The Clean Power Act: A Policy Analysis

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The Clean Power Team
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Executive Summary

The Clean Power Act (CPA) of 2003 is a four-pollutant bill, sponsored by Senator Jim Jeffords (I–VT) which authorizes a domestic cap-and-trade program for carbon dioxide (CO_2) emissions from electric utility point sources. In response to international scientific consensus on the progression of global climate change, this bill imposes a cap on CO_2 emissions levels from these sources. The issue of global climate change poses a challenge to both current and future generations. It is a polarizing issue both internationally and domestically, as exemplified by international carbon regulation and U.S. resistance to ratifying the Kyoto Protocol. However, even without U.S. participation, Kyoto Protocol was ratified by Russia in November 2004, and will go into effect in February 2005. This is a reflection of the global importance many countries place on the problem of climate change, and indicates the international political importance of the Clean Power Act of 2003.

The Clean Power Act is the first piece legislation in the U.S. designed to curb CO_2 emissions. It aims to reduce national CO_2 emissions from utilities to 17 percent below 2000 levels by 2020. Currently, the U.S. emits an estimated 25 percent of global CO_2 emissions, with the power-generation sector contributing 35 percent of those emissions. Our implementation plan is tailored to correspond with modifications seen during Congressional mark-ups and the Federal Rulemaking Process to the bill. Our plan meets the goal of achieving a politically feasible law and ensuring effective program options. The most important modifications include an extension of compliance deadlines and an incremental phase-in of emissions caps to promote long-term capital investment with short-term efficiency improvements.

The Carbon Dioxide Emissions Program of the Clean Power Act addresses industry skepticism with flexibility by establishing a market-based CO_2 cap-and-trade program through existing Clean Air Markets. It also provides financial assistance through grant funds and loan opportunities to promote research and development and state energy efficiency initiatives. The program will be federally regulated but implemented at the state level, and will measure success through reductions in carbon dioxide emissions, as well as analysis of economic impacts to both consumers and producers. The Clean Power Act's Carbon Dioxide Reductions Program implements a flexible domestic CO_2 reduction scheme to encourage the development of and investment in technological solutions while minimizing the short-term costs to American consumers and the U.S. economy.

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Introduction

The Clean Power Act of 2003 is a multi-pollutant bill that sets strict caps on the emissions of four pollutants—carbon dioxide (CO_2), sulfur dioxides (SO_2), nitrogen oxides (NO_X), and mercury (Hg)—by establishing industry reduction requirements for the electricity-generation sector. The Act directs the Environmental Protection Agency (EPA) to administer an emissions allowance program, which determines annual caps for the four aforementioned pollutants while enabling operational flexibility for power plants. In addition, the CPA encourages energy conservation, the use of renewable and clean energy technologies, and pollution reduction as long-term strategies to protect human health and the environment.

The following analysis outlines the necessary steps for implementation and measurement assuming passage of the bill by Congress and some modifications to the bill as a result of the Federal Rulemaking process. This analysis focuses exclusively on a new Carbon Dioxide Reduction Program designed to meet the CO_2 reductions mandated by the Act. The reductions of CO_2 to 2.05 billion tons by 2009 as mandated by the original Clean Power Act of 2003, which is 17 percent below 2000 levels, has excessive economic costs of implementation. Therefore, in the following analysis, the CPA establishes a three-phase reduction plan of 17 percent below 2000 by year 2020. Here forward, references to the Clean Power Act of 2003 include these modifications while still being referenced as the Clean Power Act of 2003.

<u>I. Political Context</u>

Clean Power Act Legislative Summary

Clean Air Act History

Congress passed the Clean Air Act (CAA) in 1963 to improve air quality in the United States. This legislation allocated funds to state and local regulatory agencies in the form of grants to implement pollution control efforts. Over the course of the next three decades, Congress passed a series of amendments to strengthen the CAA in 1970, 1977, and 1990.

The 1970 CAA Amendments coincided with increased national environmental awareness and activism. They represent a landmark in federal involvement in air quality control by establishing the National Ambient Air Quality Standards (NAAQS), targeting both vehicle and stationary source emissions, and enabling citizens to pursue legal recourse when NAAQS standards are not met. The 1977 Amendments took additional steps to protect air quality by strengthening pollution standards and including the designation of carcinogenic emissions as hazardous air pollutants. The 1990 Amendments set additional strict standards on individual pollutants and enforced the use of maximum achievable control technology (MACT) for certain emissions sources.

Congress has periodically amended the CAA to address new scientific concerns of air pollution and to incrementally improve air quality control on a national level.

An Overview of the Clean Power Act

The CAA has historically been successful in reducing air pollution because it continually updates its standards to reduce pollution based on updated medical information about health impacts and technological feasibility. Carbon dioxide, however, has never been federally regulated, and unlike other pollutants, its environmental ramifications are experienced globally. Innovations in air emissions policies, typified by the 1990 Acid Rain Program and advances in pollution abatement technologies, demonstrate that it is possible to make economical emissions reductions from the electricity generating sector.

The CPA amends the CAA to establish a cap on carbon dioxide emissions. It establishes a three-phase system of reduction caps with 2009, 2015, and 2020 deadlines and authorizes EPA to use a system of tradable emissions allowances to achieve these limits. The allowances provide for dramatic emissions reductions at a decreased cost to utilities as compared to traditional command-and-control regulations. The Act also encourages energy conservation, use of renewable energy technologies, and development and implementation of clean energy and advanced pollution reduction technologies as long-term strategies.

The CPA of 2003 outlines four specific measures to reduce carbon reduction:

- Emissions Limits
- Emissions Allowances
- Enforcement
- Special Provisions

Emissions Limits

The CPA explicitly defines the national pollution limits that the electricity generating industry cannot exceed during a year. The Act sets carbon dioxide emission caps at year 2000 levels for 2009, 10 percent below year 2000 levels by 2015, and, finally, 17 percent below year 2000 levels by 2020.

Emissions Allowances

EPA's Administrator is responsible for establishing an emission allowance trading system by which electric companies will be able to buy and sell allowances on the open market. An emissions allowance system enables maximum pollution reduction at the lowest cost by equitably distributing the relative burden of emissions reductions throughout the regulated sector. Cap-and-trade programs ensure a given level of air quality while allowing the industry to meet that standard in an economically efficient way. Under the CPA, one allowance is equivalent to one ton of carbon dioxide emissions. Allowance allocation is a two-part process managed by EPA and individual states.

At the end of each year, power facilities must submit one emission allowance to EPA, via state permitting authorities, for every ton of carbon dioxide emitted. Facilities that emit more CO_2 than they have allowances will be in violation of the CPA and liable to penalty as specified in the Act. In order to meet emissions caps, individual facilities may purchase unused allowances from other plants on the open market or through EPA's allowance auction. Because the sum of all emissions allowances equals the nationwide annual quota for emissions, the aggregate level of CO_2 emitted does not increase when a given facility emits more than its limit and purchases allowances to make up the difference. The emissions allowance system gives individual power plants flexibility in choosing compliance strategies while maintaining adherence to air emissions regulations. The allowance system also creates a financial incentive for production efficiency, energy conservation, the use of clean and renewable technologies, and pollution prevention.

Enforcement

The CPA explicitly states the penalty for violating the Act: for emitting pollutants in excess of emissions allowances, a fine of three times the market value of an allowance exceeded will be incurred. For example, if a facility emits 5,000 tons of carbon dioxide beyond the number of allowances it holds and the market value of a CO_2 allowance for that year is $10, then the facility would have to pay $150,000.

Special Provisions

The CPA provides multiple provisions designed to offset economic harm resulting from its implementation, such as the promotion of efficiency and renewable technologies, and the funding of research on carbon sequestration. In addition, each year the EPA Administrator may distribute a portion of the emissions allowances for transition assistance to displaced workers and communities economically impacted by this act, as well as to producers of electricity-intensive products. Up to 6 percent of the total allowances may be distributed to these groups starting in 2009; this percentage decreases by 0.5 percent each year thereafter until expiration in 2018. Additionally, revenues from the sale of allowances will help assist states and power companies through grants and revolving loans. Both programs will be run by EPA with and annual application process to determine distributions of funding.

The CPA also supplies transitional assistance to individual electricity generating facilities based on their output to help defray the capital costs of pollution abatement technology. Up to 10 percent of the total allowances may be distributed to these facilities in 2009; this percentage decreases by 1 percent per year until expiration in 2018. Producers of renewable energy, energy efficient sources, and clean energy sources are also eligible for allowances based on the amount of electricity generated by these sources or the electricity saved through the use of more efficient sources. In order to promote research in the sequestration of carbon dioxide, up to 0.075 percent of the allowances (more than 15,000,000 in the first year) for CO_2 will be used to develop permanent and environmentally-benign sequestration methods. Further description of the provisions inclusive of the science and political implications will be provided in subsequent sections of this analysis.

Political Background

The Clean Power Act, first sponsored by Senator Jim Jeffords (I-VT) in 2001, proposed nationwide reductions of air pollutant emissions from large power plants but made little progress in the 107th Congress. Although Jeffords secured 19 co-sponsors for the subsequent CPA of 2003, the Act was (and is) still thought to be too politically controversial. Opponents of the Act maintain that the costs to industry are too high (and that subsequent costs to consumers would be prohibitive), the emission targets are overly ambitious, and the proposed time scale infeasible.

Political Supporters

Supporters of the CPA include environmentalists, human health advocates, and Northeastern states, as well as the international community, and some multinational corporations. Further support of carbon reductions outside of CPA can be seen through many state and federally sponsored reductions programs.

Environmental groups are the primary political supporters of the CPA of 2003. National, state, and local groups such as the Natural Resources Defense Council (NRDC), Sierra Club, and State and Territorial Air Pollution Program Administrators (STAPPA) strongly support the CPA, particularly for its novel regulation of CO_2 emissions.

Human health advocates as well as insurance providers also support the bill. For example, the American Lung Association and the American Cancer Society commend the Act's ability to address the threats to public health posed by air pollution.

Northeastern states, including New York, New Hampshire, Connecticut, Vermont, and Delaware, support the Act because of the environmental benefits they stand to receive through its regulations. Support is also exemplified by the seven states participating in litigation against EPA for pending violations of the Clean Air Act – New York, Connecticut, Rhode Island, New Jersey, Massachusetts, Maine and Washington – also support CPA. These seven states, generally the most adversely affected by air pollution originating from Midwest power plants, assert that the modernization of older power plants will curtail the negative impacts produced by these facilities.

The international community supports measures that would reduce global CO_2 emissions, as shown by the recent ratification of the Kyoto Protocol, which will go into effect in early 2005. In addition, British Prime Minister Tony Blair, intends to designate global climate change as his primary concern when he leads the Group of Eight (G8) summit in 2005.

International carbon regulations have implications for both multinational corporations and their domestic competitors. Many multinational energy companies have already begun implementing environmental controls on their operations in response to increased global environmental consciousness. These entities support the Act, because it would level the playing field for all constituents in the industry by requiring common standards both in the U.S. and abroad. Domestic CO_2 emissions regulation diminishes uncertainty for corporations and would clarify their opportunities in the context of international carbon regulations and variable state policies.

Political Opponents & Competing Legislation

Various entities have opposed the bill, primarily for its strict emissions caps and its ambitious implementation deadlines. These include utility companies, state representatives, industry interest groups, the Chairman of the Environment and Public Works committee, and the current White House administration.

Utilities such as American Electric Power, CenterPoint, First Energy Corporation, and the Tennessee Valley Authority oppose the bill because of anticipated compliance costs attributed to the strict emission reductions. These companies argue that existing legislation and current practices sufficiently maintain and improve environmental quality, and that additional rules, requiring the installation of pollution control equipment, impede their long-term strategies to reduce pollution.

