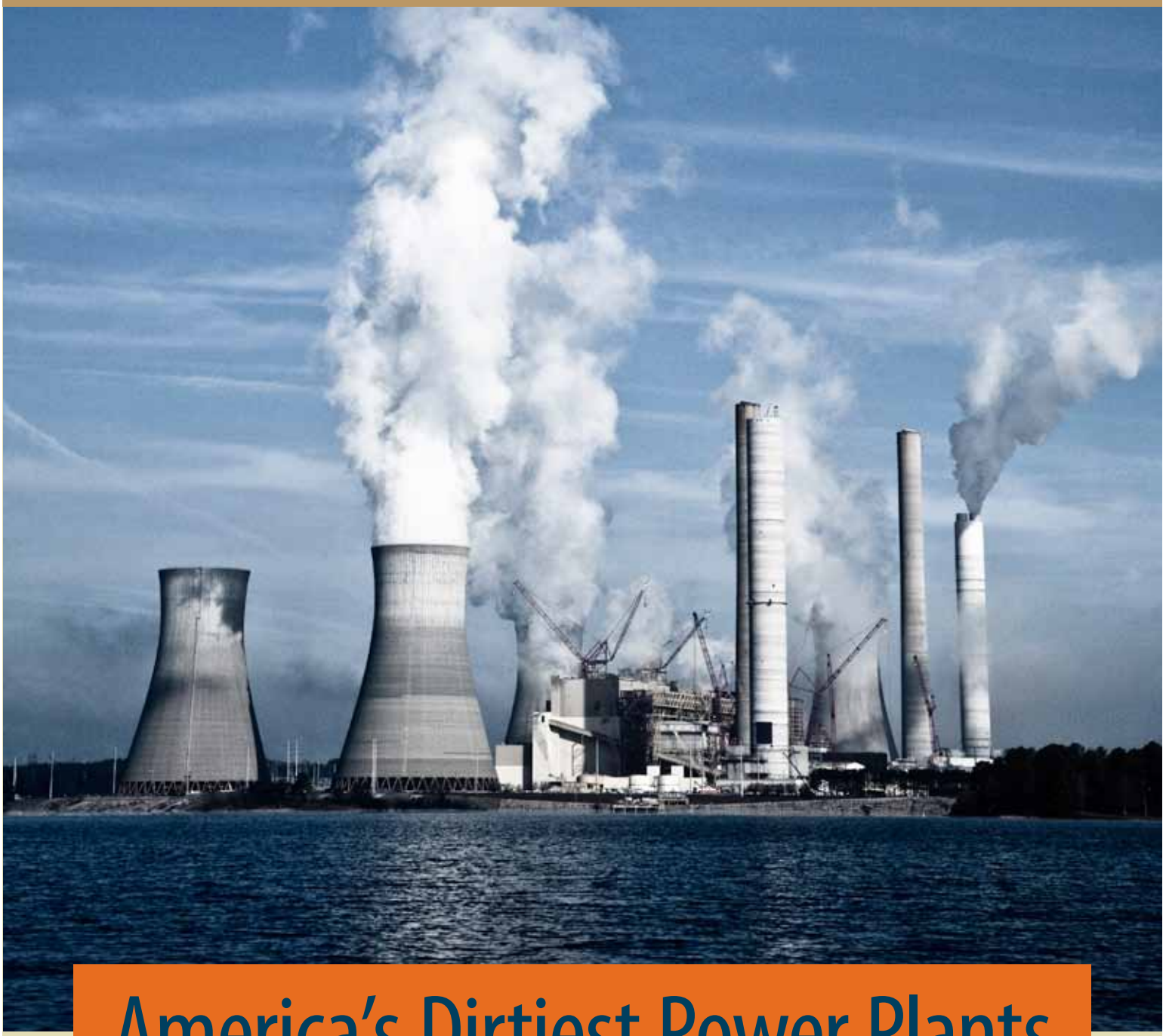

America's Dirtiest Power Plants

Their Oversized Contribution to Global Warming and What We Can Do About It

ENVIRONMENT MAINE
RESEARCH & POLICY CENTER

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Cover photo: Georgia Power Company's Plant Scherer in Juliette, Georgia, is the nation's most-polluting power plant. Each year, it emits more carbon dioxide pollution than that produced by energy consumption in Maine. See Table 1 in report.

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Cover design: Kathleen Krushas, To the Point Publications, www.tothepointpublications.com

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Executive Summary

Global warming is one of the most profound threats of our time, and we're already starting to feel the impacts – especially when it comes to extreme weather. From Hurricane Sandy to devastating droughts and deadly heat waves, extreme weather events threaten our safety, our health and our environment, and scientists predict things will only get worse for future generations unless we cut the dangerous global warming pollution that is fueling the problem. Power plants are the largest source of global warming pollution in the United States, responsible for 41 percent of the nation's production of carbon dioxide pollution, the leading greenhouse gas driving global warming.

America's power plants are among the most significant sources of carbon dioxide pollution in the world. **The 50 most-polluting U.S. power plants emit more than 2 percent of the world's energy-related carbon dioxide pollution – or more pollution than every nation except six worldwide.**

Despite their enormous contribution to global warming, U.S. power plants do not face any federal limits on carbon dioxide pollution. To protect our health, our safety and our environment from the worst impacts of global warming, the United States should clean up the dirtiest power plants.

A small handful of the dirtiest power plants produce a massive and disproportionate share of the nation's global warming pollution.

- In 2011, the U.S. power sector contributed 41 percent of all U.S. emissions of carbon dioxide, the leading pollutant driving global warming.
- There are nearly 6,000 electricity generating facilities in the United States, but most of the global warming pollution emitted by the U.S. power sector comes from a handful of exceptionally dirty power plants. For example, about 30 percent of all power-sector carbon dioxide emissions in 2011 came from the 50 dirtiest power plants; about half came from the 100 dirtiest plants; and about 90 percent came from the 500 dirtiest plants. (See Figure ES-1.)

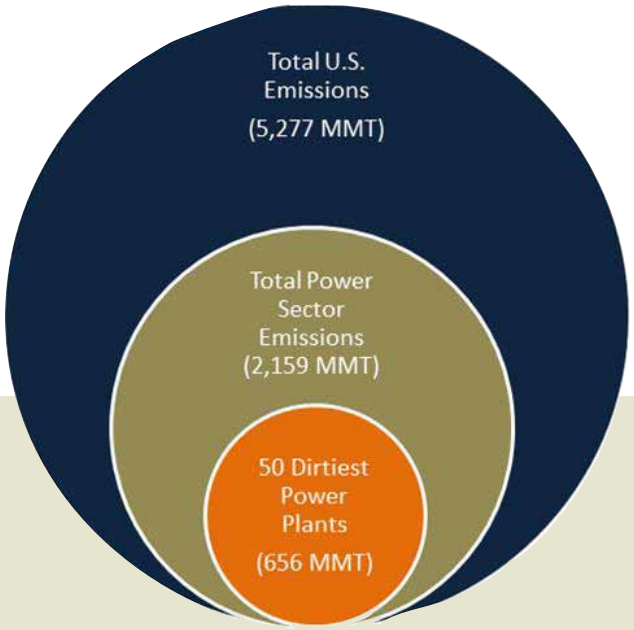


Figure ES-1. The 50 Dirtiest Power Plants Contribute Significantly to U.S. Carbon Dioxide Pollution (Million Metric Tons – MMT), 2011

- The dirtiest power plant in the United States, Georgia Power's Plant Scherer, produced more than 21 million metric tons of carbon dioxide in 2011 – more than the total energy-related emissions of Maine. (See Table ES-1.)
- Dirty power plants produce a disproportionate share of the nation's global warming pollution – especially given the relatively small share of total electricity they produce. For example, despite producing 30 percent of all power-sector carbon dioxide emissions, the 50 dirtiest power plants only produced 16 percent of the nation's electricity in 2011.

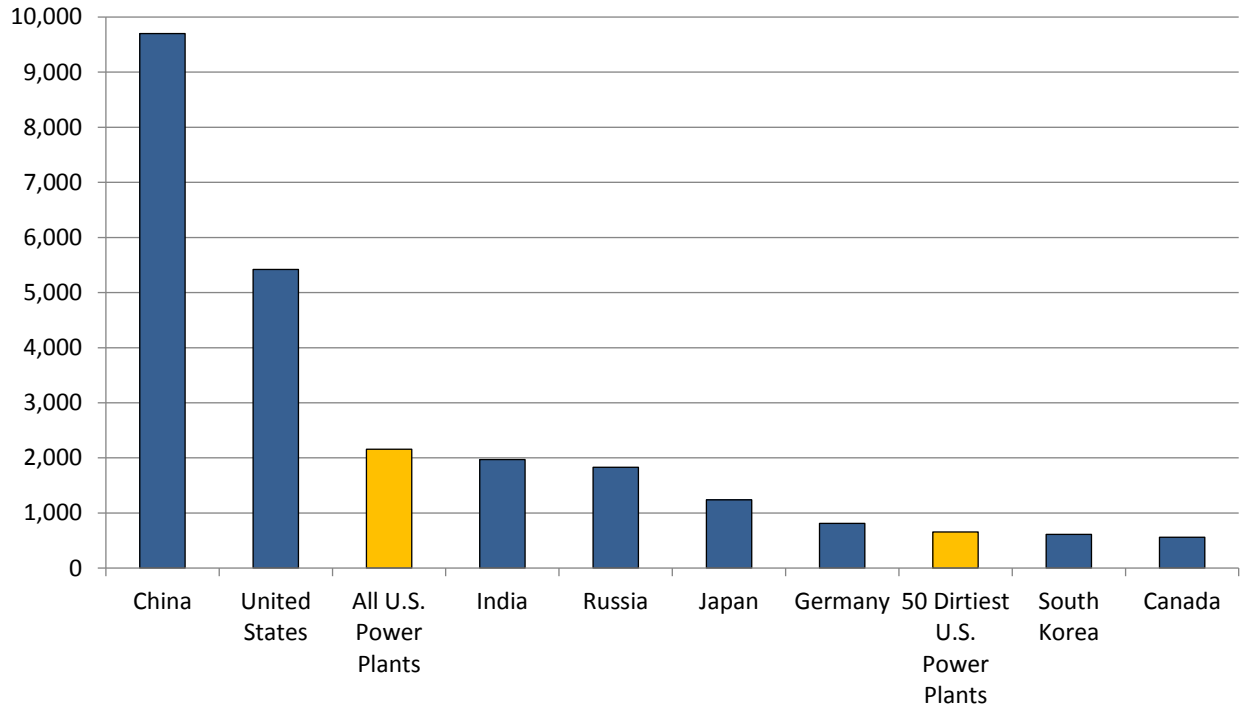
The dirtiest U.S. power plants are major sources of global warming pollution on a global scale.

- If the 50 most-polluting U.S. power plants were an independent nation, they would be the seventh-largest emitter of carbon dioxide in the world, behind Germany and ahead of South Korea. (See Figure ES-2.) These power plants emitted carbon dioxide pollution equivalent to more than half the emissions of all passenger vehicles in the United States in 2010.

Table ES-1. Emissions Equivalencies for the Nation's Top Emitters of Global Warming Pollution

	Total 2011 Emissions (Million Metric Tons of Carbon Dioxide)	Percent of Total U.S. Carbon Dioxide Emissions	Percent of Global Carbon Dioxide Emissions from Energy Use	These Plants Produce Carbon Dioxide Greater Than or Equivalent To…
Top Polluting Plant (Scherer Power Plant, GA)	21	0.4%	0.1%	• The total energy-related emissions of Maine • The pollution produced by electricity use in all New England homes in a year
Top 10 Polluting Power Plants	179	3.4%	0.5%	• The pollution emitted by all the passenger vehicles in New York and California • The total energy-related emissions of Venezuela
Top 50 Polluting Power Plants	656	12.4%	2.0%	• Half the emissions of all passenger vehicles in the United States • The total energy-related emissions of Texas
Top 100 Polluting Power Plants	1,052	19.9%	3.2%	• The emissions of all passenger vehicles in the United States • The pollution produced by electricity use in all U.S. homes in a year

Figure ES-2. Carbon Dioxide Pollution Emitted by the 50 Dirtiest Power Plants Compared to Other Countries (MMT CO_2)



- The 100 most-polluting U.S. power plants produced more than 3 percent of the world's carbon dioxide emissions from energy use in 2011, while the 500 most-polluting power plants were responsible for about 6 percent.

