



Switch Reliable Energy from Renewable Sources

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## Air Pollution

### What is air pollution?

Air pollution or emissions refers to gases and particles that are put into the air or emitted by various sources. Air pollution is a major problem on the east and west coasts of the US, where a large proportion of the population lives. A significant share of these pollutants comes from centralized power plants. Energy generated from renewable resources, because it produces little or no air pollution and because it displaces fossil fuel-based energy systems that do pollute, represents a powerful antidote to the growing air pollution problem in the US.

The amounts and types of emissions change every year. These changes are caused by changes in the nation's economy, industrial activity, technology improvements, traffic, and by many other factors. Air pollution regulations and emission controls also have an effect.

The United States Environmental Protection Agency (EPA) is mainly concerned with emissions which are or could be harmful to people. EPA calls this set of principal air pollutants, [criteria pollutants](#):

- **Carbon monoxide (CO):** Carbon monoxide is a colorless and odorless gas, formed when carbon in fuel is not burned completely,
- **Lead (Pb),**
- **Nitrogen dioxide (NO<sub>2</sub>):** Nitrogen dioxide is a reddish brown, highly reactive gas that is formed in the ambient air through the oxidation of nitric oxide (NO). Nitrogen oxides (NO<sub>x</sub>), the generic term for a group of highly reactive gases that contain nitrogen and oxygen in varying amounts, play a major role in the formation of ozone, PM, haze, and acid rain,
- **Ozone (O<sub>3</sub>):** Ozone is an odorless, colorless gas composed of three atoms of oxygen. **Bad Ozone.** In the Earth's lower atmosphere, near ground level, ozone is formed when pollutants emitted by cars, power plants, industrial boilers, refineries, chemical plants, and other sources react chemically in the presence of sunlight,
- **Particulate matter (PM):** PM can be directly emitted, or it can be formed when emissions of nitrogen oxides (NO<sub>x</sub>), sulfur oxides (SO<sub>x</sub>), ammonia, organic compounds, and other gases react in the atmosphere, and
- **Sulfur dioxide (SO<sub>2</sub>):** Sulfur dioxide belongs to the family of SO<sub>x</sub> gases. These gases are formed when fuel containing sulfur (mainly coal and oil) is burned at power plants and during metal smelting and other industrial processes.

There are also a large number of compounds, which have been determined to be hazardous which are called [air toxics](#). Toxic air pollutants, also known as hazardous air pollutants, are those pollutants that are known or suspected to cause cancer or other serious health effects, such as reproductive effects or birth defects, or adverse environmental effects. EPA is working with state, local, and tribal governments to reduce air toxics releases of [188 pollutants](#) to the environment. Examples of toxic air pollutants include benzene, which is found in gasoline; perchlorethylene, which is emitted from some dry cleaning facilities; and methylene chloride, which is used as a solvent and paint stripper by a number of industries. Examples of other listed air toxics include dioxin, asbestos, toluene, and metals such as cadmium, mercury, chromium, and lead compounds.



## **What is the potential harm caused by pollutants?**

***Carbon monoxide poisoning:*** CO enters the bloodstream through the lungs and reduces oxygen delivery to the body's organs and tissues. The health threat from levels of CO sometimes found in the ambient air is most serious for those who suffer from cardiovascular disease such as angina pectoris.

***Nitrogen dioxide:*** NO<sub>x</sub> contribute to a wide range of environmental effects directly and when combined with other precursors in acid rain and ozone. Increased nitrogen inputs to terrestrial and wetland systems can lead to changes in plant species composition and diversity. Similarly, direct nitrogen inputs to aquatic ecosystems such as those found in estuarine and coastal waters (e.g., Chesapeake Bay) can lead to eutrophication (a condition that promotes excessive algae growth, which can lead to a severe depletion of dissolved oxygen and increased levels of toxins harmful to aquatic life). Nitrogen, alone or in acid rain, also can acidify soils and surface waters. Acidification of soils causes the loss of essential plant nutrients and increased levels of soluble aluminum that are toxic to plants. Acidification of surface waters creates conditions of low pH and levels of aluminum that are toxic to fish and other aquatic organisms. NO<sub>x</sub> also contribute to visibility impairment.

The direct effects on human health are equally significant. Short-term exposures (e.g., less than 3 hours) to low levels of NO<sub>2</sub> may lead to changes in airway responsiveness and lung function in individuals with preexisting respiratory illnesses. These exposures may also increase respiratory illnesses in children. Long-term exposures to NO<sub>2</sub> may lead to increased susceptibility to respiratory infection and may cause irreversible alterations in lung structure.

NO<sub>x</sub> react in the air to form ground-level ozone and fine particle pollution, which are associated with adverse health effects.