Congressmen and congresswomen from coal and Midwestern states also oppose the bill for its anticipated economic impact. Representatives from West Virginia, Pennsylvania, and Ohio allege that the bill's stringent emission reduction requirements and ambitious deadlines will adversely affect the coal industry. They also predict that many coal-fired power plants would effectively have to close, thereby leaving thousands of workers unemployed.

Industry interest groups supporting the coal and power industry such as Coalition for Affordable and Reliable Energy (CARE), National Association of Manufacturers (NAM), American Petroleum Institute, and American Coal Foundation oppose the bill on the basis of cost to their industries. According to CARE, "The consequences of adopting [The Clean Power Act of 2003] are clear: Escalating energy prices and significant risk of electricity shortages for American consumers and businesses." (Oakley, 2002).

Senator James Inhofe (R-OK), Chair of the Environment and Public Works Committee (EPW), is a long-time steward of private energy and electricity interests. He believes the CPA's initiative is too broad in scope, and instead advocates more localized requirements for emissions standards. Inhofe is the sponsor of a competing Senate bill, the Clear Skies Initiative of 2003, upon which the White House models their Clean Air Interstate Rule. Clear Skies calls for a similar cap-and-trade program on sulfur dioxide and nitrogen oxide, and permits the trading of mercury, whereas the CPA does not. However, Clear Skies does not regulate CO_2 emissions.

Senator Tom Carper (D-DE) also sponsored a competing bill during the 108^{th} Congress called the Clean Air Planning Act of 2003. This bill places emission caps on the same four pollutants as the CPA, CO_2, SO_2, NO_X, and Hg; however it has proposed emissions caps that allow higher amounts of pollution than the caps in the CPA, making it less stringent. The Clean Air Planning Act also establishes a cap-and-trade program with varying cap allowances by pollutant. The Clean Air Planning Act Senate Bill, S.843 is currently stalled in the Committee on Environment and Public Works and its corresponding House bill, H.R. 3093, remains stalled in the Subcommittee on Energy and Air Quality.

It has been argued that the considerable restrictions and expense of CPA caps render implementation at the federal level undesirable. These opponents support continued reliance on existing voluntary programs at the state level, particularly for carbon dioxide emission reductions. Many states already possess or propose laws addressing various components of this Act. However, there are also national voluntary programs that include the Climate Vision Partnership, Climate Leaders, and Voluntary Registry for Reporting Greenhouse Gas (GHG) Reductions the Clean Energy Group, the Clean Energy States Alliance, and Targeted Incentives for GHG Sequestration.

Relation to Current Legislation

During the decades since the Clean Air Act's original ratification, Congress has passed three rounds of amendments placing stricter regulations on air pollution sources, including power plants. Both federal and state governments proposed both stricter and less stringent laws while actually passing and implementing bills that further efforts to reduce power plant emissions. Some of these proposed programs complement the goals of the CPA, while others are redundant and less robust. Legislation that regulates power plant emissions remains a source of political contention as it represents divergent regional interests, and, to a lesser extent, partisanship. As a substitute for Clear Skies Act of 2003, which has not been welcomed by Congress, EPA has initiated rules known as the Interstate Air Quality Rule (IAQR) and the "Mercury Rule." These rules are continually changing and we explore the changes being proposed for the Mercury Rule later on in this text. Under EPA, these different rules would circumvent the legislative process and reduce some Hg, $SO_{2,}$ and NO_X. However, the reductions would not be as rigid as those seen in the proposed in the Clear Skies Act.

Currently, existing federal regulations governing power plant emissions authorize the EPA to regulate SO_2 and NO_X as criteria pollutants through its National Ambient Air Quality Standards. In particular, EPA's Acid Rain Program targets SO_2 emissions nation-wide, and its NO_X State Implementation Plan budget trading program focuses on reducing nitrous oxides at the state level. EPA also mandates New Source Review (NSR) be implemented at power plants, which requires new stationary sources of air pollution or major modifications of existing facilities to apply the Lowest Achievable Emissions Rate (LAER) in their operations. However, because of ambiguity in the interpretation of NSR as it applies to older sources, some older sources have effectively delayed implementation of LAER by expanding the definition of routine maintenance to include technological upgrades. Others have avoided NSR altogether, by delaying or not making emission abatement upgrades to their older facilities and subsequently generating greater levels of pollution.

In December 2003, EPA instated a revision of NSR that is currently being challenged by a variety of states and other organizations because they believe it has reduced the triggering points for NSR, effectively allowing an increase in future emissions. The CPA requires all facilities to apply Best Available Control Technology (BACT), which is similar to LAER but does not include the cost of implementation as a determining factor for installation. It requires BACT installation by specified deadlines, regardless of the facility's age. Furthermore, none of the revisions to NSR, the Clear Skies Act, or any of EPA's proposed rules to circumvent congressional approval regulate CO_2.

Recently, a federal court ruled that EPA must set mercury emissions limits for all coal and oil-fired facilities by December 15, 2003 (since postponed until March 15, 2005). This court mandate motivated the recently proposed legislative initiatives. On January 30, 2004, EPA outlined three alternatives for controlling emissions of mercury from power plants. The first option requires power plants to install controls known as "maximum achievable control technologies" (MACT). The second option establishes "standards of performance," which limit mercury emissions from new and existing utilities. The third option also includes a cap-and-trade program but would be federally administered under the Clean Air Act. EPA proposed to revise its December 2000 finding that it is "appropriate and necessary" to regulate utilities' hazardous air emissions using the MACT standards provisions of the Clean Air Act. This action would give EPA the flexibility to implement a more cost effective way to control mercury emissions. As of May 6, 2004, the regulations for mercury emissions at power plants were set to be unveiled on March 15, 2005. EPA has posted on their webpage that the organization is currently on track to meet that deadline.

There are a variety of state-level regulations and voluntary reductions programs to reduce emissions similar to those outlined in the CPA. Existing state plans include multi-pollutant programs in Massachusetts, Connecticut, and New Hampshire. New Jersey has proposed mercury emissions and New Hampshire has an emission fee established for distributed generation. California and New York also are seen in bills establishing regulations for distributed generation whereas Texas has a standard NO_X permitting process.

Of particular note are state greenhouse gas (GHG) emissions reduction programs that have been developed or are being developed in 28 states and Puerto Rico. These include voluntary CO_2 caps, GHG inventories, and extensive reporting mechanisms. Figure 1 illustrates states with existing State Action Plans (SAP) for GHG as well as states with plans in progress. They have utilized such measures as increased energy efficiency, demand-side energy conservation, renewable energy source reliance, and carbon sequestration to reduce emissions, and they focus on various sectors, including energy, agriculture, and transportation.

State Climate Action Plan Programs

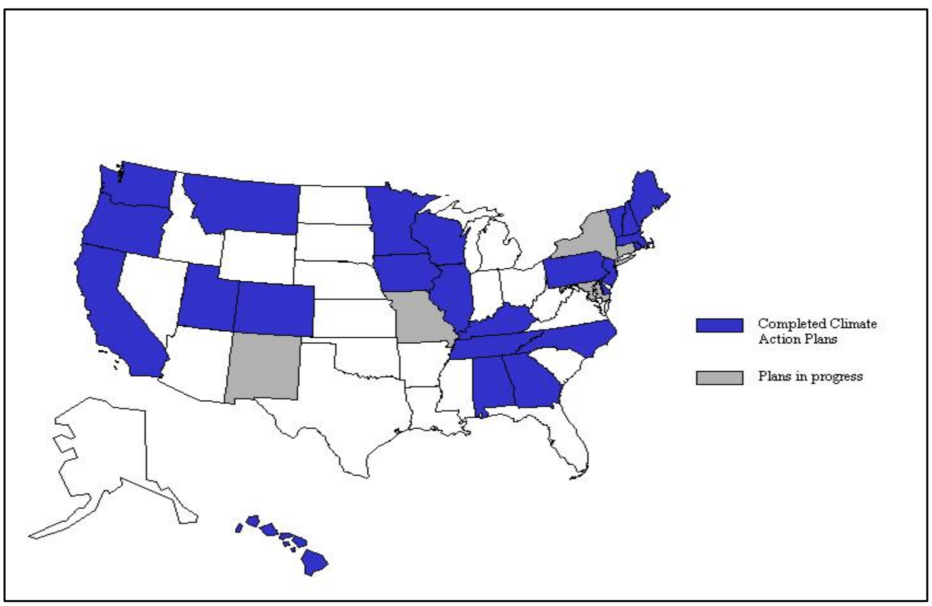


Figure 1: State Action Plan Programs (Source: Pew Climate)

Several federal climate change-related legislative proposals have been presented in Congress since 1997. Energy policy acts calling for capped GHG emissions and improved energy efficiency have been proposed in both the House and the Senate, and the bi-partisan McCain-Lieberman Climate Stewardship Act of 2003 provides for GHG emission allowance trading. Still, these measures have not gained enormous support. Federal legislation dealing with climate change is a source of major political contention, and some remain skeptical of whether climate change is a real threat to the environment. Being that it is difficult to quantify the potential threat to both humans and nature, legislators are constrained when determining if regulations are warranted based on the high economic costs of implementation of cleaner technologies to both industry and the public. There is also a question of whether enacting legislation to curb GHG emissions can make any significant or worthwhile difference to the global climate. Some politicians argue that the nation should take a precautionary approach and limit GHG emissions now, while others reject such initiatives based on significant costs, given unconfirmed benefits. Understanding the science behind global climate change and the proposed solutions can help us gain some information for understanding the complexity of the issue. It will also give us the necessary reasoning to justify the implementation of the CPA.

II. Scientific Background

Environmental Impact of Carbon Dioxide

Carbon (C) is an elemental constituent of both fossil fuels and the atmosphere. The combustion reaction that occurs during power generation releases carbon into the atmosphere in the form of carbon dioxide (CO_2). Carbon dioxide is a gaseous compound uniformly distributed over the Earth's surface, due to its rapid mixing in the atmosphere. Carbon dioxide is generated and sequestered through natural cycles such as respiration and photosynthesis. Fossil fuel combustion has greatly increased CO_2 concentrations in the atmosphere since the Industrial Revolution. The exact intricacies of this process are expressed in The Science behind Carbon Dioxide seen below.

The Science behind Carbon Dioxide

Carbon dioxide is important for sustaining warm temperatures on Earth, and life on this planet as a whole. Naturally, CO_2 occurs as part of the carbon cycle, incorporating photosynthesis and metabolism into the cycle of life of plants and animals. Through the process of respiration, animals (including humans) release CO_2 as they exhale:

glucose + oxygen $\rightarrow$ $CO_2 + H_2O$

Plants then utilize CO_2 for photosynthesis, the process by which plants manufacture carbohydrates and oxygen. According to the Carbon Dioxide Information Analysis Center, "Photosynthesis is dependent on favorable temperature and moisture conditions as well as on the atmospheric carbon dioxide concentration. Increased levels of carbon dioxide can increase net photosynthesis in many plants" (1990). This process is represented by the following equation:

$CO_2 + H_2O$ ***+ sunlight*** $\rightarrow$ ***glucose (sugar) + oxygen,***

Industrially, CO_2 is a natural by-product of combustion and is inherent in the fossil-fuel based electricity production process. In the combustion process, a fossil fuel source combines with oxygen to produce energy (heat) as well as carbon dioxide and water

hydrocarbon fuel $+ O_2 \rightarrow CO_2 + H_2O$

In the past 200 years, as human-induced fossil fuel combustion has released trillions of tons of CO_2 into the air, scientists have observed significant increases in the atmospheric carbon dioxide concentration. Upon first glance, this may not seem significant since carbon dioxide accounts for only 0.035 percent of the Earth's total atmosphere. However, this small amount is sufficient to trap outgoing long-wave radiation (heat released from the Earth), which would otherwise escape into space. Without carbon dioxide and other greenhouse gases, average surface temperatures on Earth would fall well below 0 degree Celsius. Greenhouse gases, including CO_2, which comprise roughly 1 percent of the Earth's atmosphere, are vital to maintaining the average global temperature of about 15 degree Celsius, warm enough to sustain life as we know it on the planet.