To protect our health, our safety, and our environment from the dangers of global warming, America must clean up polluting power plants.

- The Obama Administration should set strong limits on carbon dioxide pollution from new power plants to prevent the construction of a new generation of dirty power plants, and force existing power plants to clean up by setting strong limits on carbon dioxide emissions from all existing power plants.
  - New plants – The Environmental Protection Agency (EPA) should work to meet its September 2013 deadline for re-proposing a stringent emissions standard for new power plants. It should also set a deadline for finalizing these standards no later than June 2015.
  - Existing plants – The EPA should work to meet the timeline put forth by President Obama for proposing and finalizing emissions standards for existing power plants. This timeline calls for limits on existing plants to be proposed by June 2014 and finalized by June 2015. The standards should be based on the most recent climate science and designed to achieve the emissions reduction targets that are necessary to avoid the worst impacts of global warming.

In addition to cutting pollution from power plants, the United States should adopt a suite of clean energy policies at the local, state, and federal levels to curb emissions of carbon dioxide from energy use in other sectors.

In particular, the United States should prioritize establishing a comprehensive, national plan to reduce carbon pollution from all sources – including transportation, industrial activities, and the commercial and residential sectors.

Other policies to curb emissions include:

- Retrofitting three-quarters of America's homes and businesses for improved energy efficiency, and implementing strong building energy codes to dramatically reduce fossil fuel consumption in new homes and businesses.
- Adopting a federal renewable electricity standard that calls for 25 percent of America's electricity to come from clean, renewable sources by 2025.
- Strengthening and implementing state energy efficiency resource standards that require utilities to deliver energy efficiency improvements in homes, businesses and industries.
- Installing more than 200 gigawatts of solar panels and other forms of distributed renewable energy at residential, commercial and industrial buildings over the next two decades.
- Encouraging the use of energy-saving combined heat-and-power systems in industry.
- Facilitating the deployment of millions of plug-in vehicles that operate partly or solely on electricity, and adopting clean fuel standards that require a reduction in the carbon intensity of transportation fuels.
- Ensuring that the majority of new residential and commercial development in metropolitan areas takes place in compact, walkable communities with access to a range of transportation options.
- Expanding public transportation service to double ridership by 2030, encouraging further ridership increases through better transit service, and reducing per-mile global warming pollution from transit vehicles. The U.S. should also build high-speed rail lines in 11 high-priority corridors by 2030.
- Strengthening and expanding the Regional Greenhouse Gas Initiative, which limits carbon dioxide pollution from power plants in nine northeastern state, and implementing California's Global Warming Solutions Act (AB32), which places an economy-wide cap on the state's greenhouse gas emissions.

Introduction

It doesn't take a trip to the Arctic Circle to see evidence of global warming these days. The impacts of a warming planet are now appearing on our doorsteps, making headlines in the morning paper. The United States has seen much more than its usual share of extreme downpours and intense heat waves in recent years, and emerging science links the increase in frequency and severity of some of these events to global warming.[1] New research also shows that a warmer world is likely to exacerbate the impacts of extreme weather events, such as hurricanes, floods, drought and wildfires.[2] Many extreme weather events of 2012 foreshadow the kind of disruption global warming may cause in the future. From the late-season "superstorm" Hurricane Sandy wreaking havoc on the East Coast, to early-season wildfires destroying thousands of homes in the West, to year-round drought conditions parching the largest area of the continental U.S. since 1956, extreme weather events are occurring with increasing frequency and severity.[3]

Since 2007, federally declared weather-related disasters in the United States have affected counties housing 243 million people – or nearly four out of five Americans.[4] These events have caused billions of dollars in economic damage, have harmed our natural environment, and have jeopardized the lives of thousands of people. Climate science tells us that the impacts of these events will only worsen for future generations unless we immediately and dramatically reduce the dangerous carbon pollution that is fueling the problem. Meeting that challenge can seem overwhelming, and it's certainly not going to be easy. But the United States and the world can make a major down-payment toward those emission reductions by cleaning up our biggest sources of pollution.

In the case of the United States, that means power plants. As this report will show, a small number of dirty power plants make a massive and disproportionate contribution to the nation's global warming emissions. Cleaning up our existing power plants – and preventing construction of a new generation of dirty power plants – would make a significant difference in fighting global warming.

For the first time in history, the United States is preparing to take action to clean up these massive sources of carbon pollution. In 2012, the Environmental Protection Agency (EPA) issued the first-ever pollution standards for new power plants, and this summer President Obama directed the EPA to establish a standard for existing power plants by 2015.[5]

By finalizing strong carbon pollution standards for new and existing power plants, the U.S. will seize one of its best available opportunities to significantly reduce carbon pollution – helping to forestall the worst impacts of global warming for future generations.

Photo: Keith Syvinski

Indiana Michigan Power Company's coal-fired Rockport power plant in Spencer County, Indiana, is the 11th largest emitter of carbon dioxide pollution in the U.S. power sector. It produces global warming pollution equivalent to that produced by 3.2 million passenger vehicles in a year. See Table A-2 in Appendix.

By finalizing strong carbon pollution standards for new and existing power plants, the U.S. will seize one of its best available opportunities to significantly reduce carbon pollution – helping to forestall the worst impacts of global warming for future generations.

The Dirtiest U.S. Power Plants Are a Major Source of Global Warming Pollution

Carbon dioxide is the leading greenhouse gas driving global warming, and power plants are the largest source of carbon dioxide pollution in the United States.[6] Burning fossil fuels for electricity generation produced about 41 percent of total U.S. carbon dioxide emissions in 2011.[7] A disproportionate share of these power-sector carbon dioxide emissions come from a small subset of the nation's dirtiest power plants, particularly coal-fired power plants. However, despite their enormous contribution to global warming, U.S. power plants currently face no federal limits on carbon dioxide pollution. Cleaning up these dirty power plants with strong, nationwide pollution standards is one of the most important steps the U.S. can take to curb global warming pollution.

The 50 Dirtiest Power Plants Contribute a Massive and Disproportionate Share of Carbon Dioxide Emissions

There are nearly 6,000 electricity generating facilities in the United States, but most of the global warming pollution emitted by the U.S. power sector comes from a handful of exceptionally dirty power plants.[8] These dirty power plants also produce a disproportionately large amount of the nation's total global warming pollution. For example, just one of these dirty power plants, Georgia Power's Plant Scherer, produces more global warming pollution each year than all the energy-related emissions of Maine.[9]

- **In 2011, the 50 dirtiest U.S. power plants were responsible for 30 percent of all U.S. power-sector emissions of carbon dioxide, 12 percent of total U.S. energy-related emissions, and 2 percent of worldwide energy-related emissions**.[10] (See Figure 1.) If the 50 dirtiest power plants were an independent nation, they would be the seventh-largest emitter of carbon dioxide pollution in the world, behind Germany and ahead of South Korea.[11] (See Figure 2.) Their emissions in 2011 were greater than half the emissions of all passenger vehicles in the United States in 2010.[12] (See Table 1 for additional comparisons.)
- The 100 dirtiest plants were responsible for about half of total carbon dioxide emissions from the U.S. electricity sector in 2011, and more than 3 percent of total worldwide emissions from energy use.[13]
- The 500 dirtiest power plants were responsible for around 90 percent of total carbon dioxide emissions from the U.S. electricity sector, and about 6 percent of total worldwide emissions from energy use.[14]

Figure 1. The 50 Dirtiest Power Plants Contribute Significantly to U.S. Carbon Dioxide Emissions

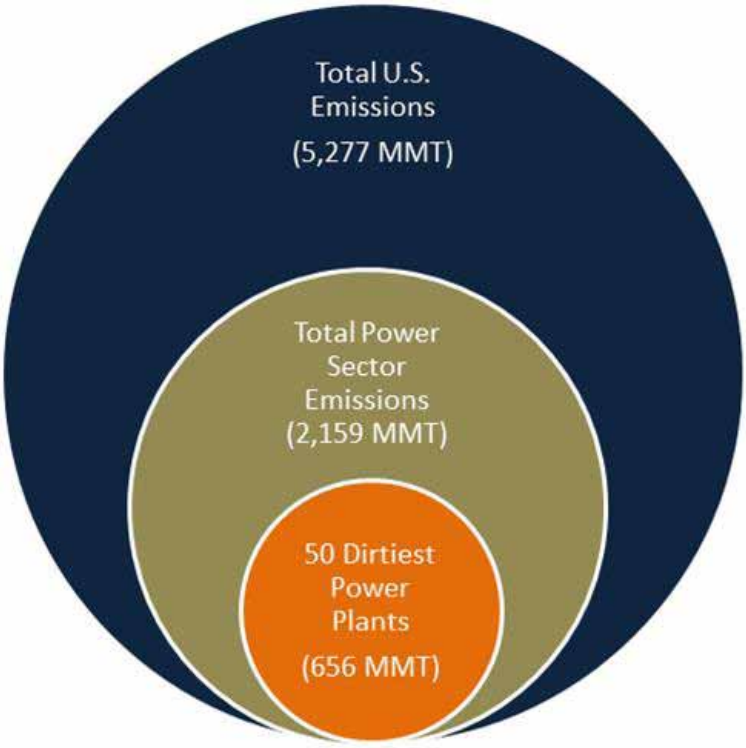


Figure 2. Carbon Dioxide (CO_2) Pollution Emitted by the 50 Dirtiest Power Plants Compared to CO_2 Pollution in Other Countries (MMT)

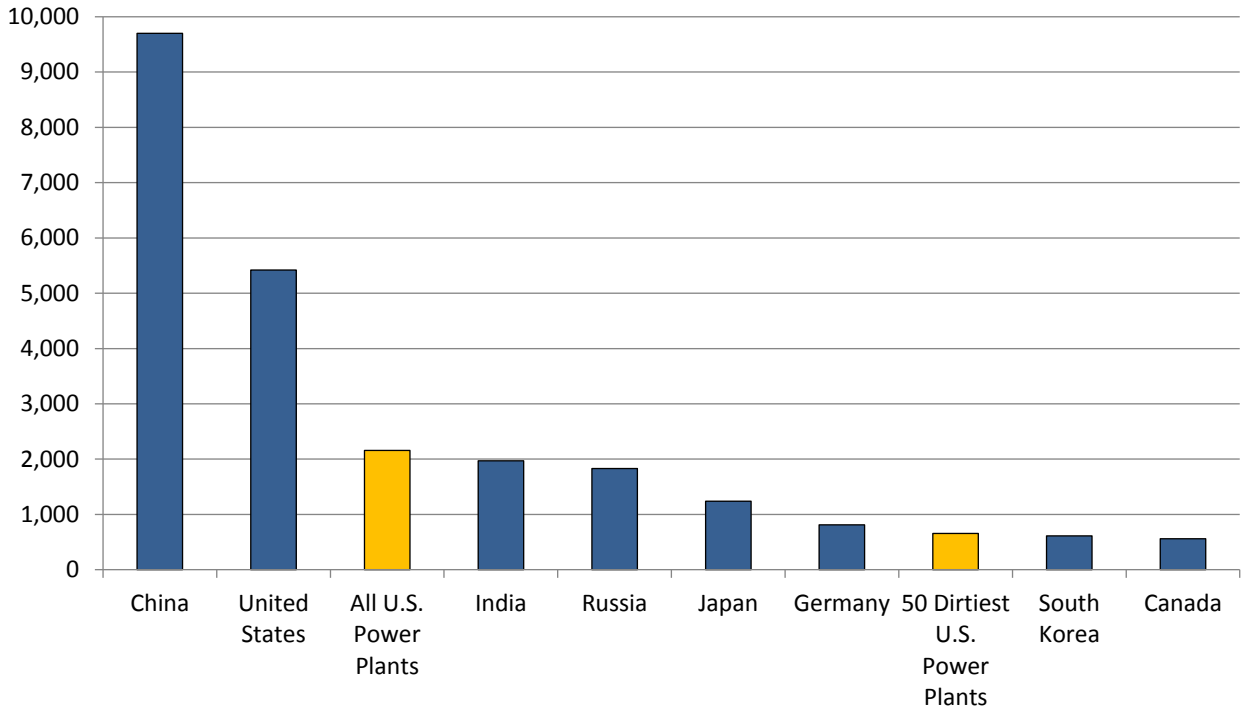


Table 1. Emissions Equivalencies for the Nation's Top Emitters of Global Warming Pollution[15]

