Figure 6, "Emissions from Electric Generation, by Fuel Source," indicates, almost all mercury from electric generation is attributable to coal.) In December 2000 the Agency published its conclusion that hazardous air pollutants emitted by electric generators, including mercury, warrant control. EPA anticipates proposing hazardous air pollutant emission reduction requirements for electric generators by December 2003.

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G. Another Overlay of Regulation: the Acid Rain Program

The National Ambient Air Quality Standards are the main drivers in terms of regulating power plants and other sources. The Acid Rain Program, however, is a parallel scheme of regulation, *only for power plants*. The Program addresses two of the criteria pollutants that are also the subject of the NAAQS: sulfur dioxide and oxides of nitrogen. As its name indicates, it is specifically aimed at reducing acid deposition, or acid rain, which results when these pollutants react in the atmosphere to form sulfuric and nitric acids. Acidified precipitation, as we have discussed, causes damage to lakes, forests and other ecosystems.

"Allowance trading" is a major innovation of the Acid Rain Program. Since the Acid Rain Program introduced trading, it has been used in a number of other environmental programs. With a national cap in place on sulfur dioxide emissions from electric generating units, these units are allocated allowances, with each allowance permitting the emission of one ton of sulfur dioxide during or after a specified year. The electric generator can use each allowance to emit a ton of sulfur dioxide or, if it is more practical for it to limit its emissions (for example, by switching to a less polluting fuel or putting on emissions control technology), it can do so and trade its allowances. No matter how many allowances a generator holds, however, it may not emit at levels that would violate the Implementation Plan of the state in which it is located.

VI. More on the Federal Clean Air Act and on New York Requirements: How Does the Act Treat Old and New Power Plants Differently?

The Clean Air Act regulates new power plants much more strictly than old ones, with enormous resulting differentials in emissions.

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The acid rain requirements of the Act, which we have discussed in the prior section, apply to all power plants, old and new. But old power plants—that is, those built prior to 1971—are subject to fewer other federal regulations than the newer ones are. For this reason, the Clean Air Act is often said to "grandfather" older power plants. Since many power plants were built in the 1950's and 1960's, this grandfathering effect poses serious air pollution problems. For example, older plants generally emit ten to 40 times more oxides of nitrogen than new facilities.

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The term "grandfathering" usually refers to an exemption from regulation for entities that existed prior to a new enactment, whatever that may be. It is something of a misnomer, in the Clean Air Act context, for two separate reasons. First, a number of federal Clean Air Act requirements do indeed apply to older plants. Second, a state may choose to regulate even the older plants in drafting its State Implementation Plan, in order to allow the state to meet the National Ambient Air Quality Standards. In fact, New York and certain other northeastern states have done just that, and as a result the older power plants in this part of the country are cleaner than those in the Midwest, although not as clean as they would be required to be if they were new.

New power plants are subject to stringent air pollution standards—just how stringent, depends on whether they are located in attainment or nonattainment areas for the criteria pollutants, and the degree of severity of the nonattainment (a classification scheme we have discussed above). New York City is in "severe" nonattainment for ozone, the next to the worst grade out of five. New plants located in attainment areas are subject to BACT (best available control technology); in nonattainment areas, to LAER (lowest achievable emission rate). The key difference between BACT and LAER standards is that BACT takes into account the economic impact of the technology; LAER does not.

New plants in nonattainment areas are subject to another important requirement. They must assure emissions reductions that would not otherwise be required, in order to "offset" the additions in air pollution that they cause. Offsets, as they are called, can come from the installation of advanced controls producing extra emission reductions, or from the shutdown of existing sources. Offsets are meant to guarantee that there is a greater reduction than increase in air pollution. The required offset ratio is dependent upon the degree of nonattainment of the area where the plant is located. For example, in a marginal ozone nonattainment area, the increase in emissions of oxides of nitrogen and the offset reductions must be related in a 1.1-to-1 ratio; in severe areas, the ratio is 1.3-to-1.