The chief concern of scientists and policymakers is that the amount of greenhouse gases released during human activities such as electricity generation is causing a dangerous excess of the heat-trapping potential of the atmosphere. CO_2 represents nearly 80 percent of anthropogenic, or man-made, greenhouse gases and is thus a primary regulatory concern (Pew, 2004). A significant increase in the concentration of atmospheric CO_2 poses the threat of disrupting life-sustaining natural cycles. Scientific evidence shows a correlation between the rising concentration of CO_2 in the atmosphere and departure from the long-term mean temperature of the planet. According to the National Academy of Sciences, the Earth's surface temperature has risen by about 1 degree Fahrenheit in the past century, with most of the warming attributed to human activities.

According to EPA, atmospheric concentrations of CO_2 have increased nearly 30 percent in the last century, and are expected to continue to rise in the coming decades. Figure 2 illustrates the rise in concentration of atmospheric CO_2 since 1959.

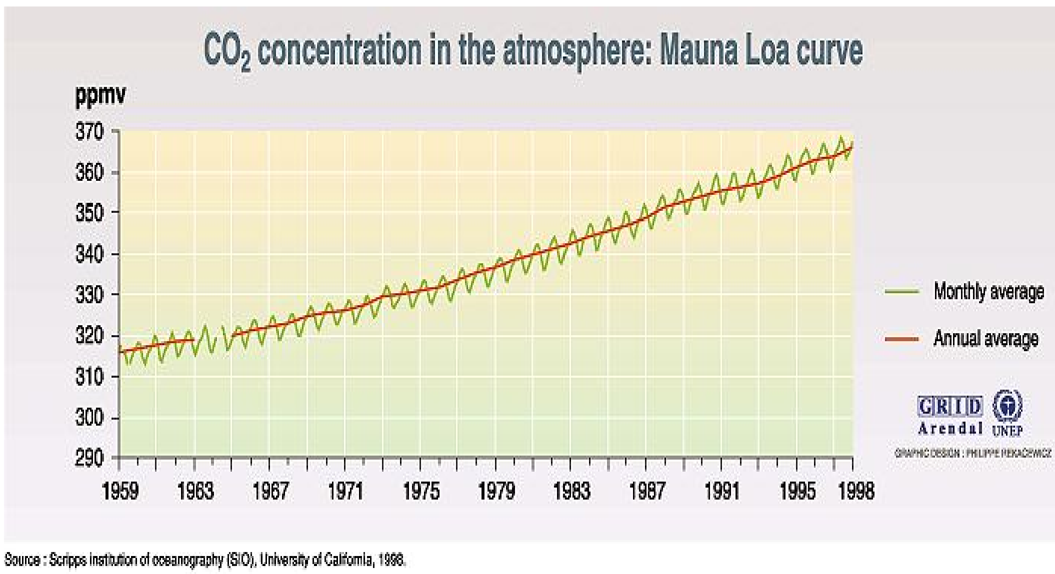


Figure 2: Rise in Global Atmospheric CO_2 Concentrations

(Source: Scripps Institution of Oceanography,
University of California, 1998)

Currently, atmospheric CO_2 concentrations are increasing steadily at a rate of about 0.3-0.4 percent per year. While carbon dioxide itself does not pose immediate threats to human health, CO_2 is a greenhouse gas that traps solar radiation, altering global surface temperatures. Climatic disruptions have the potential to damage animals, plant life, and global ecosystems. Many researchers predict calamitous environmental consequences due to the changing climate and weather patterns, including extreme weather events such as intense storms, hurricanes and flooding, heat waves, and drought. Long-term regional temperature shifts may alter ecosystems and increase desertification, disrupting not only natural ecosystems, but also agricultural patterns by permanently altering the boundaries of vegetation zones. Ultimately, subtle alterations in climatic patterns may destroy natural habitats and lead to the widespread extinction of sensitive animal and plant species.

Global climate change has implications to human health as well as environmental impacts, such as heat-related mortality and greater incidence of disease. Warming temperatures may extend the ranges and seasons of some disease-transmitting organisms, particularly insects and rodents. This can accelerate the spread of certain infectious parasites and increase the prevalence of vector-borne diseases such as malaria and West Nile Virus and that of non-vector-borne infectious diseases like typhoid and cholera.

An increase in the incidence of extreme weather events resulting in increased precipitation could lead to damage from flooding, and may also introduce chemical pollutants into water supplies (through excessive runoff), resulting in deaths, injuries, and various illnesses. Such events can also alter agricultural regions in the short and long-term, causing food shortages and starvation. Warmer temperatures are associated with glacial melting, which have led to rising sea levels and may inundate coastal urban centers, which hold much of the world's population. Densely populated regions like New York City and Bangladesh could easily be flooded by heightened sea levels due to global climate change.

Despite the overwhelming evidence of global climate change's occurrence, there remains some controversy surrounding its connection to increased ambient concentrations of carbon dioxide and other human generated greenhouse gases. Some scientists argue that the rise in CO_2 is a natural occurrence and cite CO_2 fluctuations in the atmosphere over geologic time as evidence. Others recognize the anthropogenic role in CO_2 increases but postulate that increasing global temperatures will be more beneficial than harmful, as additional regions become suitable for agricultural production and colder regions attain more comfortable temperatures. Scientists promoting these impacts comprise a small, but vocal, constituency that often weigh in on decisions regarding the importance of reducing CO_2 emissions. The argument that expensive regulations would do little, if anything, to counter observed trends in climate change has made achieving consensus for federal carbon dioxides regulation difficult, despite the severity of projected consequences.

Power Plants

The Clean Power Act of 2003 explicitly targets electric power-generating plants and their emissions. These facilities contribute approximately one-third of U.S. carbon dioxide emissions (General Accounting Office, 2002), and this chapter will briefly outline the way power plants operate, the fuels they combust, and the emissions produced during electricity generation.

In order to evaluate the scientific feasibility of reaching the CPA's specified emissions reductions in the given timeframe, it is critical to understand how power plants produce electricity and how CO_2 is formed during electricity generation. While carbon control technology does not yet exist on a commercial scale, promising technologies are in development and will be available in time to meet the goals established by the Act. It is hoped that in the future, such emissions can be dramatically reduced, or avoided entirely, through the use of new or improved power generation methods.

Power Plant Operations

There are more than 9,000 power-generating facilities in the United States providing electricity to homes and businesses nationwide. These facilities produce electricity using a variety of inputs, most commonly fossil fuels including coal, petroleum (oil), and natural gas. Power plants can also use nuclear energy, hydropower, and renewable energy sources such as wind power, solar energy, geothermal energy, and biomass fuel. Figure 3 illustrates the amount of energy produced annually by fuel source.

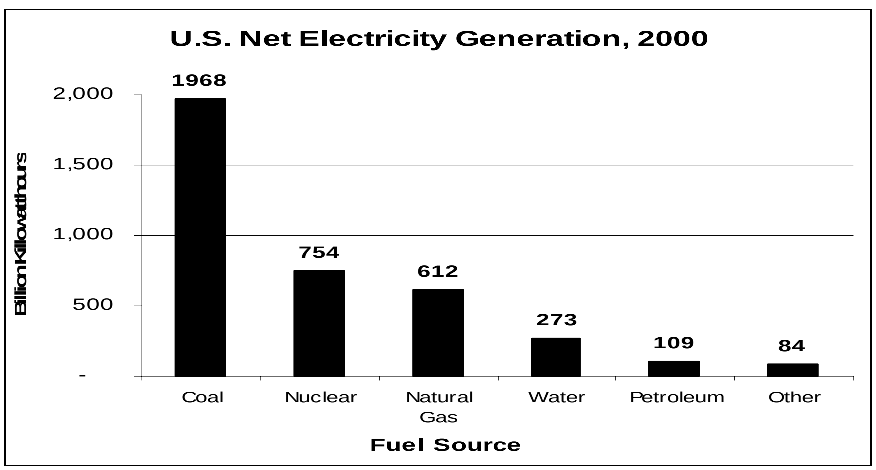


Figure 3: Fuel Source for U.S. Electricity Generation (Source: Energy Information Administration)

This report focuses on fossil fuel-powered facilities, with primary attention paid to coal-fired power plants because they generate the largest percentage of electricity within the U.S.

Fossil Fuels Used for Electricity Production

Coal is a naturally occurring and abundant resource in the United States that has been used for electricity generation since the late 1800's. To generate electricity, coal is crushed into a fine powder and then used as a combustion fuel. Coal is an inexpensive and domestically available fuel source; however, it is less efficient than other fuel sources and contains comparatively high amounts of contaminants such as mercury and sulfur. Coal-fired power plants comprise the majority (51 percent) of electricity generation in the United States, and, contribute the greatest amount of harmful emissions (EPA, 2000). Polluting emissions released during this combustion vary by grade of coal; however, the dirtier grades of coal tend to be less expensive and more plentiful than the cleaner grades.

Natural gas is a blanket term used to describe various gases naturally occurring deep in the Earth. The vast majority of natural gas occurs as methane, but other forms include ethane, propane, and butane. Most of the natural gas extracted domestically comes from Texas, New Mexico, Oklahoma, and Wyoming. Natural gas is utilized in gas-fired, combined-cycle, and cogeneration processes as discussed below. This fuel source is both cleaner and more efficient than coal, and comprises 16 percent of fuel used for U.S. electricity production (EPA, 2000).

Petroleum is the third fossil fuel used to generate electricity and is used in power generation similarly to natural gas. Oil, however, is used primarily as a fuel source for transportation and contributes less than 3 percent of total electric power generation.

Fuel Use

Combustion of fossil fuels is the most prevalent form of electricity production in the United States. Figure 4 depicts a coal-fired power plant and illustrates the commonly used process of steam-powered electricity production. In its most basic interpretation, the fuel source (A) is inserted into the power plant. The fuel is burned in the boiler (B) where the heat generated boils water to create steam (C). Steam pressure turns a turbine (D), which powers an electrical generator (E) and produces electricity (F). The water used in the boiler condenses, assisted by cooling water piped in from a river or reservoir (G), and returns to the boiler. Excess hot gases and particulates created in the power generation process escape as exhaust through the emissions stack (H).

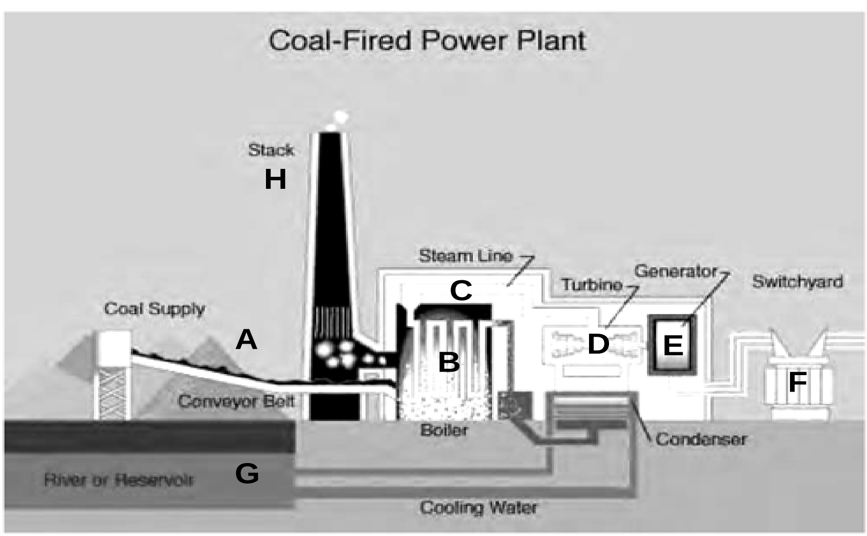


Figure 4: Coal-Fired Power Plant Schematic (Source: Community Science Action Guides)

Power Plant Cycles

Utilities can use one of four main power generation processes – steam generation, gas generation, combined cycle and cogeneration – each employing some form of the electricity production procedure described above. Steam generation is a process by which steam alone turns a turbine and produces electricity through the electrical generator as depicted in Figure 5. Gas generation uses the hot gases created by combustion of the fuel in the boiler to turn a gas turbine; the gas turbine, illustrated in the bottom of Figure 5, powers the generator to produce electricity. According to industry expert Steve Kellogg of Exxon Mobil Corporation, these two processes are between 25 percent and 32 percent efficient. In both cases, hot gases are released as waste through the stack.