	Total 2011 Emissions (Million Metric Tons of Carbon Dioxide)	Percent of Total U.S. Carbon Dioxide Emissions	Percent of Global Carbon Dioxide Emissions from Energy Use	These Plants Produce Carbon Dioxide Greater Than or Equivalent To…
Top Polluting Plant (Scherer Power Plant, GA)	21	0.4%	0.1%	• The total energy-related emissions of Maine[16] • The pollution produced by electricity use in all New England homes in a year[17]
Top 10 Polluting Power Plants	179	3.4%	0.5%	• The pollution emitted by all the passenger vehicles in New York and California[18] • The total energy-related emissions of Venezuela[19]
Top 50 Polluting Power Plants	656	12.4%	2.0%	• Half the emissions of all passenger vehicles in the United States[20] • The total energy-related emission of Texas[21]
Top 100 Polluting Power Plants	1,052	19.9%	3.2%	• The emissions of all passenger vehicles in the United States[22] • The pollution produced by electricity use in all U.S. homes in a year[23]

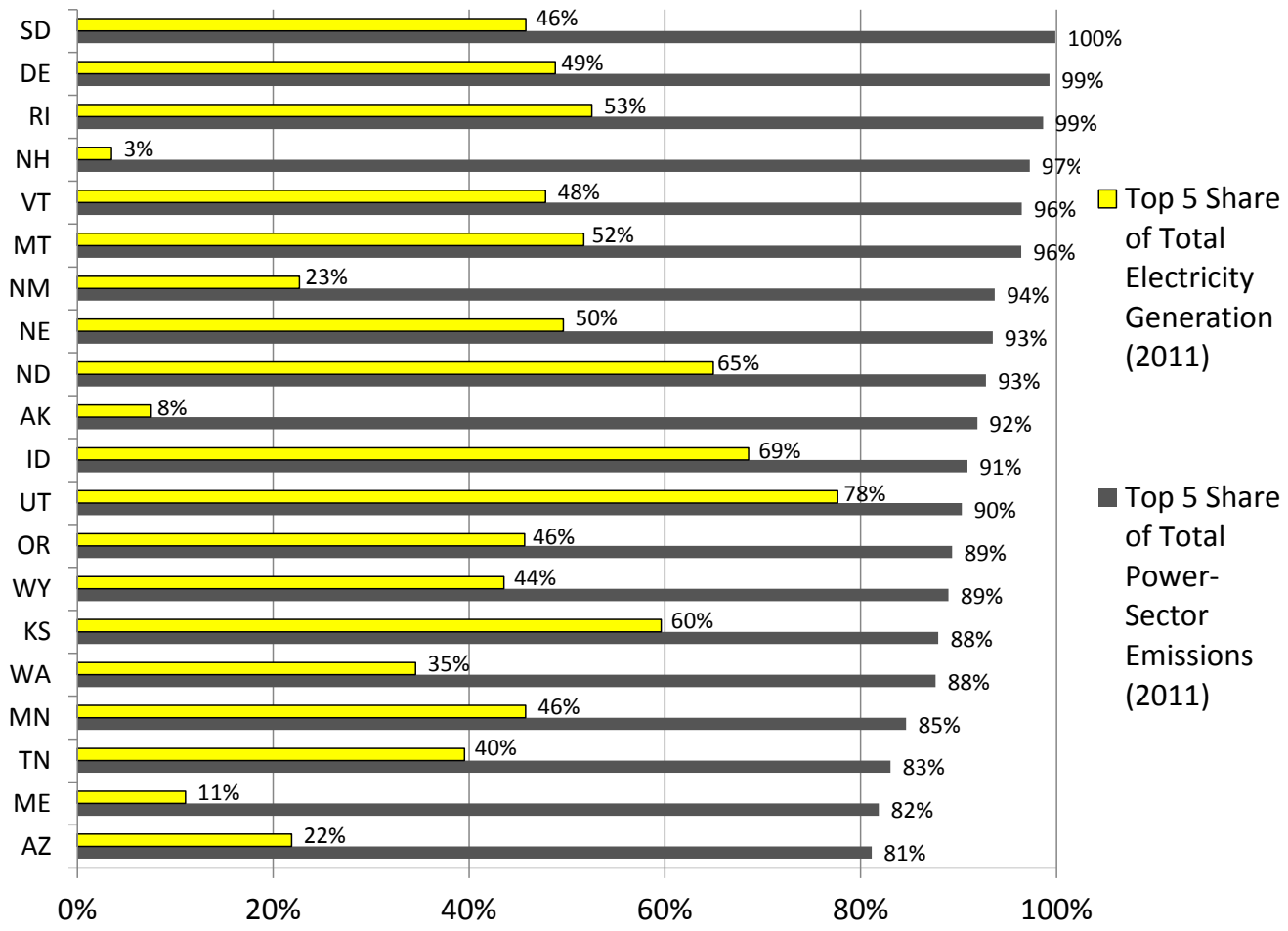
The Dirtiest Power Plants Are Old and Inefficient

Coal-fired power plants are among the biggest sources of carbon dioxide pollution in the electric power sector.[24] In fact, 98 of the nation's 100 most-polluting power plants in terms of total carbon dioxide emissions are coal plants; among the top 500, 317 (63 percent) are coal plants.[25] The remainder are older oil and gas-fired power plants. (See Table A-2 in Appendix).

Most of the nation's coal plants are old and inefficient. About 74 percent of U.S. coal plants were at least 30 years old at the end of 2012, and about half were 40 to 60 years old, according to the Energy Information Administration (EIA).[26] Coal plants are not designed to last much longer than 30 years, but coal companies routinely renovate these plants to extend their lifetimes.[27] Still, many of these plants are inefficient to operate, so power providers run them at only a fraction of their full capacity or for shorter periods of time, which results in a lower "capacity factor" (the ratio of a power plant's actual output compared to its full capacity) for the oldest and dirtiest plants. In 2009, the average capacity factor for the whole U.S. coal fleet was 64 percent, with about 40 percent reporting capacity factors below 30 percent.[28]

Although many coal plants today are underutilized because of their age and inefficiency, they remain

Figure 3. Share of Statewide Power-Sector Emissions vs. Share of Electricity Generation for Top 5 Emitters in 20 States[31]



among the worst contributors to global warming pollution. For example, coal-fired power plants were responsible for nearly 80 percent of the global warming pollution produced by electric power plants in 2011, even though they produced only 42 percent of the nation's electricity.[29] The 50 dirtiest plants produced 30 percent of all power-sector carbon dioxide emissions, but only 16 percent of electricity nationwide in 2011.[30] In some states, this imbalance is even more extreme. (See Figure 3.)

In some states, emissions from a handful of the dirtiest power plants can exceed emissions from the rest of the economy, including the industrial and transportation sectors. For example, in five states – Wyoming, Montana, North Dakota, West Virginia, and New Mexico – the five dirtiest power plants are responsible for about half of total statewide energy-related emissions; and in 31 states, these top polluters are responsible for at least one-quarter of statewide energy-related emissions. (See Table 2 and Table A-3 in the Appendix.)

Table 2. Emissions of Top 5 Polluting Plants as a Share of Power-Sector and Statewide Total Carbon Dioxide Emissions in 50 States, 2011[32]

State	Total Emissions of Top 5 Power Plants (Million Metric Tons of Carbon Dioxide)	Top 5 Share of Power-Sector Emissions (2011)	Top 5 Share of Total Emissions[33]
Wyoming	38.1	89%	59%
Montana	16.1	96%	55%
North Dakota	27.1	93%	52%
West Virginia	49.3	69%	52%
New Mexico	29.1	94%	50%
Utah	30.6	90%	49%
Arizona	43.0	81%	46%
Nebraska	24.7	93%	45%
Arkansas	32.0	92%	45%
Kansas	30.8	88%	41%
Alabama	48.1	63%	36%
Delaware	3.9	99%	36%
North Carolina	43.0	71%	36%
Missouri	50.1	62%	35%
Georgia	52.1	76%	34%
Iowa	29.7	75%	34%
Kentucky	50.4	54%	34%
South Carolina	26.3	70%	34%
Tennessee	34.4	83%	34%
Oklahoma	35.0	69%	32%
Hawaii	5.6	77%	31%
New Hampshire	4.9	97%	31%
Wisconsin	29.1	67%	29%
Maryland	18.6	80%	28%
Nevada	9.3	64%	28%
Colorado	26.2	67%	28%
Rhode Island	3.5	99%	28%
Michigan	42.8	64%	27%
Indiana	58.7	52%	27%
Minnesota	26.3	85%	27%
Mississippi	14.1	61%	25%
Ohio	54.7	50%	24%
South Dakota	2.9	100%	23%
Pennsylvania	55.7	48%	22%

Table 2. (continued)

State	Total Emissions of Top 5 Power Plants (Million Metric Tons of Carbon Dioxide)	Top 5 Share of Power-Sector Emissions (2011)	Top 5 Share of Total Emissions[33]
Oregon	5.9	89%	22%
Illinois	44.0	46%	19%
Virginia	16.8	60%	19%
Florida	41.7	37%	18%
Massachusetts	10.5	66%	16%
Connecticut	5.9	75%	16%
Washington	6.7	88%	15%
Louisiana	35.0	61%	12%
Maine	2.8	82%	11%
Texas	74.6	30%	10%
New Jersey	9.9	64%	10%
New York	11.0	32%	7%
Alaska	2.8	75%	6%
Idaho	0.4	91%	4%
California	7.5	19%	2%
Vermont	0.0	96%	0%

Despite the large contribution of fossil fuel-fired power plants to U.S. global warming emissions, neither these highly polluting plants nor proposed new power plants face any federal regulations limiting emissions of carbon dioxide or other greenhouse gases. As a result, these power plants have emitted carbon dioxide pollution unchecked for decades, and there is no guarantee that new power plants will be built in ways that minimize their contribution to global warming.

Cutting U.S. Power Plant Pollution Can Help Prevent the Worst Impacts of Global Warming

Global warming threatens our health, our safety, and our environment. Rising global average temperatures and other climate impacts have already resulted in extreme precipitation events and heat waves in the United States, and climate science tells us that global warming will likely lead to further changes in weather extremes.[34] Extreme weather events such as Hurricane Sandy, extended droughts, heat waves, and floods caused by heavy precipitation are likely to become more common in a warming world.[35] At the same time, global warming-induced sea-level rise, changes in summer and winter precipitation patterns, and ecosystem changes could reduce the ability of natural and man-made systems to withstand even normal weather events.

To avoid the worst impacts of global warming, worldwide emissions of carbon dioxide and other global warming pollutants will have to peak roughly three years from now, and then decline quickly and dramatically – dropping by more than 50 percent by 2050.[36] In the United States, addressing this challenge means cleaning up our biggest sources of global warming pollution – especially dirty power plants, which are responsible for more than 40 percent of our emissions of carbon dioxide each year.[37]

A handful of exceptionally dirty power plants are the worst contributors to this problem. By focusing on cleaning up power plants – our country's largest single source of carbon pollution – and preventing construction of a new generation of dirty power plants in the United States, America can make a meaningful difference in preventing the worst impacts of global warming.