New power plants may benefit the environment for one final additional reason. The electricity grid is managed such that plants that are less expensive to run go on-line before the more expensive ones do. Therefore, when cleaner, more efficient plants (often the new ones) operate at a lower cost than higher-emitting, less efficient facilities, at least in theory the cleaner plants should "displace" the more polluting facilities. Differences of opinion exist as to the extent to which displacement will actually occur.

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Glossary

Acid Rain Program

A federal Clean Air Act Program, directed only at power plants, designed to reduce acid deposition by reducing emissions of sulfur dioxide and oxides of nitrogen. The Program puts in place a cap for sulfur dioxide, and establishes *allowance trading* for sulfur dioxide; neither is applicable to oxides of nitrogen.

Allowance trading

A market-based system first established by the federal Clean Air

Act's Acid Rain Program. Power plants are allocated "emissions allowances" for sulfur dioxide, that require them to reduce their emissions or acquire allowances from other companies to achieve compliance.

Attainment/nonattainment

Classification scheme that refers to whether areas meet or fail to meet *National Ambient Air Quality Standards*.

BACT (Best Available Control Technology)

The pollutant control technology standard for new facilities located in attainment areas. This standard takes cost into account. "Best available" refers to the standard that is generally in use in new construction. Compare *LAER (Lowest Available Emission Rate)*.

Criteria pollutants

EPA's list of air pollutants that in its judgment pose especially serious problems for public health or welfare. These are the pollutants for which *National Ambient Air Quality Standards* are set. Currently on the list are ozone, carbon monoxide, particulate matter, sulfur dioxide, nitrogen dioxide and lead.

Displacement

The electricity grid is managed such that the plants that are least expensive to run go on-line before the most expensive ones do. Although there is some disagreement on this point, when cleaner, more efficient plants operate at a lower cost than dirtier, less efficient facilities, the cleaner plants will arguably "displace" the dirtier facilities.

Eutrophication

Nutrient enrichment problem attributable to oxides of nitrogen, mainly in eastern coastal waters. It causes fish kills, red and brown tides, toxic algae and plankton blooms that affect shellfish and coral communities.

Hazardous air pollutants or air toxics

Congress' list (i.e., contained in the federal Clean Air Act itself, rather than compiled by EPA) of 188 air pollutants that present a threat of adverse human health or environmental effects. The Act directs EPA to develop categories of sources that emit these pollutants, and technology-based emissions standards for each of the categories. These standards are based on the best available control technologies or work practices. Compare the definition of *National Ambient Air Quality Standards*.

LAER (Lowest Achievable Emissions Rate)

The technology applicable to new plants in nonattainment areas, which does not factor in cost considerations. The LAER standard is more stringent than *BACT (Best Available Control Technology)*.

Mobile source

Non-stationary sources of air pollutants, like cars, trucks, airplanes and trains.

National Ambient Air Quality Standards (NAAQS)

The standards that EPA sets for the "*criteria pollutants*." "Primary" standards are set to protect the public health; "secondary" standards protect the public welfare. Unlike the standards for hazardous air pollutants, the NAAQS are not based on the technologies that are available but, rather, on the degree of protection needed. The approach reflects the view that technologies and other solutions will be developed in order to reach the standards.

Offsets

The emissions reductions that new plants in nonattainment areas must assure, to offset the additional air pollution that they cause. The required offset ratio depends upon the degree of nonattainment in the area where the plant is located.

New plants in nonattainment areas are subject to an important additional requirement. They must assure emissions reductions that would not otherwise be required, to "offset" the additions in air pollution. Offsets, as they are called, can come from the installation of advanced controls producing extra emissions in reductions, or from the shutdown of existing sources. Offsets are meant to guarantee that there is a greater reduction of than increase in air pollution. The required offset ratio is dependent upon the degree of nonattainment of the area where the plant is located.