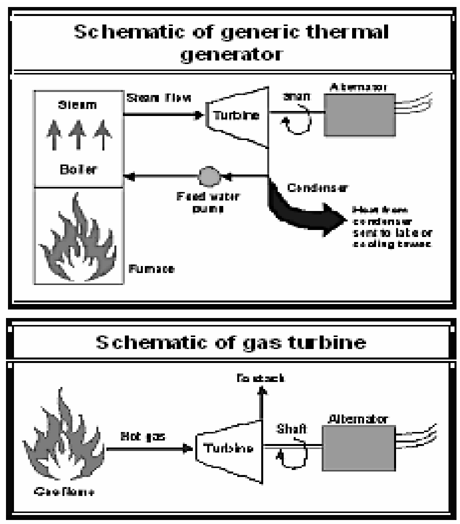


Figure 5: Schematics of Steam Generation and Gas Generation (Source: Baldick, 1999)

Combined cycle electricity generation shown in Figure 6 typically uses both gas and steam generation processes. In this case, the hot "waste" gases from gas generation are captured and reused to power an additional steam turbine and create additional electricity, increasing the efficiency of power generation. This process can increase the efficiency to over 40 percent.

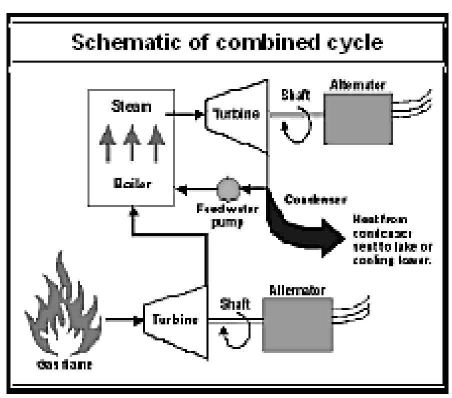


Figure 6: Schematic of Combined Cycle Generation (Source: Baldick, 1999)

Cogeneration, a process that uses the excess hot gases produced through gas-fired generation for other purposes such as manufacturing or central heating shown in Figure 7, can achieve up to 50 percent efficiency. Cogeneration plants are typically smaller in size and located adjacent to the recipient of the generated heat. This process eliminates the need to burn additional fossil fuels for heating purposes, and this increased efficiency reduces overall emissions. According to the Energy Information Administration (EIA), cogeneration accounts for more than half of all new power plant capacity built in North America in the last decade.

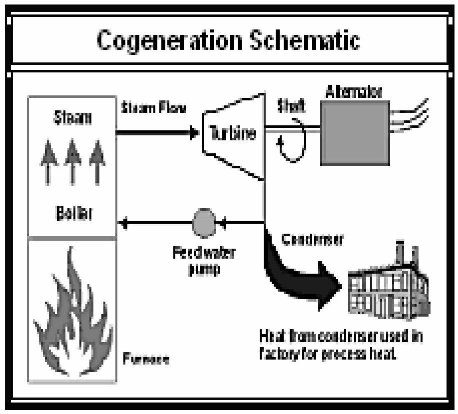


Figure 7: Schematic of Cogeneration (Source: Baldick, 1999)

Emissions

Emission levels are largely a product of fuel source combustion and electricity generation cycle. Unlike other pollutants, which are formed from impurities in fossil fuels, carbon dioxide is an inherent constituent of the combustion process (formed when burning coal (carbon) interacts with oxygen in the combustion chamber), and releases are mitigated only by implementing increased efficiency in combustion techniques. Figure 8 illustrates emission levels driven by each fuel source. Using the most pollution-intensive and most widely used fuel source, coal-burning power plants release the majority of all CO_2 emissions from the U.S. energy sector. Natural gas is typically used in the more efficient combined and cogeneration cycles and, therefore, uses less fuel to produce the same amount of electric power, thereby producing less carbon dioxide than other methods. However, natural gas is currently twice as expensive as coal and is also more vulnerable to price fluctuations on the open market.

Fossil Fuel Carbon Dioxide Emission Levels (Pounds per Billion Btu of Energy Input)	
Coal	**208,000**
Oil	**164,000**
Natural Gas	**117,000**

Figure 8: Fossil Fuel CO_2 Emission Levels (Source: Energy Information Administration)

Available Strategies or Technologies for CO_2 Reductions

Coal power produces a disproportionate amount of the pollutants addressed by the Clean Power Act, so technology and efficiency investments that affect coal electricity production provide the greatest potential for reaching the required reductions of pollutants by 2020. There are four ways to reduce CO_2 emissions from coal-based power generating facilities: 1) demand-side management, 2) fuel switching, 3) improved plant efficiency, or 4) carbon sequestration. Demand-side management is a strategy that encourages conservation on the part of electricity consumers, and is already being undertaken through some state programs. Such measures were implemented in California during the recent energy crisis to yield dramatic energy conservation, which consequently reduced CO_2 emissions. Similarly, fuel switching is an existing and proven strategy, and improvements in plant efficiency are well understood, though they vary in relative returns in efficiency improvements. Current research and technologies focus on new techniques for increasing power generation efficiency and carbon sequestration, removing CO_2 from the atmosphere after it is emitted. Although cost is undoubtedly a factor in any new initiative such as the ones outlined in the CPA, effective technological development as well as increased demand for these technologies will eventually decrease costs. The CPA's phased emissions reduction targets are designed to take full advantage of newly developed technologies as they become available.

Demand-side Management

Demand-side management (DSM) entails the creation of programs that aim to improve or promote the reduction of energy consumption by focusing on reduced energy use of homeowners, businesses, institutions, and industrial consumers of electricity. Methods include energy conservation, improved energy efficiency, and load management.

Energy conservation aims to reduce the amount of electricity used for cooking, heating, lighting, and other functions. This can be achieved by such simple measures as turning off lights and improving building insulation. Improving energy efficiency entails utilizing more energy-efficient processes and appliances. The U.S. EPA-sponsored EnergyStar™ program identifies appliances, lighting, heating and cooling, and other products, some of which reduce energy consumption by up to 70 percent. Finally, load management is a process by which electric generation companies match their energy production to periods of peak and off-peak consumption. Multiple states have introduced DSM programs as a way of reducing greenhouse gas emissions.

Fuel Switching

A second method for reducing carbon dioxide emissions is switching the fuel source away from coal and using another form of fuel. As mentioned above, the majority (51 percent) of fuel used in American power plants is coal, though coal is the largest emitter of carbon dioxide relative to the energy produced. Switching to either traditional natural gas or liquid natural gas (LNG) would greatly decrease the amount of carbon dioxide emissions. Alternatives, such as biomass or methane gas recovered from landfills, may also hold some promise as fuel sources for the future. However, coal is an abundant domestic source of energy in the U.S., and for this reason, our program design pushes for the development of clean coal technologies rather than inducing plants to shift toward cleaner, but expensive and scarce, natural gas.

Efficiency Improvements

Efficiency is the most important strategy for meeting the initial emissions reduction targets outlined by the CPA. Power plants can improve their efficiency by upgrading their facilities or by replacing existing infrastructure (pipes, valves, air compressor controls, etc.). Some efficiency improvements include reducing venting during combustion, using gas (rather than coal) to start and restart engines, employing cogeneration or combined heat and power systems that capture otherwise wasted heat energy. Efficiency gains from cogeneration or combined heat and power systems can lead to overall system efficiencies in excess of 80 percent (Bailie et al., 2003)

Power plants can also replace their entire power-generating infrastructure with newer technologies such as pressurized fluidized combustion systems or coal gasification. Pressurized fluidized combustion can achieve high efficiency by increasing the pressure of the gas and accelerating combustion. This process yields as much as a 50 percent increase in energy produced per fuel input, thus reducing CO_2 emissions for any given amount of electricity. Coal gasification is another process that results in a decrease of CO_2 emissions per unit of electricity produced. In this process, coal is combined at high temperatures with steam and oxygen, creating combustible gases such as carbon monoxide (CO), hydrogen (H), and other gaseous compounds. This process creates highly concentrated CO_2 emissions which can potentially be captured and removed from the emission stream. According to the U.S. Department of Energy, coal gasification offers one of the most versatile ways to use coal cleanly and efficiently.

Carbon Sequestration

In addition to employing technologies to improve combustion efficiency or implementing demand-side management, carbon sequestration techniques are being developed to capture and remove airborne CO_2. One type of carbon sequestration involves utilizing natural carbon sinks such as vegetation and oceans to absorb airborne CO_2. This can be achieved through planting trees (terrestrial sequestration), or injecting CO_2 deep into the ocean (oceanic sequestration). Another method of carbon sequestration is to store CO_2 in abandoned mines, oil wells and empty aquifers (geologic sequestration).

To begin the process of sequestration, carbon dioxide must be separated from the other atmospheric gases and captured in a concentrated form. As the majority of power plants use air-fired combustion, they exhaust CO_2 along with other gases such as SO_2 and NO_X. Carbon dioxide comprises 10-12 percent of this flue gas emitted from coal-fired power plants and 3-6 percent from natural gas-fired power plants. Several options for capturing the emitted carbon dioxide currently exist but the most promising include chemical absorption and gas separation membranes (DOE, 2004). Carbon dioxide is an acid-producing gas, therefore chemical absorption depends on an acid-base neutralization reaction, which uses basic solvents such as alkanolamines, ammonia, and potassium carbonates. Since SO_2 and NO_X reduce the absorption capacity of these solvents, they must be removed before the CO_2 can be properly absorbed. The second method involves the installation of gas separation membranes. The CO_2 gas gets dissolved in the membrane and transported by a diffusion process. There are many types but the most efficient are porous metallic and ceramic membranes. These membranes can separate the flue gas by the different sizes of the molecules that make up the gas.

Once the gas has been properly separated and captured, there are three major methods for storage: oceanic, geologic, and terrestrial. The storage systems do require more research before they can be fully utilized for sequestration and are currently in the development stage. Oceanic sequestration requires CO_2 to be injected directly into the ocean at depths of at least 1,000 meters to ensure proper storage. The challenge will be to determine how to use the buffering capacity of bottom sediment, such as calcium carbonate, to react with the CO_2 in order to increase the capacity and effectiveness of this method. Building the necessary infrastructure for oceanic sequestration is also a daunting task. Another method of oceanic sequestration would be to increase phytoplankton growth at the ocean's surface by increasing the availability of nutrients such as iron, nitrogen and phosphorus. More phytoplankton would increase reactions with atmospheric CO_2 through the process of photosynthesis. Once the plankton die they will settle down to the ocean floor, bringing the CO_2 with them.

CO_2 can also be stored in geologic formations such as abandoned oil and gas wells. It can be trapped as a gas or a liquid under low-permeability caprock, much in the same way natural gas is naturally trapped underground. An additional method is to dissolve the CO_2 in another liquid before injecting it underground; this method would reduce the likelihood of leakages.

Finally, we can pursue terrestrial carbon sequestration by protecting ecosystems that trap and store carbon, or by manipulating these ecosystems to increase sequestration beyond current conditions. Land sequestration can be done through either soil or biomass. Soil is better for carbon storage than biomass because the gas has a longer residence time in this medium. Residence time can be extended by increasing the depth at which carbon is stored in the soil or by increasing the density of carbon in the soil. Other possible carbon storage methods include the creation of smart fertilizers seen as mixtures of minerals created at power plants, such as carbonates, silicates, and oxides, with biomass, such as sewer sludge. Other ways of increasing CO_2 absorption on land include increasing the rate of accumulation of trees and plants, increasing the density of total biomass per area, and decreasing carbon dioxide-releasing decomposition rates.