The U.S. must act now to prevent the worst impacts of global warming

In 2007, the Intergovernmental Panel on Climate Change (IPCC) – the world's foremost scientific authority on the subject – concluded that "warming of the climate system is unequivocal" and that "[m]ost of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic [greenhouse gas] concentrations."[38] In 2013, in a draft of its upcoming Fifth Assessment Report on climate change, the IPCC strengthened this assertion, citing "near certainty" that global warming is human-caused and suggesting that seas could rise by as much as three feet by the end of the century if greenhouse gas emissions continue unabated.[39]

Clear signs of global warming have already begun to emerge:

- Global average sea and air temperatures in 2010 were tied for the hottest on record, according to the National Oceanic and Atmospheric Administration (NOAA).[40] 2001 to 2010 was the hottest decade on record, with average temperatures estimated to be 0.83˚F hotter than the 1961-1990 norm.[41] 2010 was also the wettest year on record based on global average precipitation.[42]

- Oceans have absorbed 80 percent of the extra heat in the climate system, causing ocean water to expand.[43] Coupled with melting glaciers, this has caused sea levels to rise by about eight inches – with the rate of increase accelerating.[44]
- Hurricanes have become more intense, and the frequency of extreme rain and snowstorms has increased.[45]
- At the same time, droughts in many parts of the world have become longer and more severe, especially in the tropics and subtropics.[46]
- In the United States, warmer average annual temperatures are connected to increases in extreme precipitation and more intense heat waves. Furthermore, the U.S. has experienced an increase in the frequency and severity of extreme weather events, including floods, prolonged drought, more intense wildfires, and stronger tropical storms and hurricanes.[47]

The more global warming pollution that humanity emits, the more serious the consequences. And the changes will be largely irreversible for a thousand years after emissions stop.[48]

On our current emissions path, humanity risks increasing the average global temperature by 4°C (7.2°F) or more (above the pre-industrial era) by the end of this century even if current emission reduction commitments and pledges are met, according to a 2012 report by the World Bank.[49] Warming on this scale would have catastrophic consequences, including:

- Sea level rise of as much as 3 feet in the next century, causing extensive coastal inundation and increasing the risk of storm surge flooding in major coastal cities.50 By 2300, global mean sea levels could rise as high as 13 feet above present-day levels.[51]
- A 150 percent increase in ocean acidity above pre-industrial levels, resulting in wide-ranging, negative impacts on marine species and ecosystems, with particularly severe damage to coral reefs and fisheries.[52]
- An increase of 20-30 percent in the amount of precipitation falling during heavy rainstorms, increasing the risk of major flooding events in many parts of the world.[53]
- Increasing aridity, drought and extreme temperatures in Africa, southern Europe and the Middle East, and most of the Americas, Australia, and Southeast Asia.[54]

Global Warming Endangers Public Health

Hotter temperatures bring about numerous threats to public health. High temperatures combine with sunlight, nitrogen oxides and volatile organic compounds to create ozone "smog," which damages the respiratory system, reduces lung function, and aggravates asthma and other respiratory diseases.[55] The Union of Concerned Scientists estimates that, by 2020, students in the United States could experience more than 900,000 additional missed school days, and seniors and infants could experience more than 5,000 additional hospitalizations due to increases of ozone smog exposure that result from the higher temperatures caused by global warming.[56] Higher temperatures will also allow pollen allergens such as ragweed to proliferate, causing those who suffer from seasonal allergies to experience worsening symptoms, such as hay fever and asthma.[57]

Global warming can also be expected to increase the number of deaths caused by heat stress.[58] Excessive heat events happen when high temperatures combine with other weather conditions – such as dew point temperature, cloud cover, wind speed and surface atmospheric pressure throughout the day –

and contribute to heat-related deaths in a particular location.[59] According to a 2012 study by the Natural Resources Defense Council (NRDC), excessive heat events caused by global warming could kill up to 150,000 people in America's 40 largest cities by the end of the century.[60]

Higher temperatures may also change the patterns of occurrence of various infectious diseases. A 2009 study, for example, found a correlation between warmer temperatures and increased reports of infection by West Nile Virus.[61] Global warming may also increase the risk of more frequent and more widespread outbreaks of waterborne illnesses by allowing warm-water pathogens to expand into cooler climates, or by exposing more urban water bodies to sewage contamination after flooding caused by major precipitation events, according to NRDC.[62]

Increases in droughts and flooding caused by global warming can also reduce water available for drinking or for irrigation; they can also harm crops directly, diminishing food variety, nutritional content, and availability, all of which can contribute to malnutrition and the spread of disease.[63] Finally, sea-level rise and disasters such as strong storms and floods can damage urban infrastructure and displace existing communities.[64]

Global warming pollutants are not the only emissions from power plants that harm human health. For example, in 2010, two-thirds of all airborne mercury pollution in the United States came from the smokestacks of coal-fired power plants.[65] Mercury is a potent neurotoxicant, and exposure to mercury during critical periods of brain development can contribute to irreversible deficits in verbal skills, damage to attention and motor control, and reduced IQ.[66] Coal- and natural gas-fired power plants also emit nitrogen oxides (NO_X), which exacerbate ozone smog pollution, as well as other pollutants that contribute to particulate matter and acid rain. Like smog, particulate matter pollution contributes to a host of respiratory and cardiovascular ailments.[67] Sulfur dioxide, too, is a respiratory irritant for sensitive populations.[68] In addition, it is a major component of acid rain that has damaged forests across the eastern United States.[69]

Cleaning Up U.S. Power Plants Would Cut Carbon Pollution at a Global Scale

Humanity as a whole must limit emissions to no more than 1 trillion metric tons of carbon dioxide from 2000 through 2050 in order to have a 75 percent chance of limiting the global temperature increase to 3.6° F (2° C) above the pre-industrial era – a target the international community has set to limit the most severe global warming impacts.[70] For the world, this means that emissions will need to peak by 2015 and decline by more than half by 2050 to have a chance at preventing the worst impacts of climate change.[71] For the United States and other developed countries, emission reductions must occur more quickly and more steeply, with reductions of at least 25 to 40 percent below 1990 levels by 2020 and 80 to 95 percent by 2050.[72]

As of 2011, annual U.S. greenhouse gas emissions were still 10 percent above 1990 levels.[73] The annual emissions from a small group of the nation's dirtiest power plants are greatly hindering our ability to meet the emissions reduction targets necessary to avoid the worst impacts of global warming. Replacing these power plants with zero-emission energy sources such as wind and solar power, or eliminating the need for the power they produce through energy efficiency and conservation, would reduce U.S. greenhouse gas emissions to 11 percent below 1990 levels, even in the absence of other efforts to reduce emissions.[74]

Limiting carbon dioxide pollution from new and existing power plants is one of the most effective ways to reduce U.S. global warming pollution in the short run and for decades to come, reducing the risk that

emissions will reach a level that triggers dangerous, irreversible climate change impacts.

Adopting federal limits on carbon dioxide pollution from power plants as part of a suite of policies to reduce global warming pollution at all levels of government would help the United States achieve 2020 emissions reduction targets – even in the absence of a federal, economy-wide cap on carbon pollution. For example, Environment America Research & Policy Center's 2011 report, *The Way Forward on Global Warming,* demonstrated that with a suite of local, state and federal policies to increase energy efficiency, deploy clean energy technologies and improve public transportation, **the United States could curb emissions of carbon dioxide from energy use by as much as 3.5 percent below 1990 levels by 2020 and 20 percent below 1990 levels by 2030.**[75] A nationwide cap on carbon pollution from all sources – not just power plants – would allow the United States to make the remaining emissions reductions necessary to prevent the worst impacts of global warming.

Carbon Pollution Standards Are Needed to Clean Up Existing Power Plants

The unprecedented threat that global warming poses to our health, our safety and our environment demands that the United States takes urgent action to reduce emissions of global warming pollution. However, U.S. power plants currently face no federal limits on the amount of carbon dioxide pollution they can emit.

Given the enormous share of global warming pollution contributed by U.S. power plants, limiting carbon dioxide emissions from both new and existing power plants must be a key part of any strategy to reduce U.S. global warming emissions. Fortunately, the first steps toward setting these standards are already being taken. On June 25, 2013, President Obama announced his plan to address global warming through executive action, using existing statutory authority and funds.[76] The two most important elements of this plan are finalizing carbon emissions standards for new power plants and directing the EPA to quickly propose and implement a limit on existing plants.[77]

The EPA proposed a limit on new power plants in March 2012. Since then, the EPA has received more than 3.2 million public comments supporting limiting carbon pollution from power plants, and President Obama has asked the EPA to re-propose a carbon pollution standard for new power plants by September 20, 2013.[78]

The originally proposed limit restricts global warming pollution for facilities 25 megawatts (MW) or larger to 1,000 pounds of CO_2 per megawatt-hour (MWh) of electricity they produce.[79] According to the EPA, this standard was based on commonly used combined-cycle natural gas power plants – a standard that new coal plants are highly unlikely to meet.[80] Existing coal plants produce an average of 2,180 lbs CO_2/MWh, with the worst plants producing more than 3,000 lbs CO_2/MWh.[81]

The EPA has yet to propose a standard for existing power plants, a large portion of which are aging coal-fired plants. However, the president has directed the EPA to propose and submit carbon pollution limits for existing plants by June 2014 and to finalize those limits the following year.[82] (See "The Long Road to Carbon Pollution Limits" on page 21.)

Some states already limit carbon pollution from power plants. California has an economy-wide cap on carbon dioxide emissions, and nine states from Maine to Maryland participate in the Regional Greenhouse Gas Initiative (RGGI), which caps pollution from power plants in the Northeast. Once finalized, the EPA's carbon pollution limits for all new power plants nationwide would go a long way toward reducing future U.S. global warming pollution. However, the agency must also move quickly to establish strong federal standards for existing power plants – and force the nation's largest sources of carbon pollution to clean up.

The Long Road to Carbon Pollution Limits

The Obama administration's recent actions indicating progress toward carbon dioxide pollution from power plants are the culmination of a 14-year campaign to clean up the nation's power plants. In 1999, one year after the EPA declined to include carbon dioxide pollution limits in new vehicle emissions standards, 19 environmental and public interest groups petitioned the EPA to classify carbon dioxide as an air pollutant subject to the Clean Air Act regulation.[83] They cited carbon dioxide's contribution to global warming – which threatens human health and the environment – as rationale for regulation.[84]

In 2003, the EPA released an official statement that it did not believe the Act authorized the EPA to regulate global warming pollution, and that even if it did authorize regulating greenhouse gases, the EPA objected to doing so on policy grounds.[85] However, the U.S. Supreme Court disagreed with the EPA in 2007, ruling with several states and environmental groups that the EPA does indeed have the authority to regulate greenhouse gases, and that its policy objections were insufficient to decline to regulate.[86] The court also directed the EPA to determine if greenhouse gases contribute to global warming and, if so, whether global warming endangered public health and welfare.[87] By the end of 2009, the EPA officially determined that emissions of carbon dioxide endanger public health and welfare by contributing to global warming.[88]

In December 2010, the EPA announced its plan to release new performance standards and mandatory emissions guidelines for all new fossil fuel-fired power plants.[89] The EPA proposed an interim carbon pollution standard for new power plants in April 2012 that is in effect until a rule can be finalized.[90] This step set the first-ever national limits on the amount of carbon pollution power plants can emit.[91]

Policy Recommendations

To protect our health, our economy, and our environment from the dangers of global warming, America must clean up its dirtiest power plants.

- The Obama Administration should set strong limits on carbon dioxide pollution from new power plants to prevent the construction of a new generation of dirty power plants, and force existing power plants to clean up by setting strong limits on carbon dioxide emissions for all existing power plants.
    - New plants – The EPA should work to meet its September 2013 deadline for re-proposing a stringent emissions standard for new power plants. It should also set a deadline for finalizing these standards no later than June 2015.
    - Existing plants – The EPA should work to meet the timeline put forth by President Obama for proposing and finalizing emissions standards for existing power plants. This timeline calls for limits on existing plants to be proposed by June 2014 and finalized by June 2015.[92] The standards should be based on climate science and designed to achieve the emissions reductions targets that are necessary to avoid the worst impacts of global warming.

In addition to cutting pollution from power plants, the United States should adopt a suite of clean energy policies at the local, state, and federal level to curb emissions of carbon dioxide from energy use in other sectors.

In particular, the United States should prioritize establishing a comprehensive, national plan to reduce carbon pollution from all sources – including transportation, industrial activities, and the commercial and residential sectors.

Other policies to curb emissions include:

- Retrofitting three-quarters of America's homes and businesses for improved energy efficiency, and implementing strong building energy codes to dramatically reduce fossil fuel consumption in new homes and businesses.
- Adopting a federal renewable electricity standard that calls for 25 percent of America's electricity to come from clean, renewable sources by 2025.
- Installing more than 200 gigawatts of solar panels and other forms of distributed renewable energy at residential, commercial and industrial buildings over the next two decades.
- Strengthening and implementing state energy efficiency resource standards that require utilities to deliver energy efficiency improvements in homes, businesses and industries.