Ozone

Ozone is one of the *criteria pollutants*, and is one of the major components of smog. At ground-level it is dangerous to human health and the environment. In the stratosphere, it is beneficial, because it filters the sun's ultraviolet rays. It is regulated mainly through the regulation of oxides of nitrogen and, to a lesser extent, by the regulation of substances known as "volatile organic compounds."

State Implementation Plans (SIPs)

The plans that states must develop that indicate how they will achieve each of the *National Ambient Air Quality Standards*.

Stationary source

Any building or structure that emits any air pollutant, like factories, power plants, or smaller-sized businesses such as dry cleaners and gas stations. To be contrasted with *mobile source*.

Transport

Conveyance of pollution from southwest to northeast, on account of the direction of the prevailing winds.

Volatile organic compounds

Chemicals that react with nitrogen oxides in the presence of sunlight to form ozone.

Sources

Figure 1: NO_x, SO_2, and PM: U.S. EPA Emissions Trends Database 1998. Mercury: 1993 NTI Version 9801 U.S. County Emissions Data for Mercury & Compounds. CO_2: 1997 EPA Global Warming Website, http://www.epa.gov/globalwarming/index.html.

Figure 2: NO_x, SO_x, and PM: U.S. EPA Emissions Trends Database 1998. Mercury: U.S. EPA, "Mercury Report to Congress", 1997. CO_2: 1994-5 Inventory of U.S. Greenhouse Gas Emissions and Sinks.

Figure 3: New York Power Pool, "1999 Load and Capacity Data." July 1, 1999.

Figure 4: Department of Energy, Energy Information Administration, Form EIA-759, "Monthly Power Plant Report," 1999.

Figure 5: Department of Energy, Energy Information Administration, Form EIA-759, "Monthly Power Plant Report;" Form EIA-867, "Annual Nonutility Power Producer Report," 1999.

Figure 6: NO_x, SO_x, and PM: U.S. EPA Emissions Trends Database 1998. Mercury: U.S. EPA, "Mercury Report to Congress," 1997. CO_2: 1994-5 Inventory of U.S. Greenhouse Gas Emissions and Sinks.

Figure 7: NO_x, SO_2, and CO_2: Department of Energy, Energy Information Administration, Form EIA-767, 1998. Emissions are estimated based on reported fuel consumption data and activity levels, as well as U.S. EPA AP-42 emission factors. All power plants in the eastern U.S. (i.e., east of the Mississippi) were aggregated to calculate average emission rates. Mercury: average emission factors reported by the Electric Power Research Institute (EPRI) for coal, oil, and gas. PM: STAPPA/ALAPCO, "Controlling PM under the Clean Air Act: A Menu of Options," July 1996, page 145 and personal correspondence with Joe Miakisz, M.J. Bradley & Associates, October 4, 2000.

Figure 8: For coal plant, analysis assumes 30 percent efficiency, heat rate of 11,373 BTU/KWh. NO_x, SO_2 and CO_2 emission rates from STAPPA/ALAPCO, "Reducing Greenhouse Gases and Air Pollution: A Menu of Harmonized Options," October 1999, page 31. Mercury emission rate average emission factors reported by the Electric Power Research Institute (EPRI) for coal. PM emission rate: personal correspondence with Joe Miakisz, M.J. Bradley & Associates, October 4, 2000. Assuming natural gas-fired combined cycle plant with selective catalytic reduction and combustion controls. For natural gas combined cycle power plant, analysis assumes 50 percent efficiency, heat rate of 6,825 BTU/KWh. NO_x and CO_2 emission rates from STAPPA/ALAPCO, "Reducing Greenhouse Gases and Air Pollution: A Menu of Harmonized Options," October 1999, page 36. SO_2 emission rates as reported by American Gas Association www.aga.org. PM emission rates from STAPPA/ALAPCO, "Controlling PM under the Clean Air Act: A Menu of Options," July 1996, page 145. Mercury emission rate average emission factors reported by the Electric Power Research Institute (EPRI) for natural gas.