While carbon dioxide sequestration is being researched by government and academic institutions, both the capture technology and ability to permanently sequester the carbon without harmful side effects has yet to be developed, tested, and perfected. The primary obstacle to carbon sequestration is the cost. The process of capturing and sequestering a ton of CO_2 currently costs approximately $150 per ton, the majority of which involves the capture process. One source estimates installing current technologies at power plants would increase the cost of electricity from 2.5 to 4 cents per kilowatt-hour (DOE, 2004). For carbon sequestration to be economically viable, the cost would have to be reduced to about $10-$20 per ton.

Alternative Energy Sources

The Clean Power Act provides incentives for further development of alternative energy sources such as wind power, solar power, fuel cells, biomass, landfill gas, geothermal, and other energy sources. This provision is intended to increase the use of and research into alternative energy generation, which can help reduce overall carbon dioxide output without compromising energy supply. The timeframe for carbon dioxide reductions in the Act allows for limited implementation of currently available alternative energies to meet initial reduction targets because alternatives are not available to replace a significant portion of the nation's energy needs. At this time, wind power and solar energy, and the possible increased use of existing nuclear power represent the most feasible sources of non-fossil fuel energy.

Wind Power

Wind power is the world's fastest growing energy source and has been used in rural communities for hundreds of years. In the late 1800s technological improvements made wind power efficient on a large scale. Since then, the creation of lighter, stronger materials and other advances in technology have led to the development of large wind farms, which collectively generate enough electricity for five cities the size of Miami (AEI, 2004). Some estimates have indicated that the costs of wind power implementation will continue to drop as the technology advances. Widespread use of wind energy could prevent the emission of millions of tons of CO_2. Moreover, requiring carbon dioxide abatement at coal-fired power plants may be enough to make wind power more economically competitive.

Wind power may be less reliable than traditional fossil fuel generation because of the unpredictable variations in wind velocity. In addition, wind farms require wide expanses of land, which are difficult to find near populated areas. Within populated areas that can be developed landowners often see the turbines as unsightly structures that are aesthetically unappealing. Therefore, it can be difficult to motivate land owners with enough open space to develop wind power because it would make the area seem less natural. Developing wind farms in uninhabited areas where sufficient space and wind exists necessitates extensive transmission lines to transport the power. Furthermore, wind power developments entail large capital investments and currently depend on government tax credits to make installation economically feasible. The collectiveness of these circumstances make wind power expansions complicated.

Solar Power

The sun is another energy source that holds some promise. Solar power technology harnesses the sun's radiative energy and converts it into electricity. Like wind power, solar power is an emission-free technology. In solar power generation, silicon chips called photovoltaic cells convert sunlight into electricity by generating direct current (DC). The cells also convert the DC into alternating current (AC) that can be used or sold to electric utility companies on the existing electric grid. Photovoltaic cells can continue operating with little maintenance for up to 30 years. Drawbacks to the widespread use of solar energy include inconsistent sunlight, the large amount of surface area required, and the capital cost of the photovoltaic equipment. Solar power is not currently used for large-scale electricity generation; however, due to its efficiency on a small-scale, many individuals have begun using solar power to meet a portion of their energy needs. As in the case of wind power, it is anticipated that additional research will lead to decreased costs which will make this technology more accessible.

Fuel Cells

Fuel cells are another potential energy technology that will likely be investigated as a viable alternative to fossil fuel electricity generation. Fuel cells work like batteries, generating clean electricity by transforming stored energy into electricity and heat. They have many applications and virtually no emissions. Fuel cells do not create power by themselves, however. Even the cleanest fuel cells may not represent true carbon dioxide reductions if the energy stored by the cell is created by burning fossil fuels. Fuel cells are not yet used on a broad scale, and in fact constitute a far smaller share of America's energy portfolio than even solar power.

Nuclear Power

Because wind power, solar photovoltaic cells, and fuel cells are unlikely to significantly reduce national dependence on fossil fuels by 2009, the power-generating industry may become more dependent on existing nuclear energy facilities in response to potential decreased output from coal-fired power plants. Atomic fission creates abundant and consistent energy and emits no greenhouse gases, and nuclear energy already comprises 20 percent of electricity production in the United States. The current political milieu is unfavorable to the construction of new nuclear facilities, stemming from the potential human impact of a nuclear accident and the risk associated with the storage of nuclear waste. No new nuclear power plants have been constructed in over 20 years. Nonetheless, the efficiency of existing nuclear-powered electricity generation could be increased with plant upgrades such as those that have shown results in some of Europe and Japan's new facilities. U.S. nuclear power plants have shown a steady improvement over the past 10 years and are already highly efficient. With more efficiency improvements, existing facilities may yield more electricity to meet the country's growing energy needs. Although requiring significant gains in public support, new technology may enable nuclear power to replace some of the high-emissions power generation. Continual improvement of oversight and safety measures will also allay public fear of nuclear power.

The Future of Alternative Energies

Legislation such as the CPA of 2003 is expected to spur innovation and research into alternative electricity technologies that will minimize emissions; however, the 2009 deadline to reach year 2000 emissions levels arrives too soon to adopt new technologies on a scale that meets our current energy needs. To meet this initial deadline, we may have to conserve energy and depend on our existing nuclear infrastructure to substitute megawatts currently generated by coal-fired power plants.

Although the list of alternative energy sources is growing, these sources have been comparatively more costly and therefore not competitive with current electricity generating practices. Because the cost of coal remains low and is likely to remain stable due to an abundant domestic supply, alternative energies have limited potential as solutions to the energy/CO_2 predicament, at least for the near term. In the future, utilities may use alternative technologies in a supplemental role to meet the initial caps, yet the more stringent caps will develop methods to continue the use of inexpensive coal through cleaner coal power generation technology.

III. Implementation

Despite general consensus within the international scientific community on the correlation between increasing concentrations of carbon dioxide and global climate change (as indicated in Part II), the issue is still disagreed upon in the U.S. government and among some industries. Additional issues compounding the controversial nature of carbon dioxide regulation in the U.S. include the fact that the U.S. is a fossil fuel based economy, the advantage of coal as a cheap and abundant domestic fuel source, and the right that many Americans feel they have to inexpensive electricity. The Clean Power Act Carbon Dioxide Reduction Program, outlined in this section, offers a pragmatic approach to regulating carbon dioxide emissions from power plants. This program provides a cost effective method to reduce emissions while ensuring minimal impact to affected industry and the U.S. economy.

Modifications to the Original Bill

Under a provision of the Clean Power Act, the EPA establishes CO_2 regulations within the first year after congressional passage in order to avoid legal recourse. The program's first year of implementation only involves the Federal Rulemaking Process (explicated in the Appendix: "Expanded Federal Rulemaking Process").

Following the Federal Rulemaking Process, the EPA will set emissions targets and deadlines listed in Figure 9. As explained earlier, the emissions targets and deadlines for this analysis deviate from the original Clean Power Act of 2003, having been adjusted to ensure feasible implementation.

Phase	Year	Reduction
1	2009	To 2000 levels
2	2015	10%*
3	2020	17%*

Figure 9: Emissions targets of the CPA established following the federal rule making process (*Below 2000 levels)

Under the EPA-administered allocation system, allowances are distributed through a three-phase incremental program similar to the two-step program used in the Acid Rain Program. Allowances will be initially distributed to states. Allowances will then be allocated by the states to facilities in accordance with approved State Implementation Plans or through an EPA allowance distribution formula. Phase I will bring power plant CO_2 emissions down to year 2000 levels by 2009; this reduction target is expected to be achieved primarily through state-sponsored demand-side management plans. California has demonstrated the feasibility of such an approach, detailed in the following box:

Case Study: California's Energy Action Plan

In response to the energy crisis of 2001, the State of California developed an Energy Action Plan (EAP) in 2003 in coordination with the Consumer Power and Conservation Financing Authority, the Energy Resources Conservation and Development Commission, and the Public Utilities Commission. This action plan is designed to "eliminate energy outages and excessive price spikes in electricity and natural gas" while being "sensitive to the implications of energy policy on global climate change and the environment generally" (EAP, 2003). Of the six specific means through which the state intends to achieve their goals, the primary action item is to meet the state's energy growth needs by "optimizing energy conservation and resource efficiency and reducing per capita electricity demand." This demand-side reduction in energy consumption is outlined in nine specific actions, stated as follows:

1. *Implementation of a voluntary dynamic pricing system to reduce peak demand*
2. *Improve new and remodeled building efficiency by 5 percent*
3. *Improve air conditioner efficiency by 10 percent above federally mandated standards*
4. *Make every new state building a model of energy efficiency*
5. *Create customer incentives for aggressive energy demand reduction*
6. *Provide utilities with demand response and energy efficiency investment rewards comparable to the return on investment in new power and transmission projects*
7. *Increase local government conservation and energy efficiency programs*
8. *Incorporate distributed generation or renewable technologies into energy efficiency standards for new building construction*
9. *Encourage companies that invest in energy conservation and resource efficiency to register with the state's Climate Change Registry (EAP, 2003).*

These robust measures are aimed at reducing the electricity consumed in the state in light of current annual energy consumption growth at 2 percent and a population expected to exceed 40 million by the year 2010. And according to a status report completed in September of 2004, energy efficiency savings have increased significantly and are expected to continue to do so in coming years. Furthermore, all independent operating utilities (IOUs) are active members in the Climate Registry, new building efficiency standards have been approved with training programs and incentives currently available, and appliance regulations have been approved and implemented. Additionally, both large and small customer dynamic pricing pilot programs appear successful in curtailing energy consumption, and these programs are being modified to increase participation. (Status Report, 2004).

Demand-side energy reduction in California is ultimately poised to "minimize the need for new generation [of electricity], reduce emissions of toxic and criteria pollutants and greenhouse gases, avoid environmental concerns, improve energy reliability and contribute to price stability" (EAP, 2003). The example set by California provides a model for all states in conserving electricity and reducing utility emissions across the United States.

Phase II will reduce CO_2 emissions to 10 percent below year 2000 levels by 2015, and can be achieved utilizing existing technology for efficiency enhancements and transitions to processes such as combined cycle and cogeneration techniques. Finally, Phase III will reduce CO_2 emissions to 17 percent below year 2000 levels by 2020, primarily through the implementation of new technologies and carbon sequestration.

The program design for the CPA includes methodologies for emissions allocation, an annual auction of retained emissions, federal financial assistance via grants and a revolving loan fund, emissions reporting, and performance management. The design of the program has incorporated flexible management mechanisms to minimize transition costs to EPA, the states, and regulated facilities.

Program Design

This section identifies the key components of the Carbon Dioxide Reduction Program for reducing emissions as mandated by the Clean Power Act. These include emission allowance allocations (including voluntary CO_2 reduction credits) and federal financial assistance (including grants for state programs and the establishment of a revolving loan fund), as well as detailed staffing requirements, budgetary outlays, and a scheme for performance management.

Precedent for the Program Design

The CPA requires that EPA distribute emissions allowances for carbon dioxide under a cap-and-trade system. EPA currently administers the highly successful Acid Rain Program in which it distributed allowances for SO_2. Additionally, EPA allocated and distributed allowances to states as part of the NO_X State Implementation Plan (SIP) Call which is a program in which Eastern states reduce persistent levels of nitrogen oxide. While carbon dioxide is currently unregulated at the federal level, some state-level CO_2 programs are operating, including a major CO_2 reduction initiative by the State of California. The following issues identify areas of EPA discretion in implementing the CPA requirements. Policy options for carrying out the CPA are largely based on established models of regulation under the Acid Rain Program (see below) and other existing programs.