- Encouraging the use of energy-saving combined heat-and-power systems in industry.
- Setting strong energy efficiency standards for household appliances and commercial equipment, and promoting the use of energy-efficient boilers, process heat systems, and energy-saving combined heat-and-power in industrial facilities.
- Facilitating the deployment of millions of plug-in vehicles that operate partly or solely on electricity, and adopting clean fuel standards that require a reduction in the carbon intensity of transportation fuels. The U.S. should also adopt strong fuel economy standards for heavy-duty trucks.
- Ensuring that the majority of new residential and commercial development in metropolitan areas takes place in compact, walkable communities with access to a range of transportation options.
- Expanding public transportation service to double ridership by 2030, encouraging further ridership increases through better transit service, and reducing per-mile global warming pollution from transit vehicles. The U.S. should also build high-speed rail lines in 11 high-priority corridors by 2030.
- Carrying out President Obama's Executive Order 13514, which requires large reductions in global warming pollution from federal agencies.
- Rejecting proposals to increase our access to and use of carbon-intensive fuels, including current proposals to import tar sands oil from Canada via the Keystone XL pipeline and to open more land to hydraulic fracturing for shale oil and natural gas.
- Strengthening and expanding the Regional Greenhouse Gas Initiative, which limits carbon dioxide pollution from power plants in nine northeastern states, and implementing California's Global Warming Solutions Act (AB32), which places an economy-wide cap on the state's greenhouse gas emissions.

Methodology

In this report we examine emissions of carbon dioxide from all utility and non-utility power plants within the United States in 2011. We derive emissions data from fuel consumption figures reported to the U.S. Department of Energy and estimates of the carbon content of each fuel source developed by the U.S. Environmental Protection Agency. Details follow.

- We obtained fuel consumption and electricity generation data for power plants operating in the United States from the U.S. Department of Energy's Energy Information Administration (EIA), *2011 December EIA-923 Monthly Time Series*.[93] We focused on fuel consumption for electricity generation, excluding any fuel consumption for the purposes of generating heat.

- We obtained estimates of the carbon dioxide emissions created per unit of energy output of the different fuels used in electricity generation from the U.S. Environmental Protection Agency, Center for Climate Leadership, *Emission Factors for Greenhouse Gas Inventories*, November 2011; and U.S. Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2011*, April 2013. Table 3 lists these coefficients. For all biomass fuels, including wood waste and the biogenic fraction of municipal solid waste, we assigned an emissions value of zero, since these fuels are already part of the non-fossil portion of the world's carbon cycle.

- We multiplied fuel consumption in terms of heat content by the appropriate carbon dioxide emissions factors, yielding an estimate of 2011 carbon dioxide emissions by plant. Using database tools, we sorted or aggregated the data in various ways to generate the facts in this report. Our methodology resulted in a value for 2011 carbon dioxide pollution from the power sector very similar to that listed in the EPA's 2011 greenhouse gas emissions inventory (see above); our analysis resulted in a value of 2,202 MMT of carbon dioxide from all U.S. power plants, while the EPA's emissions inventory gave a value of 2,159 MMT of carbon dioxide emissions from the power sector – a difference of less than 2 percent. EIA's 2011 *Annual Energy Review* lists a value of 2,166 MMT of carbon dioxide emitted by power plants in 2011.[94]

- We chose to estimate 2011 carbon dioxide pollution based on plant-level energy consumption data because EIA's *Form 923* database (which contains such data) includes information on a broader range of power plants than the EPA's *Air Markets Program Data*, which provides estimates of carbon dioxide emissions for a subset of large electric power plants.[95]

Table 3: Carbon Dioxide Emission Coefficients

Category	Fuel	Emission Coefficient (Kg CO2 / MMBtu)
Coal	Bituminous	93.40
Coal	Lignite	96.36
Coal	Sub-Bituminous	97.02
Coal	Waste Coal[96]	94.38
Coal	Coal-Derived Synthesis Gas[97]	94.38
Coal	Anthracite	103.54
Coal	Coal-Based Synfuel[98]	92.91
Petroleum Products	Distillate Fuel Oil[99]	73.15
Petroleum Products	Jet Fuel	72.22
Petroleum Products	Kerosene	75.20
Petroleum Products	Petroleum Coke	102.41
Petroleum Products	Petroleum Coke-Derived Synthesis Gas[100]	102.41
Petroleum Products	Residual Fuel Oil[101]	78.80
Petroleum Products	Propane	61.46
Petroleum Products	Waste Oil[102]	66.53
Natural Gas and other gases	Natural Gas[103]	53.02
Natural Gas and other gases	Blast Furnace Gas[104]	274.32
Natural Gas and other gases	Other Fossil-Fuel Gas[105]	59.00
Other	Purchased Steam[106]	88.18
Other	Tire-Derived Fuels[107]	85.97
Other	Municipal Solid Waste - Non-Biogenic Fraction	90.70

Appendices

Table A-1. Power Plant Carbon Dioxide Emissions as a Share of Total State-Level Emissions (MMT), 2010[108]

State	Electric Power Sector Emissions	Total Statewide Energy-Related Emissions	Percentage of Statewide Emissions from Power Plants	Estimated Share of Statewide Emissions Contributed by Top 5 Emitting Power Plants±	Total Power Sector Emissions Equivalent in Number of Passenger Vehicles (Millions)[109]
Alabama	76.7	132.7	58%	36%	16.0
Alaska	3.0	38.7	8%	6%	0.6
Arizona	54.4	95.9	57%	46%	11.3
Arkansas	32.3	66.1	49%	45%	6.7
California	43.5	369.8	12%	2%	99.1
Colorado	39.9	96.5	41%	28%	8.3
Connecticut	7.7	36.9	21%	16%	1.6
Delaware	4.2	11.7	36%	36%	0.9
District of Columbia	0.2	3.3	6%	6%	0.0
Florida	119.6	246.0	49%	18%	24.9
Georgia	79.1	173.7	46%	34%	16.5
Hawaii	7.6	18.9	40%	31%	1.6
Idaho	0.7	16.2	4%	4%	0.1
Illinois	94.0	230.4	41%	19%	19.6
Indiana	114.3	219.1	52%	27%	23.8
Iowa	40.6	88.7	46%	34%	8.5
Kansas	35.4	75.0	47%	41%	7.4
Kentucky	94.2	150.7	63%	34%	19.6
Louisiana	42.6	223.5	19%	12%	8.9
Maine	2.6	18.5	14%	11%	0.5
Maryland	24.9	70.5	35%	28%	5.2
Massachusetts	18.2	73.0	25%	16%	3.8
Michigan	70.4	165.9	42%	27%	14.7
Minnesota	29.3	93.4	31%	27%	6.1
Mississippi	26.4	65.5	40%	25%	5.5
Missouri	76.0	135.7	56%	35%	15.8
Montana	19.8	34.9	57%	55%	4.1
Nebraska	23.1	48.0	48%	45%	4.8

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Table A-1. Power Plant Carbon Dioxide Emissions as a Share of Total State-Level Emissions (MMT), 2010[108]

State	Electric Power Sector Emissions	Total Statewide Energy-Related Emissions	Percentage of Statewide Emissions from Power Plants	Estimated Share of Statewide Emissions Contributed by Top 5 Emitting Power Plants±	Total Power Sector Emissions Equivalent in Number of Passenger Vehicles (Millions)[109]
Nevada	16.8	38.1	44%	28%	3.5
New Hampshire	5.4	17.0	32%	31%	1.1
New Jersey	17.7	115.4	15%	10%	3.7
New Mexico	29.0	54.8	53%	50%	0.6
New York	38.1	172.8	22%	7%	7.9
North Carolina	72.2	142.9	51%	36%	15
North Dakota	29.5	52.5	56%	52%	6.2
Ohio	120.8	249.1	48%	24%	25.2
Oklahoma	47.4	103.4	46%	32%	9.9
Oregon	9.8	40.3	24%	22%	0.2
Pennsylvania	119.6	256.6	47%	22%	24.9
Rhode Island	3.1	11.0	28%	28%	0.6
South Carolina	40.9	84.0	49%	34%	8.5
South Dakota	3.5	15.1	23%	23%	0.7
Tennessee	43.3	107.1	40%	34%	0.9
Texas	220.4	652.6	34%	10%	45.9
Utah	34.8	64.2	54%	49%	7.2
Vermont	0.0	6.0	0%	0%	0.0
Virginia	34.3	109.8	31%	19%	7.1
Washington	13.1	76.1	17%	15%	2.7
West Virginia	74.3	98.9	75%	52%	15.5
Wisconsin	42.6	99.2	43%	29%	8.9
Wyoming	42.8	64.9	66%	59%	8.9
Total*	2,240.0	5,631.3	40%	24%	466.7

* For the emissions of the United States as a country see, U.S. Energy Information Administration, *Monthly Energy Review*, Section 12: Environment, August 2013. Differing methodologies between that data series and the state-by-state data listed here causes the total for all states to be slightly different from the national-level estimate. The amount varies no more than 0.5 percent. NOTE: The District of Columbia is included in the data tables, but not in the analysis as it is not a state.

± Estimates obtained by multiplying Emissions for Top 5 as a Share of Power-Sector Total (2011) by Emissions for Power-Sector as a Share of Statewide Total (2010). U.S. EIA does not have state-by-state data on power-sector emissions from 2011. See Table A-3.

Table A-2. The Nation's 100 Most-Polluting Power Plants, Carbon Dioxide Emissions Equivalent in Passenger Vehicles and Primary Fuel Category, 2011

Rank	State	Operator Name	Plant Name	Primary Fuel Category	Emissions (Million Metric Tons)[112]	Emissions Equivalent in Passenger Vehicles (Millions)[113]
1	GA	Georgia Power Co.	Scherer	Coal	21.3	4.44
2	AL	Alabama Power Co.	James H. Miller Jr.	Coal	20.7	4.3
3	TX	Luminant Generation Company, LLC	Martin Lake	Coal	18.8	3.91
4	MO	Union Electric Co. (MO)	Labadie	Coal	18.5	3.85
5	TX	NRG Texas Power, LLC	W. A. Parish	Coal	17.8	3.71
6	IN	Duke Energy Indiana Inc.	Gibson	Coal	16.9	3.53
7	OH	Ohio Power Co.	General James M. Gavin	Coal	16.6	3.46
8	PA	FirstEnergy Generation Corp.	FirstEnergy Bruce Mansfield	Coal	16.4	3.41
9	MI	Detroit Edison Co.	Monroe	Coal	16.4	3.41
10	AZ	Salt River Project	Navajo	Coal	15.9	3.32
11	IN	Indiana Michigan Power Co.	Rockport	Coal	15.4	3.22
12	KS	Westar Energy Inc.	Jeffrey Energy Center	Coal	14.7	3.05
13	GA	Georgia Power Co.	Bowen	Coal	14.2	2.97
14	WV	Appalachian Power Co.	John E. Amos	Coal	13.9	2.89
15	NM	Arizona Public Service Co.	Four Corners*	Coal	13.8	2.88
16	NC	Duke Energy Carolinas, LLC	Belews Creek	Coal	13.8	2.87
17	TX	Luminant Generation Company, LLC	Monticello	Coal	13.7	2.85
18	MT	PPL Montana, LLC	Colstrip	Coal	13.6	2.82
19	TX	NRG Texas Power, LLC	Limestone	Coal	13.3	2.77
20	LA	Louisiana Generating LLC	Big Cajun 2	Coal	13.2	2.75
21	MN	Northern States Power Co. – Minnesota	Sherburne County	Coal	13.1	2.73
22	SC	South Carolina Public Service Authority	Cross	Coal	12.9	2.69
23	WY	PacifiCorp	Jim Bridger	Coal	12.9	2.68
24	IL	Dynegy Midwest Generation Inc.	Baldwin Energy Complex	Coal	12.8	2.67
25	OH	Dayton Power & Light Co.	J. M. Stuart	Coal	12.7	2.66
26	KY	Kentucky Utilities Co.	Ghent	Coal	12.7	2.65
27	TN	Tennessee Valley Authority	Cumberland	Coal	12.4	2.57
28	WY	Basin Electric Power Coop	Laramie River Station	Coal	12.2	2.54
29	UT	Los Angeles Department of Water & Power	Intermountain Power Project*	Coal	12.0	2.51
30	KY	Tennessee Valley Authority	Paradise	Coal	12.0	2.49