***Sulfur dioxide:*** High concentrations of SO<sub>2</sub> can result in temporary breathing impairment for asthmatic children and adults who are active outdoors. Short-term exposures of asthmatic individuals to elevated SO<sub>2</sub> levels during moderate activity may result in breathing difficulties that can be accompanied by symptoms such as wheezing, chest tightness, or shortness of breath. Other effects that have been associated with longer-term exposures to high concentrations of SO<sub>2</sub>, in conjunction with high levels of PM, include aggravation of existing cardiovascular disease, respiratory illness, and alterations in the lungs' defenses.

Together, SO<sub>2</sub> and NO<sub>x</sub> are the major precursors to acidic deposition (acid rain). SO<sub>2</sub> also is a major precursor to PM<sub>2.5</sub>, which is a significant health concern, and a main contributor to poor visibility.

***Ozone (ground-level):*** Most people only have to worry about ozone exposure when ground-level concentrations reach high levels. In many U.S. communities, this can happen frequently during the summer months. Scientists have found that about one out of every three people in the United States is at a higher risk of experiencing ozone-related health effects.

Scientists have found that ozone can cause several types of short-term health effects in the lungs:

- Ozone can irritate the respiratory system.
- Ozone can reduce lung function.
- Ozone can aggravate asthma.
- Ozone can inflame and damage the lining of the lung.



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Scientists suspect that ozone may have other effects on people's health. Ozone may aggravate chronic lung diseases, such as emphysema and bronchitis. Also, studies in animals suggest that ozone may reduce the immune system's ability to fight off bacterial infections in the respiratory system.

Most of these effects are considered to be short-term effects because they eventually cease once the individual is no longer exposed to elevated levels of ozone. However, scientists are concerned that repeated short-term damage from ozone exposure may permanently injure the lung.

Four groups of people are particularly sensitive to ozone:

- Children. Active children are the group at highest risk from ozone exposure.
- Adults who are active outdoors.
- People with respiratory diseases, such as asthma, and
- People with unusual susceptibility to ozone.

**Smog:** Smog is the brownish haze that pollutes our air, particularly over cities in the summertime. Smog can make it difficult for some people to breathe and it greatly reduces how far we can see through the air.

The primary component of smog is ozone, a gas that is created when nitrogen oxides (NO<sub>x</sub>) react with other chemicals in the atmosphere, especially in strong sunlight. NO<sub>x</sub> is produced whenever we burn something, such as coal in a power plant or gasoline in a car's engine.

NO<sub>x</sub> can travel large distances before reacting to form ozone. For that reason, it creates regional pollution problems, rather than simply affecting the local area where it is emitted.

**Acid Rain:** "Acid rain" is a broad term used to describe several ways that acids fall out of the atmosphere. A more precise term is acid deposition, which has two parts: wet and dry.

Wet deposition refers to acidic rain, fog, and snow. As this acidic water flows over and through the ground, it affects a variety of plants and animals. Dry deposition refers to acidic gases and particles. About half of the acidity in the atmosphere falls back to earth through dry deposition. The wind blows these acidic particles and gases onto buildings, cars, homes, and trees. Dry deposited gases and particles can also be washed from trees and other surfaces by rainstorms. When that happens, the runoff water adds those acids to the acid rain, making the combination more acidic than the falling rain alone.

Prevailing winds blow the compounds that cause both wet and dry acid deposition across state and national borders, and sometimes over hundreds of miles.

Scientists discovered, and have confirmed, that sulfur dioxide (SO<sub>2</sub>) and nitrogen oxides (NO<sub>x</sub>) are the primary causes of acid rain. Acid rain occurs when these gases react in the atmosphere with water, oxygen, and other chemicals to form various acidic compounds. Sunlight increases the rate of most of these reactions.

Acid deposition has a variety of effects, including damage to forests and soils, fish and other living things, materials, and human health. Acid rain also reduces how far and how clearly we can see through the air. Acid rain causes acidification of lakes and streams and contributes to damage of trees at high elevations and many sensitive forest soils. In addition, acid rain accelerates the decay of building materials and paints, including irreplaceable buildings, statues, and sculptures that are part of our nation's cultural heritage. Prior to falling to the earth, SO<sub>2</sub> and NO<sub>x</sub> gases and their particulate matter derivatives, sulfates and nitrates, contribute to visibility degradation and harm public health.

The harm to people from acid rain is not direct. Acid rain looks, feels, and tastes just like clean rain. Walking in acid rain, or even swimming in an acid lake, is no more dangerous than walking or swimming in clean water. However, the pollutants that cause acid rain (sulfur dioxide (SO<sub>2</sub>) and nitrogen oxides (NO<sub>x</sub>)) also damage human health. These gases interact in the atmosphere to form fine sulfate and nitrate particles that can be transported long distances by winds and inhaled deep into people's lungs. Fine



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particles can also penetrate indoors. Many scientific studies have identified a relationship between elevated levels of fine particles and increased illness and premature death from heart and lung disorders, such as asthma and bronchitis.