Case Study: Sulfur Dioxide component of the EPA's Acid Rain Program

Under the Clean Air Act's Acid Rain Program, the EPA Administrator allocated sulfur dioxide emission allowances at an emission rate of 1.2 pounds of SO_2/mmBtu (million British thermal units) of heat input, multiplied by the unit's baseline mmBtu (the average fossil fuel consumed from 1985 through 1987). Reserve allowances were set aside for utilities that installed clean technology in order to encourage that practice as a means of reducing SO_2 emissions. In addition, the EPA Administrator auctioned 2.8 percent of the total annual allowances in order to ensure the liquidity and economic efficiency of the market and to avoid potential imbalances between demand and supply. The special reserve also allowed for the addition of new electrical generation capacity. Once the allowances were allocated, utilities and other market participants could buy and sell according to need or strategy on the Chicago Board of Trade. The value of an allowance is quickly determined by these open market trades. The price of SO_2 allowances ranged between \$100 and \$200 per ton between 1998 and 2003. Beginning in 2004, the price of an allowance has steadily increased to the current price of \$360. Despite these increases, the program is considered a fiscal success. Beginning in 1990 the EPA estimated the cost of complementing the Acid Rain Program to \$4.6 billion per year. As of 1994 the General Accounting Office estimated the cost would decrease to \$2 billion per year by 2010 and as of 1998 it had continued to drop to less than \$1 billon per year by 2010 (EPA, 1999). This is a significant decrease in cost and reflective of a successful format to build upon for other pollutants and programs.

Rationale for Program Design

A technology-forcing regulation, such as the Clean Power Act, sets an emissions standard that cannot be achieved with currently available technology and thus "forces" firms to develop innovative technological solutions to achieve compliance beyond existing technical capabilities. Under this performance-based approach, each firm will modify operations in different ways to find the most cost-effective compliance strategy by changing input materials, reorganizing production systems, and/or installing pollution-control technologies.

In the initial phase of regulation, the standards may be too costly to be socially beneficial, so the industry is expected to innovate in order to decrease compliance costs. After sufficient technological advance has occurred, the regulatory agency will review the success of the innovation and may adjust policies accordingly. Firms benefit from increasing innovation by reducing their own marginal costs while raising their rivals' marginal costs by encouraging more regulation. The costs to firms under this system include incremental tightening of regulations, innovation spillovers that reduce the marginal costs of competing firms, and increases in research and development costs.

Conventional command-and-control technology-forcing approaches demand that firms meet uniform requirements, regardless of cost. While these regulations have been effective in their policy objectives and in improving social welfare, holding every firm to the same standard is economically inefficient, given firms' varying marginal costs of abatement. In contrast, marketable permits define an overall level of emissions rights for firms and allow them to trade freely. In theory, market-based mechanisms are more economically efficient because they allow firms with low abatement costs to abate relatively more pollution than high-cost firms. This economic instrument has its shortcomings, as it often leads to increases in urban pollution because higher levels of pollution control may be shifted to rural areas where abatement costs may be lower. But since the effects of excessive carbon dioxide emissions are ubiquitous, this is an ideal way to address this particular pollutant. A combined regulatory policy of overall industry-specific technology-forcing standards with market-based mechanisms to achieve compliance, as delineated by the Clean Power Act Carbon Dioxide Reduction Program, is the most cost-effective way to simultaneously meet pollution reduction goals and induce the development of CO_2 reducing technology.

Emission Allowance Allocations

Federal EPA Allocation to States

In the initial step of the cap-and-trade program, EPA allocates emissions to states based on an average of the previous five years total carbon emissions output. The baseline for determining emissions allowance allocations will be recalculated every five years, based on a facility's emissions during those previous five years. In addition, the program reduces the pollutant multiplier within the Basic Allocation Formula (discussed in more detail below), thus tightening emission standards for the target years. Periodically updating the baseline calculation gives plants credit for recent conservation and efficiency improvements. Furthermore, utilities are assured some measure of regulatory stability and are given temporal flexibility in meeting the cap. This is vital for maintaining year-to-year facility operations. Phase I applies to all facilities that generate at least 25 megawatts. Phases II and III apply to all electricity generating facilities producing 15 megawatts or more, as specified in the CPA. EPA may retain a reserve of allowances, but the sum of EPA reserves and the distributed allowances will not exceed the total emissions cap for that year.

State Allocation to Utilities

The second step of the cap-and-trade program is to implement a state-level distribution system using EPA-approved SIPs. After EPA distributes allowances to states, state environmental agencies distribute allowances to utilities per specifications of that state's EPA approved State Implementation Plan (SIP). In order for EPA to delegate management of the Carbon Dioxide Reduction Program to a state, the state must submit an action plan detailing its specific allowance distribution scheme and program operation procedures. EPA must approve this plan, and it must be incorporated into that state's SIP before it can manage the carbon dioxide program for facilities in its borders. EPA will distribute emissions allowances to the state environmental agencies based on the average carbon emissions of the previous five years, although a state may distribute these allowances to facilities in the manner specified by its own implementation plan.

In the absence of a EPA approved SIP, the state will distribute allowances to facilities based on a mathematical formula (Basic Allocation Formula) that takes three factors into account; the facilities kWh output (kilowatt-hour, a measurement of generated electricity), efficiency, and fuel source. Inherently, an output-based allocation formula promotes power-generation efficiency since an inefficient facility that produces a given number of kWh will be given the same number of allowances as a cleaner facility producing the same kWh but uses less fuel. Since EPA will maintain an allowance reserve, less efficient facilities that have trouble securing needed allowances could be granted extra allowances in emergency situations. One such scenario would occur if an extremely hot summer causes a spike in electricity demand, forcing a facility to produce emissions well in excess of its allocation.

Accounting for the fuel source will allow EPA to control energy input choice. Specifically, EPA can adjust the formula to ensure that it does not unfairly harm coal plants and that nuclear plants, despite being emissions-free, account for their waste stream. In this way, EPA will have the regulatory flexibility to push clean coal technologies and the use of renewable energy sources, without forcing a wholesale shift toward natural gas or nuclear power.

EPA may use reserves as a way to reward facilities for current and/or previous voluntary reductions. EPA may also auction the reserves in order to raise funds for CPA mandated programs. Requiring the use of emissions allowances before the cap comes into force provides plants credit for any CO_2 reductions they achieve in this interim period, since any unused allowances from this period could be banked for future use.

This hybrid approach to allowance distribution gives all 50 states the flexibility to devise their own formula to meet EPA approval. For states with approved SIPs, EPA will distribute allowances equal to the number that the state's facilities would have received under EPA's allocation formula. If a state fails to produce an adequate SIP by the deadline, that state will still be responsible for distributing allowances to their facilities according to the Basic Allocation Formula. While this program allows for flexibility at the state level, it also prevents inaction caused by delayed SIP submission at the state level.

Due to the complexity of strategies to reduce CO_2, states benefit from the option to run individual programs through their State Implementation Plans. The fuel portfolio of the utility industry, as well as regulated or unregulated market structures vary from state to state. States can benefit from implementing unique conservation programs with grant funds. Moreover, some states have already taken the lead in managing many of EPA's air pollution programs, especially those for point sources. While the CPA represents the first federal initiative to regulate carbon emissions, some voluntary state programs aimed at CO_2 reduction have existed for years.

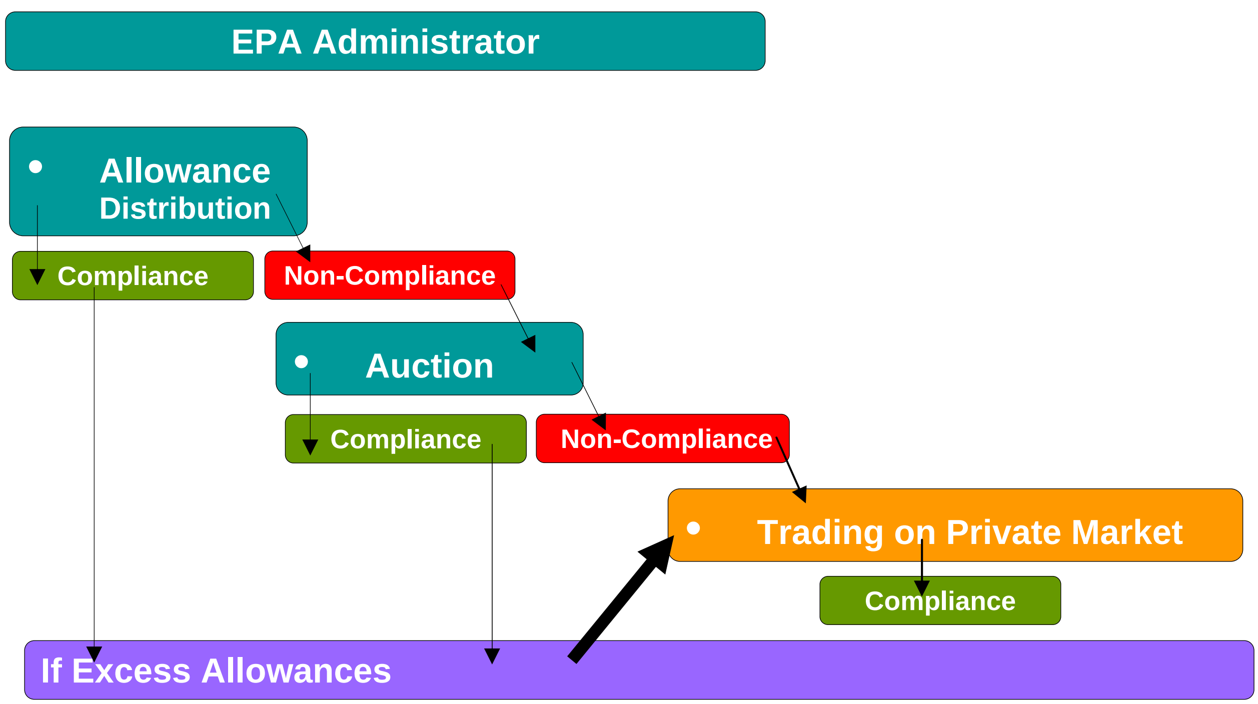


Figure 10: Emissions Allocation / Auction / Market Trading Flow-Chart

Allowance Auctions

After allocating emission allowances to states, EPA auctions 3 percent of the 2.05 billion allowances. (As a point of reference, the Acid Rain Program auctions 2.8 percent of emissions allowances through its auction.) Conducting an auction determines an early "price signal" for an allowance, creates a pool of allowances for purchase by new utilities and protects consumer interests more than a simple allowance allocation system. While the Acid Rain Program used a discriminatory format in which buyers of emissions allowances simultaneously bid the prices for which they are willing to buy a "lot" of allowances, we recommend EPA use a clock-style format, as per Virginia's auction for allowances under the NO_X SIP-Call.

In the "clock-style" auction, a firm bids on emissions allowances for a base price. If more firms demand allowances than are being offered, prices rise until the number of allowances demanded by firms equals the amount of allowances supplied at that price. This auction is similar to the state of Virginia's 2004 NO_X allowance auction, conducted by the Amerex Corporation. An advantage of this format is that it is designed to sell large numbers of identical items (e.g., allowances) and tends to generate higher prices. Disadvantages of this format include high costs to firms and its unprecedented use on a federal level; EPA has not previously used this auction format.

The clock-style format raises a significant amount of revenue for Clean Power Act programs. It is also useful because EPA intends to auction approximately 300,000,000 CO_2 allowances, an amount for which the clock-style auction is better suited than the discriminatory format. Revenues generated from the auction replenish the revolving loan fund, discussed in more detail below. The auction system proposed under the Clear Skies Act similarly earmarks auction revenues for program uses, including compliance assistance to utilities.

The allowances received after allocation, gained through open market purchase or bought during the action phase will be traded throughout the year on the same open market lead up to the end of year emissions reporting.