*Indicates that this power plant is scheduled for retirement.[110]

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Table A-2. The Nation's 100 Most-Polluting Power Plants, Carbon Dioxide Emissions Equivalent in Passenger Vehicles and Primary Fuel Category, 2011

Rank	State	Operator Name	Plant Name	Primary Fuel Category	Emissions (Million Metric Tons)[112]	Emissions Equivalent in Passenger Vehicles (Millions)[113]
31	IA	MidAmerican Energy Co.	Walter Scott Jr. Energy Center*	Coal	11.7	2.43
32	NC	Progress Energy Carolinas Inc.	Roxboro	Coal	11.6	2.42
33	NM	Public Service Co. of NM	San Juan*	Coal	11.5	2.4
34	AZ	Tucson Electric Power Co.	Springerville	Coal	11.5	2.39
35	AR	Entergy Arkansas Inc.	Independence	Coal	11.1	2.3
36	TX	Southwestern Electric Power Co.	Welsh*	Coal	11.0	2.29
37	TX	Lower Colorado River Authority	Fayette Power Project	Coal	10.9	2.26
38	TX	Oak Grove Management Co., LLC	Oak Grove	Coal	10.8	2.26
39	OH	FirstEnergy Generation Corp.	FirstEnergy W. H. Sammis	Coal	10.6	2.2
40	PA	Allegheny Energy Supply Co., LLC	Hatfields Ferry Power Station*	Coal	10.5	2.18
41	WV	Allegheny Energy Supply Co., LLC	FirstEnergy Harrison Power Station	Coal	10.4	2.16
42	AR	Entergy Arkansas Inc.	White Bluff	Coal	10.4	2.16
43	AL	Alabama Power Co.	E. C. Gaston	Coal	10.3	2.14
44	FL	Progress Energy Florida Inc.	Crystal River*	Coal	10.2	2.13
45	NC	Duke Energy Carolinas, LLC	Marshall	Coal	10.1	2.09
46	IN	Indianapolis Power & Light Co.	AES Petersburg	Coal	10.0	2.09
47	PA	GenOn Northeast Management Company	Keystone	Coal	10.0	2.08
48	PA	GenOn Northeast Management Company	Conemaugh	Coal	9.9	2.06
49	IL	Midwest Generations EME, LLC	Powerton	Coal	9.8	2.04
50	NE	Nebraska Public Power District	Gerald Gentleman	Coal	9.3	1.94
51	OK	Oklahoma Gas & Electric Co.	Muskogee	Coal	9.2	1.92
52	FL	Tampa Electric Co.	Big Bend	Coal	9.2	1.91
53	KY	Louisville Gas & Electric Co.	Mill Creek	Coal	9.1	1.89
54	PA	Midwest Generations EME, LLC	Homer City Station	Coal	9.0	1.87
55	CO	Tri-State G & T Assn., Inc.	Craig	Coal	9.0	1.87
56	KY	East Kentucky Power Coop, Inc.	H. L. Spurlock	Coal	8.9	1.86
57	ND	Great River Energy	Coal Creek	Coal	8.8	1.84
58	NE	Omaha Public Power District	Nebraska City	Coal	8.7	1.82
59	PA	PPL Brunner Island, LLC	PPL Brunner Island	Coal	8.6	1.79
60	OK	Public Service Co. of Oklahoma	Northeastern*	Coal	8.6	1.79

*Indicates that this power plant is scheduled for retirement.[110]

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Table A-2. The Nation's 100 Most-Polluting Power Plants, Carbon Dioxide Emissions Equivalent in Passenger Vehicles and Primary Fuel Category, 2011

Rank	State	Operator Name	Plant Name	Primary Fuel Category	Emissions (Million Metric Tons)[112]	Emissions Equivalent in Passenger Vehicles (Millions)[113]
61	TX	Big Brown Power Company, LLC	Big Brown	Coal	8.6	1.79
62	WV	Appalachian Power Co.	Mountaineer	Coal	8.5	1.77
63	UT	PacifiCorp	Hunter	Coal	8.4	1.76
64	MO	Kansas City Power & Light Co.	Iatan	Coal	8.4	1.75
65	PA	PPL Montour, LLC	PPL Montour	Coal	8.4	1.75
66	WV	Ohio Power Co.	Mitchell	Coal	8.4	1.74
67	TX	City of San Antonio – (TX)	J. K. Spruce	Coal	8.3	1.73
68	MO	Associated Electric Coop, Inc.	Thomas Hill	Coal	8.3	1.73
69	KS	Kansas City Power & Light Co	La Cygne	Coal	8.2	1.71
70	WV	Virginia Electric & Power Co.	Mt. Storm	Coal	8.2	1.7
71	MI	Consumers Energy Co.	J. H. Campbell	Coal	8.2	1.7
72	IN	Northern Indiana Pub Serv Co.	R. M. Schahfer	Coal	8.1	1.7
73	IN	Indiana-Kentucky Electric Corp.	Clifty Creek	Coal	8.1	1.69
74	MI	Detroit Edison Co.	Belle River	Coal	7.9	1.65
75	FL	Florida Power & Light Co.	West County Energy Center	Natural Gas and other gases	7.9	1.64
76	FL	Seminole Electric Cooperative Inc.	Seminole	Coal	7.9	1.64
77	MO	Union Electric Co. – (MO)	Rush Island	Coal	7.9	1.64
78	WV	Allegheny Energy Supply Co., LLC	FirstEnergy Pleasants Power Station	Coal	7.8	1.63
79	KY	Tennessee Valley Authority	Shawnee	Coal	7.8	1.62
80	IL	Electric Energy Inc.	Joppa Steam	Coal	7.8	1.62
81	OH	Cardinal Operating Co.	Cardinal	Coal	7.6	1.58
82	TX	Southwestern Public Service Co.	Tolk	Coal	7.5	1.57
83	IL	Ameren Energy Generating Co.	Newton	Coal	7.5	1.55
84	MN	Minnesota Power Inc.	Clay Boswell	Coal	7.4	1.55
85	AZ	Arizona Public Service Co.	Cholla	Coal	7.4	1.55
86	AL	Alabama Power Co.	Barry	Natural Gas and other gases	7.3	1.53
87	TN	Tennessee Valley Authority	Gallatin	Coal	7.3	1.51
88	WI	Wisconsin Power & Light Co.	Columbia	Coal	7.2	1.51
89	CO	Public Service Co. of Colorado	Comanche	Coal	7.2	1.5
90	GA	Georgia Power Co.	Wansley	Coal	7.2	1.5
91	OK	Grand River Dam Authority	GRDA	Coal	7.2	1.49
92	OH	Duke Energy Ohio Inc.	Miami Fort*	Coal	7.2	1.49
93	MO	Associated Electric Coop, Inc.	New Madrid	Coal	7.1	1.48
94	OH	Ohio Power Co.	Conesville*	Coal	7.1	1.47

*Indicates that this power plant is scheduled for retirement.[110]

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Table A-2. The Nation's 100 Most-Polluting Power Plants, Carbon Dioxide Emissions Equivalent in Passenger Vehicles and Primary Fuel Category, 2011

Rank	State	Operator Name	Plant Name	Primary Fuel Category	Emissions (Million Metric Tons)[112]	Emissions Equivalent in Passenger Vehicles (Millions)[113]
95	LA	Entergy Gulf States – LA, LLC	R. S. Nelson	Coal	7.0	1.46
96	LA	Cleco Power, LLC	Brame Energy Center	Coal	7.0	1.46
97	OK	Oklahoma Gas & Electric Co.	Sooner	Coal	7.0	1.45
98	KY	Louisville Gas & Electric Co.	Trimble County	Coal	6.9	1.45
99	WV	Monongahela Power Co.	FirstEnergy Fort Martin Power Station	Coal	6.8	1.42
100	IN	Hoosier Energy R E C, Inc.	Merom	Coal	6.7	1.39

*Indicates that this power plant is scheduled for retirement.[110]

Table A-3. The Share of Each State's Electricity-Sector Carbon Dioxide Pollution Contributed by the Top 5 Most-Polluting Power Plants

State	Rank	Plant Name	Operator Name	Emissions (Millon Metric tons of CO_2)	Total Emissions of Top 5 Plants (MMT of CO_2)	Emissions for Top 5 as a Share of Power-Sector Total (2011)	Emissions for Power-Sector as a Share of Statewide Total (2010)	Estimated Share of Statewide Emissions Contributed by Top 5±
AK	1	Beluga	Chugach Electric Assn. Inc.	1.27	2.8	75%	8%	6%
	2	George M Sullivan Generation Plant 2	Anchorage Municipal Light and Power	0.61				
	3	Aurora Energy, LLC Chena	Aurora Energy, LLC	0.34				
	4	North Pole	Golden Valley Elec. Assn. Inc.	0.30				
	5	Healy	Golden Valley Elec. Assn. Inc.	0.23				
AL	1	James H Miller Jr.	Alabama Power Co.	20.66	48.1	63%	58%	36%
	2	E. C. Gaston	Alabama Power Co.	10.29				
	3	Barry	Alabama Power Co.	7.33				
	4	Widows Creek*	Tennessee Valley Authority	5.06				
	5	Colbert	Tennessee Valley Authority	4.75				
AR	1	Independence	Entergy Arkansas Inc.	11.06	32.0	92%	49%	45%
	2	White Bluff	Entergy Arkansas Inc.	10.36				
	3	Plum Point Energy Station	Plum Point Energy Associates, LLC	4.00				
	4	Flint Creek	Southwestern Electric Power Co.	3.77				
	5	Union Power Partners, L.P.	Union Power Partners, L.P.	2.79				
AZ	1	Navajo	Salt River Project	15.92	43.0	81%	57%	46%
	2	Springerville	Tucson Electric Power Co.	11.45				
	3	Cholla	Arizona Public Service Co.	7.45				
	4	Coronado	Salt River Project	5.66				
	5	Mesquite Generating Station	Mesquite Power, LLC	2.50				
CA	1	Mountainview Generating Station	Southern California Edison Co.	1.85	7.5	19%	12%	2%
	2	Delta Energy Center	Delta Energy Center, LLC	1.64				
	3	Haynes	Los Angeles Department of Water & Power	1.49				
	4	Cosumnes	Sacramento Municipal Util. Dist.	1.26				
	5	Elk Hills Power, LLC	Elk Hills Power, LLC	1.23				

*Indicates that this power plant is scheduled for retirement.[113]

± Obtained by multiplying Emissions for Top 5 as a Share of Power-Sector Total (2011) by Emissions for Power-Sector as a Share of Statewide Total (2010) U.S. EIA does not have state-by-state data for power-sector emissions for 2011.