**Regional Haze:** Regional haze is the "dirty-looking" air that prevents us from seeing clearly or very far through the air. It especially affects our enjoyment of national parks, such as the Grand Canyon and the Great Smoky Mountains. Sulfate particles, formed by the reaction of sulfur dioxide (SO<sub>2</sub>) from power plants and other sources in the atmosphere, account for 50 to 70 percent of the visibility reduction in the eastern part of the United States. Both sulfate and nitrate particles (resulting from nitrogen oxides emissions) affect visibility in the western U.S.

**Lead poisoning:** Exposure to lead occurs mainly through inhalation of air and ingestion of lead in food, water, soil, or dust. It accumulates in the blood, bones, and soft tissues and can adversely affect the kidneys, liver, nervous system, and other organs. Excessive exposure to lead may cause neurological impairments such as seizures, mental retardation, and behavioral disorders. Even at low doses, lead exposure is associated with damage to the nervous systems of fetuses and young children, resulting in learning deficits and lowered IQ. Recent studies also show that lead may be a factor in high blood pressure and subsequent heart disease. Lead can also be deposited on the leaves of plants, presenting a hazard to grazing animals and humans through ingestion.

**Climate change:** The Earth's climate is predicted to change because human activities are altering the chemical composition of the atmosphere through the buildup of greenhouse gases - primarily carbon dioxide, methane, and nitrous oxide. The heat-trapping property of these gases is undisputed. (For more details, see white paper on climate change.)

### **Where do the pollutants come from?**

**Acid Rain:** In the US, About 2/3 of all SO<sub>2</sub> and 1/4 of all NO<sub>x</sub> comes from electric power generation that relies on burning fossil fuels like coal.

**Carbon Monoxide:** CO is a component of motor vehicle exhaust, which contributes about 60 percent of all CO emissions nationwide. Nonroad vehicles account for the remaining CO emissions from transportation sources. High concentrations of CO generally occur in areas with heavy traffic congestion. In cities, as much as 95 percent of all CO emissions may come from automobile exhaust. Other sources of CO emissions include industrial processes, nontransportation fuel combustion, and natural sources such as wildfires. Peak CO concentrations typically occur during the colder months of the year when CO automotive emissions are greater and nighttime inversion conditions (where air pollutants are trapped near the ground beneath a layer of warm air) are more frequent.

**Ground level ozone:** Ground-level O<sub>3</sub> remains a pervasive pollution problem in the United States. Ozone is readily formed in the atmosphere by the reaction of VOCs and NO<sub>x</sub> in the presence of sunlight, which is most abundant in the summer. VOCs are emitted from a variety of sources, including motor vehicles, chemical plants, refineries, factories, consumer and commercial products, other industries, and natural (biogenic) sources. Nitrogen oxides (a precursor to ozone) are emitted from motor vehicles, power plants, and other sources of combustion, as well as natural sources including lightning and biological processes in soil.

**Lead:** In the past, automotive sources were the major contributor of lead emissions to the atmosphere. Today, industrial processes, primarily metals processing, are the major source of lead emissions to the atmosphere.



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**Particulate matter:** Sulfates, nitrates, and carbon compounds are the major constituents of fine particle pollution. Sulfates and nitrates form from atmospheric transformation of sulfur dioxide and nitrogen oxide gases. Carbon compounds can be directly emitted, or they can form in the atmosphere from organic vapors.

In the eastern half of the country:

- Regional pollution accounts for more than half of the measured PM<sub>2.5</sub>. This regional pollution comes from a variety of sources, including power plants, and can be transported hundreds of miles.
- Sulfates account for 25% to 55% of PM<sub>2.5</sub> levels. Sulfate levels are similar in urban and nearby rural areas. Power plants are the largest contributor to this sulfate formation.

In the Industrial Midwest, Northeast, and southern California, nitrates make up a large portion of PM<sub>2.5</sub>, especially in winter. Average nitrate concentrations in urban areas are generally higher than nearby rural levels. Power plants and highway vehicle emissions are large contributors to nitrate formation.

**Sulfur dioxide:** The highest monitored concentrations of SO<sub>2</sub> are recorded near large industrial facilities. Fuel combustion, largely from electricity generation, accounts for most of the total SO<sub>2</sub> emissions.