Voluntary Carbon Dioxide Reduction Credits

It is essential to acknowledge previously installed voluntary carbon reduction and sequestration programs, administered by the U.S. Department of Energy since 1994. Within a decade, these programs successfully prevented or negated the emission of thousands of tons of carbon dioxide. Private exchanges and states also contribute to CO_2 reductions. It is advantageous that EPA grants credit for CO_2 emissions reductions achieved under these programs.

Firms that have previously undertaken independently-certified carbon dioxide reductions, whether through process changes or carbon sequestration methods will receive carbon dioxide allowances on a ton-for-ton basis during the first year of trading. These allowances will be distributed in advance of the general allowance auction, and credited allowances will be subtracted from the industry allowance cap. By granting credits, EPA sets a precedent of rewarding early and voluntary action by industry.

Federal Financial Assistance

Revolving Loan Fund

Contingent upon legislative approval, the excess revenue generated from the auction process will be used to create a Clean Power Act Revolving Loan Fund (CPARLF) to provide low interest loans to aid utilities in meeting CO_2 caps. This program will be modeled after a variety of revolving loan projects, most notably the Brownfields Cleanup Revolving Loan Fund (BCRLF), which is outlined in the case study below. The $597 million of projected excess revenue will be used in this revolving loan fund to offset compliance costs to facilities. Low-interest loans will be made available to utilities that have demonstrated good faith efforts to comply with regulations and further CO_2 reduction technologies.

Within CPARLF, facilities are eligible for low interest loans, which are not to exceed $3,000,000 over a two year period. There will be 100 loans available each year for eligible facilities. Eligible facilities will install BACT equipment in a way that will generate a projected net reduction in CO_2 as a part of a long-term carbon dioxide reduction plan. Applications for CPARLF will be analyzed through the Grants and Contracts division within the Clean Power Act Carbon Dioxide Reduction Program, which is a part of EPA Office of Air and Radiation. The CPARLF recipient will be held accountable to EPA for proper expenditure of the funds. When participating in a CPARLF project, the recipient must contribute funds equal or in excess of 20 percent of the project total cost. This can be in the form of work hours, management time, site preparation, or capital costs, and must be included in both the cost of implementation proposal and the final report of expenditures submitted for application and final review.

Case Study: Brownfields Cleanup Revolving Loan Fund (BCRLF)

EPA's Brownfields Economic Redevelopment Initiative (BCRLF) is designed to empower states, communities, and other stakeholders in economic redevelopment to work together in a timely manner to prevent, assess, safely clean up, and sustainably reuse brownfields. In 1999 and again in 2001, the U.S. EPA negotiated a $500,000 loan from the BCRLF to Hennepin County, Minnesota. Hennepin County had designed a project to clean up brownfield sites. They used the funds to loan money to individuals or companies interested in taking part in the project which included private, for profit businesses, non-profit businesses and public entities (excluding State and Federal agencies and the University of Minnesota).

All sites receiving funding will be required to enroll in the Minnesota Pollution Control Agency's (MPCA's) Voluntary Investigation and Cleanup (VIC) Program. The area consists of industry, commercial, rental facilities, and housing facilities. Contamination of the area has been traced to the fill used to even the grade of the land and not to the industry that was in operation at an earlier date. The chemicals included polynuclear-aromatic hydrocarbons, VOCs, hydrocarbons, and metals at levels exceeding the human-health based screening criteria established by the Minnesota Pollution Control Agency for residential land-use. Remediation has been planned to remove the soil and transport it off site. Both dust control procedures and stormwater run-off procedures will be carried out during the excavation process which includes the removal of 4,000 cubic yards of contaminated soil.

Redevelopment includes 48 townhouses, 84 loft style condominiums, 30 affordable housing units, 15,000 square feed of commercial/ office space and 30,000 square feed of commercial office space. Without the use of a revolving loan fund the redevelopment of these areas would have been too costly and the area would have been left contaminated with no possibility for rebuilding. (Source: U.S.EPA, 2004)

State Grants

Grant funds will be available to states to assist in initiating conservation programs, research, pilot programs, staffing requirement, and other implementation needs. Grant funds enable states to pursue demand-side management strategies which can achieve significant carbon reductions at low costs that are external to the utility sector. In order to promote implementation of efficiency programs in all states, 50 conservation grants will be available. To bolster innovation, six grants for research and development initiatives to research institutions within states will be available. Additionally, two larger grant funds will be available for pilot programs that test further development in carbon reduction research. As some states have existing carbon reduction strategies and others will likely face funding hardships, 20 staffing grants will be accessible to states. Finally, 15 discretionary grants will be made available for innovative program funding and other special needs.

Staffing Plan for 2006

The staffing plan for the Clean Power Act Carbon Dioxide Reduction Program draws upon the existing expertise at the EPA Office of Air and Radiation. The program office falls under the umbrella of the Atmospheric Programs and directly beneath the Clean Air Markets Division. This program requires 21 Full Time Equivalents (FTEs) for the CO_2 Reduction Program, with salaries ranging from GS-9 to GS-15 levels. Ten employees work on program operations and administration from EPA Headquarters, and another 10 FTEs work in the 10 EPA regional offices. The remaining FTE is placed in the EPA Office of General Council to provide legal services for the administration of the Clean Power Act.

A Program Director leads the Carbon Dioxide Reduction Program Office and oversees the main office and all program operations. Two assistant directors, each with a staff of three, report to the Director. One staffing aide serve the Director and assistant directors in miscellaneous tasks. Regional officers, based in each of the ten regional offices of the EPA, facilitate program implementation by state permitting authorities and regulated facilities.

Employee responsibilities are divided into the following categories: program administration, grants and contracts, budget, program development, emissions monitoring, market operations, assessment and communications, and SIP review. Regional coordinators make frequent site visits to maintain contact with stakeholders and assess local community perceptions of program progress. The responsibilities of these staff functions are outlined in Figure 11.

Staff Function	Responsibilities
Program Administration	All administrative needs of the CO_2 program's successful operation
Grants and Contracts	Reviewing grant and contract requests from state officials, prioritizing the requests, and submitting recommendations to the assistant directors for approval
Budget Officers	Developing an annual budget for the program
Program Development	Cost effective development and enhancement of the CO_2 program, reducing the administrative burden for regulators
Emissions Monitoring	Analyzing the data calculated by the Continuous Emissions Monitors (CEMs) to determine overall compliance with the program and providing guidance to states and facilities. Performing audits to ensure that CO_2 emissions are accurately measured and reported on time
Market Operations	Day-to-day functions of operating market-based emission reduction programs, such as recording allowance transfers, receiving emission reports, and working with stakeholders to ensure that the markets operate efficiently
Assessment and Communications	Meeting with state and industry representatives to assess the progress of the program, receive feedback for potential changes, and improvements to the system. After weighing costs and benefits (environmental, human health, and economic) of the CO_2 program, the information will be forwarded to decision makers and other customers
State Implementation Plan Coordination	Reviewing and approving or denying the action plans submitted by the states in relation to the distribution of allowances. In the case of an SIP rejection, the coordinator will require implementation of the Basic Allocation Formula

Figure 11: Carbon Dioxide Staff Reduction Program Functions and Responsibilities

Budget and Revenue Plan

This budget plan for the first operational year of the Clean Power Act includes expenses and revenues, and provides realistic expectations of the expenses and revenues for the CO_2 Reductions Program. The 2009 budget plan includes a program budget, a line item budget, and a revenue plan for the CO_2 component of the Clean Power Act of 2003. The budget plan accounts for the addition of 21 full-time employees, the creation of a CO_2 program office at EPA headquarters, grant funds available to states, and revenue from CO_2 auctions.

Personnel and Other than Personnel Services

Ten employees will work in the EPA Headquarters under the Clean Air Markets Division in a new CO_2 program office. One FTE will be placed in the EPA Office of General Council to provide legal services for the Clean Power Act. The remaining ten 10 employees will work in each of the 10 EPA regions coordinating the CO_2 emissions trading within the Region's existing infrastructure. Funding is also designated for an allowance tracking system, office supplies, site visits, seminars and training sessions. Personnel services are combined with Other Than Personnel Services (OTPS) to create an operational budget of $2,062,489.

State Grants

The largest portion of the budget is dedicated to grants to assist States in meeting emission caps. There are four areas in which states may apply for grants: conservation programs, special research, pilot programs, and special staffing needs. $14,625,220 is allocated for these grants. Grant and contract requests submitted by state officials will be reviewed by the Carbon Dioxide Reduction Program Office. Conservation grant funds will be available to all states; 50 Conservation Grants of $200,000 are allocated annually. Research and development will be promoted by six Special Research Grants of $300,000 and two Pilot Programs of $500,000 for testing further research. To assist with staffing costs in states that face hardships, 20 Staffing Grants of $76,261 will be available. Lastly, 15 Discretionary Grants of $20,000 will be available for innovative programs and special needs.

Program Revenue

A significant amount of revenue will be raised through auctioning allowances. Estimated revenue projections are based on a CO_2 allowance price of $10 per ton with 3 percent of each year's CO_2 allowances available through auctions. Average successful bids in the first year of trading CO_2 allowances on the European Energy Exchange approximated $10 per ton, while current carbon dioxide trades on the European Energy Exchange fluctuate between $8 and $9 per ton ("Kyoto and CO_2" 2004). However, as these trades are conducted in preparation for implementation of the Kyoto Protocol next year, they can take advantage of cost-saving Kyoto provisions such as the Clean Development Mechanism, which allows for lower-cost carbon reductions in the developing world. The 3 percent of emissions allowances set-aside for the auction is based on the percentage of allowances set aside in the Acid Rain program (2.8 percent). Revenues from the allowance auction will be used to offset high costs of the program to facilities while providing incentives for good faith efforts to meet standards through the revolving loan fund, described below. Revenues from the auction are expected to yield about $615,000,000.

Revolving Loan Fund

The excess revenue, contingent on legislative approval, will be used to create a revolving loan fund, which will provide low interest loans and tax credits to aid utilities in meeting CO_2 caps. This $597,988,552 in projected excess revenue will be used in the revolving loan fund to offset costs of compliance to facilities. Low-interest loans and tax credits will be made available to utilities that have demonstrated good faith efforts to comply with regulations and further CO_2 reduction technologies.

Performance Measurement and Management Innovation

Background

The CO_2 Emissions Reduction Program will measure its success through actual reductions of carbon dioxide emissions in the U.S. power generation sector. Carbon dioxide emissions monitoring, which will build upon existing infrastructure and reporting practices, will be used to monitor and enforce the reductions required by the established dates. Cost and supply of energy will be used as internal measures of the program's impact on the public. Gauges of administrative efficiency and prudent expenditure of funds will also be measured for internal purposes. Performance measures will help ensure compliance with these standards and will allow for adjustments in the program as new information and more advanced technologies become available. Ultimately, these performance measures will be used to modify the program and ensure efficiency and effectiveness in meeting its ambitious goals.

Measurement

The principal performance measure for the Carbon Dioxide Reduction Program will be CO_2 emissions reductions (in tons). The measurement system for the CO_2 monitoring program will use existing monitoring infrastructure and practices to achieve implementation in a cost-effective manner. CO_2 emissions will be measured by utilities' Continuous Emissions Monitors (CEMs), which are already installed at all facilities, as required for other pollutants under the Clean Air Act Amendments of 1990. Most power generating facilities already use CEM data to measure CO_2 emissions continuously (hourly) at the stack. For power generating facilities producing over 25 megawatts that do not have monitoring equipment installed, CEM installation for CO_2 monitoring will be compulsory. Individual facilities will also be required to measure fuel input and electricity output data, which is currently done in compliance with the Energy Information Administration's Form 759 "Monthly Power Plant Report" and the Federal Energy Regulatory Commission's Form 423, "Monthly Report of Cost and Quality of Fuels for Electric Plants." Internal measurement of program performance will occur at EPA, where expenditures (especially in grant programs) and number of workers employed for CPA administration will be recorded. An efficiency ratio measuring the amount spent on the program to the tons of emissions reduced will be used to track the progress of federal management and state implementation of this act. Energy prices per MWh will be recorded as a price signal for consumer cost.