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Table A-3. The Share of Each State's Electricity-Sector Carbon Dioxide Pollution Contributed by the Top 5 Most-Polluting Power Plants

State	Rank	Plant Name	Operator Name	Emissions (Millon Metric tons of CO_2)	Total Emissions of Top 5 Plants (MMT of CO_2)	Emissions for Top 5 as a Share of Power-Sector Total (2011)	Emissions for Power-Sector as a Share of Statewide Total (2010)	Estimated Share of Statewide Emissions Contributed by Top 5±
CO	1	Craig	Tri-State G & T Assn., Inc.	8.96	26.2	67%	41%	28%
	2	Comanche	Public Service Co. of Colorado	7.21				
	3	Cherokee*	Public Service Co. of Colorado	4.01				
	4	Pawnee	Public Service Co. of Colorado	3.05				
	5	Hayden	Public Service Co. of Colorado	2.98				
CT	1	Lake Road Generating Plant	Lake Road Generating Co., L.P.	2.07	5.9	75%	21%	16%
	2	Milford Power Project	Milford Power Co., LLC	1.54				
	3	Bridgeport Energy Project	Bridgeport Energy, LLC	1.08				
	4	Kleen Energy Systems Project	Kleen Energy Systems, LLC	0.70				
	5	Bridgeport Station	PSEG Power Connecticut, LLC	0.53				
DC	1	Benning	Potomac Power Resources	0.11	0.2	100%	6%	6%
	2	US GSA Heating and Transmission	US GSA Heating and Transmission	0.05				
	3	Buzzard Point	Potomac Power Resources	0.01				
DE	1	Hay Road	Calpine Mid-Atlantic Generation, LLC	1.70	3.9	99%	36%	36%
	2	Indian River Generating Station*	Indian River Operations Inc.	1.57				
	3	Edge Moor*	Calpine Mid-Atlantic Generation, LLC	0.37				
	4	Delaware City Plant	Delaware City Refining Company, LLC	0.18				
	5	NRG Energy Center Dover	NRG Energy Center Dover, LLC	0.11				
FL	1	Crystal River*	Progress Energy Florida Inc.	10.24	41.7	37%	49%	18%
	2	Big Bend	Tampa Electric Co.	9.18				
	3	West County Energy Center	Florida Power & Light Co.	7.89				
	4	Seminole	Seminole Electric Cooperative Inc.	7.88				
	5	St. Johns River Power Park	JEA	6.55				
GA	1	Scherer	Georgia Power Co.	21.32	52.1	76%	46%	34%
	2	Bowen	Georgia Power Co.	14.24				
	3	Wansley	Georgia Power Co.	7.19				
	4	Harllee Branch*	Georgia Power Co.	5.15				
	5	Yates*	Georgia Power Co.	4.16				

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Table A-3. The Share of Each State's Electricity-Sector Carbon Dioxide Pollution Contributed by the Top 5 Most-Polluting Power Plants

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HI	1	Kahe	Hawaiian Electric Co. Inc.	2.41	5.6	77%	40%	31%
	2	AES Hawaii	AES Hawaii Inc.	1.31				
	3	Waiau	Hawaiian Electric Co. Inc.	0.87				
	4	Maalaea	Maui Electric Co. Ltd.	0.55				
	5	Kalaeola Cogen Plant	Kalaeloa Partners, L.P.	0.51				
IA	1	Walter Scott Jr. Energy Center*	MidAmerican Energy Co.	11.67	29.7	75%	46%	34%
	2	George Neal North	MidAmerican Energy Co.	5.76				
	3	George Neal South	MidAmerican Energy Co.	4.32				
	4	Louisa	MidAmerican Energy Co.	4.30				
	5	Ottumwa	Interstate Power and Light Co.	3.65				
ID	1	Rathdrum Power, LLC	Rathdrum Operating Services Co., Inc.	0.31	0.4	91%	4%	4%
	2	Evander Andrews Power Complex	Idaho Power Co.	0.05				
	3	Bennett Mountain	Idaho Power Co.	0.03				
	4	Rupert Cogen Project	Energy Operations Group	0.03				
	5	Clearwater Paper IPP Lewiston	Clearwater Paper Corporation	0.02				
IL	1	Baldwin Energy Complex	Dynegy Midwest Generation Inc.	12.83	44.0	46%	41%	19%
	2	Powerton	Midwest Generations EME, LLC	9.80				
	3	Joppa Steam	Electric Energy Inc.	7.76				
	4	Newton	Ameren Energy Generating Co.	7.46				
	5	Joliet 29	Midwest Generations EME, LLC	6.12				
IN	1	Gibson	Duke Energy Indiana Inc.	16.95	58.7	52%	52%	27%
	2	Rockport	Indiana Michigan Power Co.	15.44				
	3	AES Petersburg	Indianapolis Power & Light Co.	10.05				
	4	R. M. Schahfer	Northern Indiana Pub Serv Co.	8.14				
	5	Clifty Creek	Indiana-Kentucky Electric Corp.	8.09				

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KS	1	Jeffrey Energy Center	Westar Energy Inc.	14.66	30.8	88%	47%	41%
	2	La Cygne	Kansas City Power & Light Co.	8.22				
	3	Lawrence Energy Center	Westar Energy Inc.	3.69				
	4	Holcomb	Sunflower Electric Power Corp.	2.76				
	5	Nearman Creek	City of Kansas City – (KS)	1.50				
KY	1	Ghent	Kentucky Utilities Co.	12.72	50.4	54%	63%	34%
	2	Paradise	Tennessee Valley Authority	11.96				
	3	Mill Creek	Louisville Gas & Electric Co.	9.05				
	4	H. L. Spurlock	East Kentucky Power Coop, Inc.	8.91				
	5	Shawnee	Tennessee Valley Authority	7.80				
LA	1	Big Cajun 2	Louisiana Generating, LLC	13.22	35.0	61%	19%	12%
	2	R. S. Nelson	Entergy Gulf States – LA, LLC	7.01				
	3	Brame Energy Center	Cleco Power, LLC	7.01				
	4	Dolet Hills	Cleco Power, LLC	5.14				
	5	Nine Mile Point	Entergy Louisiana Inc.	2.62				
MA	1	Mystic Generating Station	Constellation Mystic Power, LLC	3.64	10.5	66%	25%	16%
	2	Brayton Point	Dominion Energy New England, LLC	3.26				
	3	Fore River Generating Station	Constellation Mystic Power, LLC	1.86				
	4	Millennium Power	Millennium Power Partners, L.P.	0.92				
	5	ANP Blackstone Energy Project	ANP Blackstone Energy Company, LLC	0.82				
MD	1	Brandon Shores	Raven Power Holdings, LLC	6.02	18.6	80%	35%	28%
	2	Morgantown Generating Plant	GenOn Mid-Atlantic, LLC	5.84				
	3	Chalk Point, LLC	GenOn Chalk Point, LLC	3.79				
	4	Herbert A. Wagner	Raven Power Holdings, LLC	1.54				
	5	Dickerson	GenOn Mid-Atlantic, LLC	1.37				

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ME	1	Westbrook Energy Center Power Plant	Westbrook Energy Center	1.01	2.8	82%	14%	11%
	2	Verso Paper	Verso Bucksport, LLC	0.73				
	3	Maine Independence Station	Casco Bay Energy Co., LLC	0.69				
	4	Rumford Power Associates	Rumford Power	0.17				
	5	Androscoggin Energy Center	Verso Paper Androscoggin, LLC	0.15				
MI	1	Monroe	Detroit Edison Co.	16.39	42.8	64%	42%	27%
	2	J. H. Campbell	Consumers Energy Co.	8.16				
	3	Belle River	Detroit Edison Co.	7.91				
	4	St. Clair	Detroit Edison Co.	6.54				
	5	Trenton Channel	Detroit Edison Co.	3.76				
MN	1	Sherburne County	Northern States Power Co. – Minnesota	13.11	26.3	85%	31%	27%
	2	Clay Boswell	Minnesota Power Inc.	7.45				
	3	Allen S. King	Northern States Power Co. – Minnesota	3.18				
	4	Black Dog*	Northern States Power Co. – Minnesota	1.39				
	5	Taconite Harbor Energy Center	Minnesota Power Inc.	1.20				
MO	1	Labadie	Union Electric Co. – (MO)	18.50	50.1	62%	56%	35%
	2	Iatan	Kansas City Power & Light Co.	8.41				
	3	Thomas Hill	Associated Electric Coop, Inc.	8.29				
	4	Rush Island	Union Electric Co. – (MO)	7.85				
	5	New Madrid	Associated Electric Coop, Inc.	7.09				
MS	1	Victor J. Daniel Jr.	Mississippi Power Co.	5.28	14.1	61%	40%	25%
	2	Red Hills Generating Facility	Choctaw Generating, L.P.	2.74				
	3	Jack Watson	Mississippi Power Co.	2.73				
	4	Baxter Wilson	Entergy Mississippi Inc.	1.76				
	5	R. D. Morrow	South Mississippi El Pwr. Assn.	1.55				

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MT	1	Colstrip	PPL Montana, LLC	13.55	16.1	96%	57%	55%
	2	J. E. Corette Plant	PPL Montana, LLC	0.90				
	3	Hardin Generator Project	Rocky Mountain Power Inc.	0.77				
	4	Yellowstone Energy, L.P.	Yellowstone Energy, L.P.	0.50				
	5	Lewis & Clark	Montana-Dakota Utilities Co.	0.37				
NC	1	Belews Creek	Duke Energy Carolinas, LLC	13.76	43.0	71%	51%	36%
	2	Roxboro	Progress Energy Carolinas Inc.	11.60				
	3	Marshall	Duke Energy Carolinas, LLC	10.05				
	4	G. G. Allen	Duke Energy Carolinas, LLC	4.00				
	5	Mayo	Progress Energy Carolinas Inc.	3.56				
ND	1	Coal Creek	Great River Energy	8.82	27.1	93%	56%	52%
	2	Antelope Valley	Basin Electric Power Coop	5.79				
	3	Milton R. Young	Minnkota Power Coop, Inc	5.56				
	4	Leland Olds	Basin Electric Power Coop	3.60				
	5	Coyote	Otter Tail Power Co.	3.29				
NE	1	Gerald Gentleman	Nebraska Public Power District	9.29	24.7	93%	48%	45%
	2	Nebraska City	Omaha Public Power District	8.75				
	3	North Omaha	Omaha Public Power District	3.58				
	4	Sheldon	Nebraska Public Power District	1.58				
	5	Whelan Energy Center	City of Hasting – (NE)	1.53				
NH	1	Merrimack	Public Service Co. of NH	2.00	4.9	97%	32%	31%
	2	Granite Ridge	Granite Ridge Energy, LLC	1.47				
	3	EP Newington Energy, LLC	EP Newington Energy, LLC	1.05				
	4	Schiller	Public Service Co. of NH	0.30				
	5	Newington	Public Service Co. of NH	0.11				

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NJ	1	Bergen Generating Station	PSEG Fossil, LLC	2.46	9.9	64%	15%	10%
	2	PSEG Linden Generating Station	PSEG Fossil, LLC	2.13				
	3	Red Oak Power, LLC	Red Oak Power, LLC	1.93				
	4	PSEG Hudson Generating Station	PSEG Fossil, LLC	1.76				
	5	Linden Cogen Plant	Cogen Technologies Linden Vent	1.60				
NM	1	Four Corners*	Arizona Public Service Co.	13.85	29.1	94%	53%	50%
	2	San Juan*	Public Service Co. of NM	11.52				
	3	Escalante	Tri-State G & T Assn., Inc.	1.78				
	4	Hobbs Generating Station	CAMS NM, LLC	1.24				
	5	Luna Energy Facility	Public Service Co. of NM	0.70				
NV	1	Reid Gardner*	Nevada Power Co.	2.48	9.3	64%	44%	28%
	2	Chuck Lenzie Generating Station	Nevada Power Co.	2.30				
	3	North Valmy	Sierra Pacific Power Co.	1.98				
	4	Tracy	Sierra Pacific Power Co.	1.29				
	5	TS Power Plant*	Newmont Nevada Energy Investment, LLC	1.28				
NY	1	AES Somerset, LLC	AES Somerset, LLC	3.51	11.0	32%	22%	7%
	2	Northport	National Grid Generation, LLC	2.06				
	3	Dunkirk Generating Plant	Dunkirk Power, LLC	2.05				
	4	Ravenswood	TC Ravenswood, LLC	1.74				
	5	East River	Consolidated Edison Co. NY Inc.	1.68				
OH	1	General James M. Gavin	Ohio Power Co.	16.59	54.7	50%	48%	24%
	2	J. M. Stuart	Dayton Power & Light Co.	12.75				
	3	FirstEnergy W. H. Sammis	FirstEnergy Generation Corp.	10.55				
	4	Cardinal	Cardinal Operating Co.	7.60				
	5	Miami Fort*	Duke Energy Ohio Inc.	7.15				