**Air toxics:** Most air toxics originate from man-made sources, including mobile sources (e.g., cars, trucks, construction equipment) and stationary sources (e.g., factories, refineries, power plants), as well as indoor sources (e.g., some building materials and cleaning solvents). Some air toxics are also released from natural sources such as volcanic eruptions and forest fires.

### **What are the most affected areas?**

As of September 2002, there were 124 classified nonattainment areas on the condensed nonattainment list. As the map below shows, most of the nonattainment areas are concentrated along the eastern seaboard, substantial portions of the mid-Atlantic region and the pacific cost of California. There were, as of September 2002, approximately 126 million people living in classified areas designated as nonattainment for at least one of the criteria pollutants.

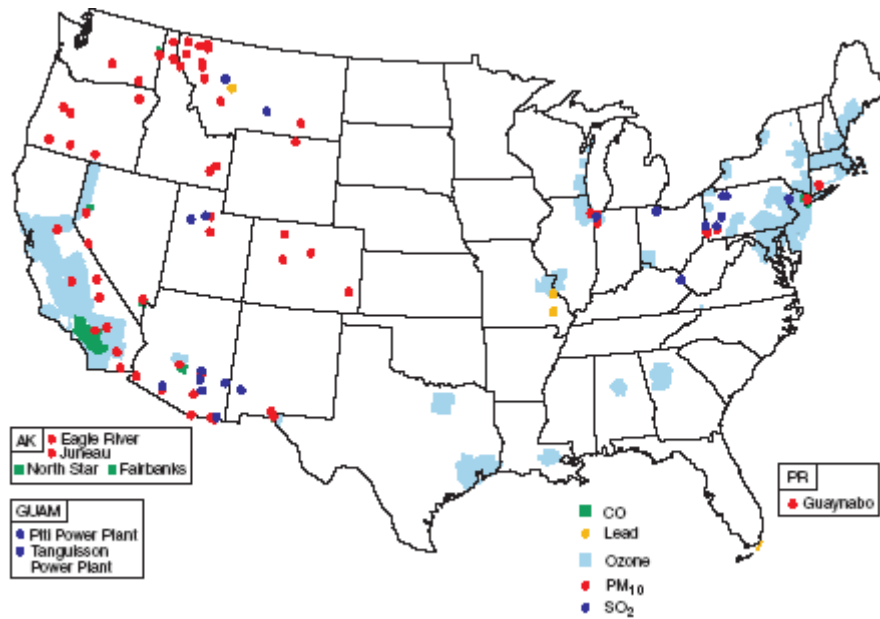
Figure 4-1. Location Of Nonattainment Areas For Criteria Pollutants, September 2002.



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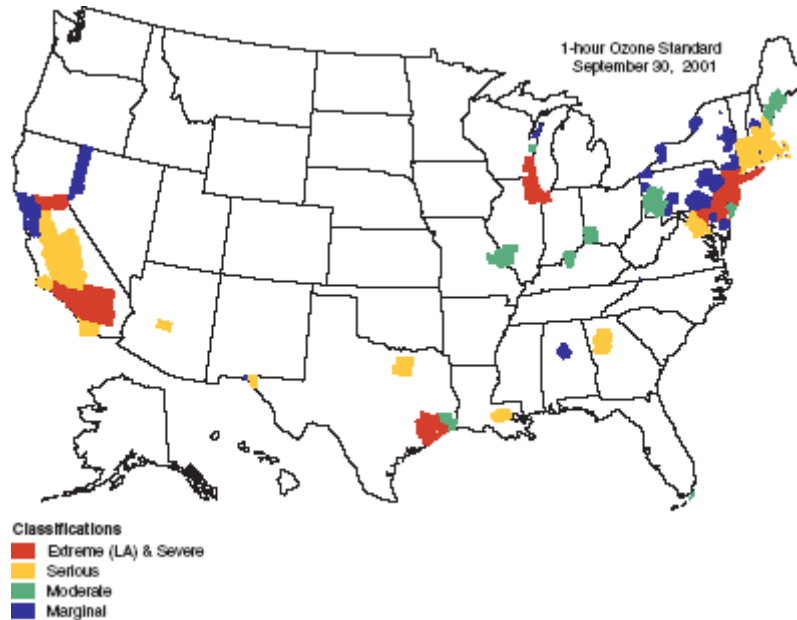
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**Note:** Incomplete data, not classified, and Section 185(A) areas are not shown.  
\*Ozone nonattainment areas on map are based on the 1-hour ozone standard.  
\*\*PM10 nonattainment areas on map are based on the existing PM10 standards.

Figure 4-2 below identifies the 1-hour ozone nonattainment areas classified by degree of severity.

Figure 4-2. Classified Ozone Nonattainment Areas.



**Note:** San Francisco is classified Other/Sec 185(A) and nonattainment areas with incomplete data are not included.