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OK	1	Muskogee	Oklahoma Gas & Electric Co.	9.20	35.0	69%	46%	32%
	2	Northeastern*	Public Service Co. of Oklahoma	8.60				
	3	GRDA	Grand River Dam Authority	7.17				
	4	Sooner	Oklahoma Gas & Electric Co.	6.96				
	5	Hugo	Western Farmers Elec Coop, Inc.	3.06				
OR	1	Boardman*	Portland General Electric Co.	3.24	5.9	89%	24%	22%
	2	Hermiston Generating Plant	Hermiston Generating Co., L.P.	0.92				
	3	Klamath Cogeneration Plant	Pacific Klamath Energy Inc.	0.74				
	4	Port Westward	Portland General Electric Co.	0.51				
	5	Hermiston Power Partnership	Hermiston Power Partnership	0.45				
PA	1	FirstEnergy Bruce Mansfield	FirstEnergy Generation Corp.	16.39	55.7	48%	47%	22%
	2	Hatfields Ferry Power Station*	Allegheny Energy Supply Co., LLC	10.46				
	3	Keystone	GenOn Northeast Management Company	10.00				
	4	Conemaugh	GenOn Northeast Management Company	9.88				
	5	Homer City Station	Midwest Generations EME, LLC	8.97				
RI	1	Entergy Rhode Island State Energy, L.P.	Entergy RISE	1.17	3.5	99%	28%	28%
	2	Manchester Street	Dominion Energy New England, LLC	1.01				
	3	Tiverton Power Plant	Tiverton Power Inc.	0.61				
	4	Ocean State Power II	Ocean State Power II	0.35				
	5	Ocean State Power	Ocean State Power Co.	0.32				
SC	1	Cross	South Carolina Public Service Authority	12.89	26.3	70%	49%	34%
	2	Winyah	South Carolina Public Service Authority	5.03				
	3	Wateree	South Carolina Electric & Gas Co.	3.76				
	4	Williams	South Carolina Genertg Co, Inc.	2.46				
	5	Jasper	South Carolina Electric & Gas Co.	2.16				

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SD	1	Big Stone	Otter Tail Power Co.	2.63	2.9	100%	23%	23%
	2	Ben French*	Black Hills Power Inc.	0.19				
	3	Groton Generating Station	Basin Electric Power Coop	0.04				
	4	Angus Anson	Northern States Power Co. – Minnesota	0.04				
	5	Lange Gas Turbines	Black Hills Power Inc.	0.00				
TN	1	Cumberland	Tennessee Valley Authority	12.36	34.4	83%	40%	34%
	2	Gallatin	Tennessee Valley Authority	7.25				
	3	Johnsonville*	Tennessee Valley Authority	5.49				
	4	Allen Steam Plant	Tennessee Valley Authority	4.73				
	5	Kingston	Tennessee Valley Authority	4.59				
TX	1	Martin Lake	Luminant Generation Company, LLC	18.76	74.6	30%	34%	10%
	2	W. A. Parish	NRG Texas Power, LLC	17.81				
	3	Monticello	Luminant Generation Company, LLC	13.69				
	4	Limestone	NRG Texas Power, LLC	13.30				
	5	Welsh*	Southwestern Electric Power Co.	11.01				
UT	1	Intermountain Power Project*	Los Angeles Department of Water & Power	12.05	30.6	90%	54%	49%
	2	Hunter	PacifiCorp	8.43				
	3	Huntington	PacifiCorp	5.54				
	4	Bonanza	Deseret Generation & Tran Coop	3.22				
	5	Carbon*	PacifiCorp	1.38				
VA	1	Chesterfield	Virginia Electric & Power Co.	6.11	16.8	60%	31%	19%
	2	Clover	Virginia Electric & Power Co.	4.92				
	3	Chesapeake*	Virginia Electric & Power Co.	2.73				
	4	Tenaska Virginia Generating Station	Tenaska Virginia Partners, L.P.	1.73				
	5	Clinch River*	Appalachian Power Co.	1.32				

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VT	1	Middlebury College	Middlebury College Biomass	0.01	0.0	96%	0%	0%
	2	Berlin 5	Green Mountain Power Corp.	0.01				
	3	J. C. McNeil	City of Burlington Electric (VT)	0.00				
	4	Colchester 16	Green Mountain Power Corp.	0.00				
	5	Rutland	Central Vermont Pub Serv. Corp.	0.00				
WA	1	Transalta Centralia Generation	TransAlta Centralia Gen, LLC	5.36	6.7	88%	17%	15%
	2	River Road Gen Plant	PUD No 1 of Clark County (WA)	0.39				
	3	March Point Cogeneration	March Point Cogeneration Co.	0.36				
	4	Mint Farm Generating Station	Puget Sound Energy Inc.	0.27				
	5	Chehalis Generating Facility	PacifiCorp	0.27				
WI	1	Columbia	Wisconsin Power & Light Co.	7.24	29.1	67%	43%	29%
	2	Pleasant Prairie	Wisconsin Electric Power Co.	6.65				
	3	Weston	Wisconsin Public Service Corp.	5.82				
	4	South Oak Creek	Wisconsin Electric Power Co.	4.96				
	5	Edgewater*	Wisconsin Power & Light Co.	4.42				
WV	1	John E. Amos	Appalachian Power Co.	13.88	49.3	69%	75%	52%
	2	FirstEnergy Harrison Power Station	Allegheny Energy Supply Co., LLC	10.37				
	3	Mountaineer	Appalachian Power Co.	8.50				
	4	Mitchell	Ohio Power Co.	8.37				
	5	Mt. Storm	Virginia Electric & Power Co.	8.18				
WY	1	Jim Bridger	PacifiCorp	12.87	38.1	89%	66%	59%
	2	Laramie River Station	Basin Electric Power Coop	12.21				
	3	Dave Johnston	PacifiCorp	5.50				
	4	Naughton	PacifiCorp	5.34				
	5	Wyodak	PacifiCorp	2.20				

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Notes

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6. Leading pollutant: Intergovernmental Panel on Climate Change, *Climate Change 2007: The Physical Science Basis, Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, 2007;* National Research Council, *Advancing the Science of Climate Change,* 2010. Power plants are the largest source of carbon dioxide in the U.S.: See U.S. Environmental Protection Agency*, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2011*, 12 April 2013.

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8. U.S. Energy Information Administration reports that there are 5,962 power plants with unique plant identification numbers that report fuel consumption data monthly or annually on EIA Form 923. This figure includes some wind and solar power plants, as well as combined heat-and-power facilities. See U.S. Energy Information Administration, *Form EIA-923 detailed data*, final data for 2011 released 23 January 2013, available at www.eia.gov/electricity/data/eia923/.

9. U.S. Energy Information Administration, *State-Level Energy-Related Carbon Dioxide Emissions*, 2000-2010, released 13 May 2013.

10. U.S. sources of carbon dioxide emissions: See note 7. Worldwide carbon dioxide emissions: European Commission, Joint Research Center and PBL Netherlands Environmental Assessment Agency, *Emission Database for Global Atmospheric Research (EDGAR*) (v. 4.2), 2011, available at edgar.jrc.ec.europa.eu/overview.php?v=CO2ts1990-2011&sort=des9. See methodology.

11. See note 10.

12. Emissions of U.S. power plants: See note 7; Emissions of passenger vehicles: We used the emissions from motor gasoline consumed in the transportation sector – adjusted for the percentage of motor gasoline used by light-duty passenger vehicles–as a proxy for emissions from passenger vehicles in each state and in the U.S. as a whole. Calculated by multiplying the CO_2 emissions from transportation-sector gasoline consumption for each state (per U.S. Energy Information Administration, *State CO_2 Emissions*, data for 2010, released 31 January 2013, available at www.

eia.gov/environment/emissions/state/state_emissions.cfm) by 95 percent, which is the percentage of transportation-sector motor gasoline that is consumed by light-duty passenger vehicles, per U.S. Energy Information Administration, "Transportation Sector Energy Use by Fuel Type Within a Mode, Reference case" *Annual Energy Outlook 2013,* released 15 April 2013.

13. See note 10.

14. Ibid.

15. Ibid.

16. See note 9.

17. In the New England states of Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont, 2011 residential electricity sales were 47,481,000 MWh (per U.S. Energy Information Administration, *Electric Sales, Revenue, and Average Price–Tabl*e 2. *Sales to Bundled and Unbundled Consumers by Sector, Census Division, and State*, released 27 September 2012). In the NPCC New England EPA *eGRID* subregion, electricity sources emit 728.41 lbs of CO_2/MWh, per U.S. Environmental Protection Agency, *eGRID2012 Version 1.0*, downloaded from www.epa.gov/cleanenergy/energy-resources/egrid/index.html on 28 August 2013. Residential electricity use in these states emitted 15.7 MMT of CO_2 in 2011.

18. See note 12, emissions of passenger vehicles.

19. Venezuela's energy-related emissions in 2011 were 178 million metric tons (MMT) of carbon dioxide. See note 10, European Commission.

20. See note 12, emissions of passenger vehicles.

21. See note 9.

22. See note 12, emissions of passenger vehicles.

23. Calculated using an annual *eGRID* CO_2 emissions output rate of 1,216.18 lbs CO_2/MWh for the U.S. as a whole (per U.S. Environmental Protection Agency, see note 17) and total U.S. residential electricity sales in 2011 (per U.S. Energy Information Administration, *Electric Sales, Revenue, and Average Price—Tabl*e 2. *Sales to Bundled and Unbundled Consumers by Sector, Census Division, and State*, released 27 September 2012). Residential sales in the U.S. were 1,422 million MWh in 2011, which resulted in emissions of 785 MMT of carbon dioxide pollution.

24. See note 7.

25. See note 7 and methodology. Note: To the extent that natural gas has replaced coal as a preferred fuel for power providers since 2011, the contribution of coal plants to U.S. carbon dioxide pollution may be reduced.

26. U.S. Energy Information Administration, *How Old Are U.S. Power Plants?*, updated 5 March 2013, available at www.eia.gov/energy_in_brief/article/age_of_elec_gen.cfm.

27. Union of Concerned Scientists, *Ripe for Retirement: The Case for Closing America's Costliest Coal Plants*, November 2012.

28. Ibid.

29. See note 7.

30. Ibid.

31. See methodology.

32. State data for carbon dioxide emissions, seen note 9; pollution from top 5 plants: see methodology.

33. We obtained these estimates by multiplying the percentage of total statewide carbon dioxide pollution from each state's power sector in 2010 by the share of each state's power-sector emissions from the top 5 polluting plants in 2011. (State data for carbon dioxide emissions, see U.S. Energy Information Administration, note 9; pollution from top 5 plants, see methodology.) The Energy Information Administration does not have state-by-state data for power-sector emissions from 2011.

34. See notes 1 and 2.

35. See note 2.

36. See, for example, Eric Roeckner, et al., "Historical and Future Anthropogenic Emission Pathways Derived from Coupled Climate-Carbon Cycle Simulations," *Climatic Change* (online), DOI: 10.1007/s10584-010-9886-6, 21 July 2010. There is great uncertainty about the level of emission reductions required to prevent dangerous climate change, based both on the uncertain future pathway of emissions in developing countries as well as uncertainties regarding the sensitivity of the climate to global warming emissions. For example, a study published by Great Britain's Royal Society estimates that developed countries may

need to make more dramatic emission reductions to prevent a 2°C rise in global average temperatures, if it is even possible at all. See: Kevin Anderson and Alice Bows, "Beyond 'Dangerous' Climate Change: Emission Scenarios for a New World," *Philosophical Transactions of the Royal Society* A, 369: 20-44, doi:10.1098/rsta.2010.0290, 2011.

37. See note 7.

38. Intergovernmental Panel on Climate Change, *Climate Change 2007: Synthesis Report: Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, 2007.

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59. Peter Altman et al., Natural Resources Defense Council, *Killer Summer Heat: Projected Death Toll from Rising Temperatures in America Due to Climate Change*, May 2012.

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96. This fuel category includes anthracite culm, bituminous gob, fine coal, lignite waste and waste coal. We used the value for Coal, Mixed Electrical Power Sector from U.S. Environmental Protection Agency, Center for Climate Leadership, *Emission Factors for Greenhouse Gas Inventories*, November 2011.

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99. Includes diesel as well as No. 1, No. 2, and No. 4 fuel oils.

100. We used the value for petroleum coke.

101. We used the value for residual fuel oils number 5 and number 6.

102. We used the value for waste oil blended with residual fuel oil, per U.S. Environmental Protection Agency, *Waste Oil* Combustion, downloaded from www.epa.gov/ttn/chief/ap42/ch01/final/c01s11.pdf on 8 August 2013.

103. We used a value representing the weighted national average for natural gas consumption for electricity generation.

104. We used a value representing the weighted national average for blast furnace gas consumption for electricity generation.

105. We used the value for fuel gas, per U.S. Environmental Protection Agency, see note 96.

106. We used the value for purchased steam and hot water, per U.S. Environmental Protection Agency, see note 96.

107. We used the value for tires, per U.S. Environmental Protection Agency, Center for Climate Leadership, see note 96.

108. See note 9.

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111. Differences between emissions data in Tables A-2 and A-3 are due to rounding.

112. See note 109.

113. See note 110.