Collection

Compliance specialists at each power plant will collect CO_2 emissions data from CEMs in the same way they currently collect emissions data for other pollutants under the Clean Air Act. The compliance specialists must then audit and validate the data by calculating CO_2 emissions based on fuel input and energy output. EPA will also collect and maintain information about each state's allowance allocations, utility auction purchases, and explanatory reports from facilities that do not meet their emission allocation limit. States and EPA will perform annual inspections of large power generating facilities to ensure compliance with facility permits. Violations will be reported to regional EPA offices. In addition, the regional EPA will be responsible for responding to public comments on the CO_2 Reductions Program.

Reporting

Each facility will be required to submit CO_2 emissions, energy output, and fuel input data to state permitting authorities on a monthly basis, as currently practiced with criteria pollutants, in spreadsheet format. Appropriate power plant personnel must sign the form and will be held liable for the reported values. Facilities also submit quarterly emissions reports to EPA as established by the Acid Rain Program. Facilities can utilize Monitoring Data Checking software (MDC) to ensure the quality of quarterly emissions reports before being submitted to the EPA through an electronic data reporting system. In addition, individual facilities will also be responsible for tracking and reporting emission exceedances to state permitting authorities, as required by the state's existing operating permit/Title V program. State permitting authorities will send data and exceedance information to the appropriate regional EPA office each month, and EPA will store all data in its existing Emissions Tracking System (ETS). EPA auditing practices will incorporate CO_2 data into their site compliance assessments for power plants. Permitting agencies and EPA will use aggregate data to determine facilities' compliance status. EPA will enforce penalties for emission allowance exceedances, levying fines three times the market value of the tonnage of emissions beyond compliance, as described in the Clean Power Act. While performance measures must also be shared with the public through Annual Performance Reports, all emissions reports submitted to a state permitting authority or EPA are public documents and will be made available to the public. Additionally, EPA is accountable under the Government Performance and Results Act (GPRA) to provide annual performance reports to evaluate the agency's progress towards its program goals. Regional EPA offices may also find it useful to report anecdotal information from utilities on innovative strategies to meet reductions requirements. The data will also be compiled on a quarterly basis for review by the EPA Administrator.

Information Analysis

Analyzing facilities' non-compliance reports will allow EPA to assist or modify the implementation of the program if compliance becomes excessively burdensome for particular regions or state permitting authorities. In addition to meeting the clearly delineated emissions reductions goals, other indicators such as non-compliance trends, public feedback, market information on the price of emission control technologies, and the development of new abatement technologies will measure success. Modifications will be made to the program design as needed if these important indicators do not change in the desired direction, especially if necessary technologies do not develop within the anticipated timeframe.

Contingency Response Mechanisms may include (but are not limited to) the following:

- Increasing emissions monitoring and/or data auditing
- Advising non-complying facilities in reduction strategies of successful power plants
- Providing technical assistance to utilities
- Allocating low interest loans or tax credits to overburdened facilities (upon legislative approval)
- Allocating grants to economically disadvantaged states
- Reallocating allowances between EPA regions
- Explicating specific recommendations for regional EPA allowance distribution to states
- Redistributing allowances between original disbursement and the auction
- Enforcing specific state allowance distribution to facilities
- Modifying compliance deadlines (based on technological feasibility)

Other Considerations

Information analysis will lead to significant incentives for firms to innovate in order to achieve CO_2 emission reduction. A "first-mover," a firm that develops or implements advanced pollution abatement technology, may be rewarded with a reduction in the total amount of allowances in the system. This is an advantage for the first mover because it forces other facilities to purchase this company's technology until competing technology becomes available. Further, EPA will encourage constructive dialogue with industry professionals to promote information sharing and to reduce asymmetries of information. This will occur through conferences, R&D grants, and the establishment of credible and feasible standards. Finally, the Department of Energy's continued research into pollution abatement technologies will provide information about technical capabilities of abatement technology. These incentives for innovation and ongoing dialogues will generate inertia for utilities and minimize companies' concerns that deadlines are infeasible. EPA will rely on feedback and performance measures to continually monitor the effectiveness of the program, to make adjustments where possible, and to develop innovations in program design and management. As the first federal program to address CO_2 emissions, it is imperative that the program remains flexible with implementation strategies yet persistent in enforcing the emissions reductions.

Future Challenges

While the CPA Carbon Dioxide Reduction Program will result in significant CO_2 reductions, leading to benefits for the environment and human welfare, implementation challenges lie ahead. Congress will have a strong interest in limiting the economic impacts of this legislation. Therefore, maintaining Congressional support will be critical to the continued viability of the bill. Sufficient advancements in scientific technology are critical in making the reduction schedule affordable to the industry. Finally, implementation consistency between the federal government and the states is vital to ensure that the program is properly implemented.

Economic considerations will be the most significant challenge to program implementation. Based on cost estimates from the U.S. Environmental Protection Agency, the Energy Information Administration of the U.S. Department of Energy, the Pew Center on Global Climate Change, and MIT, we predict the economic cost to consumers and the power generation sector of our Carbon Dioxide Reduction Program will total between $8 billion and $40 billion annually, which are both less than one-half of 1 percent of the U.S. Gross Domestic Product. The wide range in values is due to differences in baseline scenarios used for the study (i.e., conditions without regulations) and implicit assumptions of fuel supply, energy prices, and reactions to regulations—fuel switching, efficiency improvements, and technological advancement.

Under the CPA, short-term coal generation is expected to decrease by approximately 25 percent and electricity prices are expected to increase by about 30 percent, which will raise the price of production due to reliance on natural gas and renewables. The inherent flexibility of the Carbon Dioxide Reduction Program allows continued use of coal as a primary energy source, an opportunity for energy conservation, and more time for plant efficiency and abatement upgrades. Overall, we expect a shift toward lower carbon dioxide intensity in electricity generation.

Ultimately, economic impacts cannot be avoided. However, the Carbon Dioxide Reduction Program is designed to mitigate these impacts and ensure the most minimal impact to the U.S. economy thereby ensuring Congressional support.

Conclusion

The Carbon Dioxide Reduction Program operationalizes the Clean Power Act of 2003 and addresses one of the world's most pressing environmental challenges: global climate change. Reductions in carbon dioxide emissions, as specified by the Program Design, will translate into the mitigation of the negative environmental outcomes of global climate change. Given that the United States is the world's largest greenhouse gas emitter, domestic carbon dioxide regulation will have a significant effect in tackling this global problem.

The implementation strategy of the CPA Carbon Dioxide Reduction Program is built on a well-established infrastructure as well as knowledge gained through the state permitting process and the Clean Air Act's Acid Rain Program. The Program set forth in this analysis achieves a major reduction in carbon dioxide emissions, to 17 percent below year 2000 levels by 2020. This ambitious goal will be achieved through energy conservation, efficiency upgrades, and the development and implementation of more advanced technologies. The CPA allows for funding the research and development of clean and renewable energy through the sale of emissions allowances. As a result, promising technologies that are currently limited in use, such as wind and solar power, as well as new clean coal technologies, should become more economically viable and widely available to consumers.

It is important to acknowledge that postponing carbon dioxide emissions reduction policies could leave U.S. utility companies and pollution abatement technology firms in a disadvantageous position. Adoption of the program design and implementation strategy outlined in this report will result in amelioration of a pressing environmental problem in a flexible and economically efficient manner. The Clean Power Team is ready to work with all stakeholders to meet these challenges to ensure that the issue of climate change is addressed in the most effective manner possible.

Appendix

Clean Power Act of 2003 Summary & Status

S.366
Title: A bill to amend the Clean Air Act to reduce emissions from electric power plants, and for other purposes.

Sponsor: Sen Jeffords, James M. [VT] (introduced 2/12/2003)   Cosponsors (19)
COSPONSORS(19), ALPHABETICAL:
Sen Biden Jr., Joseph R. [DE] - 2/12/2003
Sen Boxer, Barbara [CA] - 2/12/2003
Sen Clinton, Hillary Rodham [NY] - 2/12/2003
Sen Collins, Susan M. [ME] - 2/12/2003
Sen Corzine, Jon [NJ] - 2/12/2003
Sen Dodd, Christopher J. [CT] - 2/12/2003
Sen Edwards, John [NC] - 2/12/2003
Sen Feingold, Russell D. [WI] - 2/12/2003
Sen Feinstein, Dianne [CA] - 2/12/2003
Sen Kennedy, Edward M. [MA] - 2/12/2003
Sen Kerry, John F. [MA] - 2/12/2003
Sen Lautenberg, Frank R. [NJ] - 2/12/2003
Sen Leahy, Patrick J. [VT] - 2/12/2003
Sen Lieberman, Joseph I. [CT] - 2/12/2003
Sen Reed, John F. [RI] - 2/12/2003
Sen Sarbanes, Paul S. [MD] - 2/12/2003
Sen Schumer, Charles E. [NY] - 2/12/2003
Sen Snowe, Olympia J. [ME] - 2/12/2003
Sen Wyden, Ron [OR] - 2/12/2003

Latest Major Action: 2/12/2003 Referred to Senate committee. Status: Read twice and referred to the Committee on Environment and Public Works.

TITLE(S):
SHORT TITLE(S) AS INTRODUCED: Clean Power Act of 2003
OFFICIAL TITLE AS INTRODUCED: A bill to amend the Clean Air Act to reduce emissions from electric power plants, and for other purposes.

STATUS:
2/12/2003: Introductory remarks on measure. (CR S2345-2346)
2/12/2003: Read twice and referred to the Committee on Environment and Public Works. (text of measure as introduced: CR S2346-2351)
2/24/2004: Introductory remarks on measure. (CR S1515-1517)

COMMITTEE(S):
Committee/Subcommittee: Senate Environment and Public Works

Activity: Referral, In Committee
LEGISLATIVE SUMMARY AS OF:
2/12/2003--Introduced.

Clean Power Act of 2003 - Amends the Clean Air Act to require the Administrator of the Environmental Protection Agency (EPA) to promulgate regulations to achieve specified reductions in emissions of sulfur dioxide, nitrogen oxide, carbon dioxide, and mercury from certain electric generation facilities by January 1, 2009. Directs the Administrator to establish an emission allowance tracking and transfer system. Makes a special rule for mercury emissions. Directs the Administrator to study the impact of emission allowance trading. Limits the trading of allowances with facilities other than electricity generating facilities to certain carbon dioxide emission control programs. Provides an allocation to: (1) dislocated workers; (2) disproportionately adversely impacted communities; (3) electricity generating facilities; (4) renewable electricity generating units; (5) efficiency projects; (6) cleaner energy sources; and (7) biological carbon sequestration activities. Directs the Administrator to establish and annually review emission limitations for mercury. Requires that captured or recovered emissions not be re-released into the environment. Requires the Administrator to request information from owners/operators about hazardous air pollutants other than mercury. Directs the Administrator to then propose and promulgate emission standards. Requires facilities to achieve specified emission standards should the regulations not be promulgated. Requires an assessment and identification of sensitive ecosystems and the objectives necessary for their protection, including the Adirondack, the mid-Appalachian, Rocky, and southern Blue Ridge Mountains. Includes as well the Great Lakes, Lake Champlain, Long Island Sound, and the Chesapeake Bay. http://thomas.loc.gov/cgi-bin/bdquery/z?d108:SN00366:@@@L&summ2=m&

Master Calendar

2007 Master Calendar

(light blue)	CO2 Program Office	(green)	Open Market EmissionsTrading
(purple)	Regional EPA	(brown)	Facilities
(gray)	States	(red)	Quarter Ends

Qtr	Mon	Day	Deadline/Project	
1	Jan	2	Allowance allocation to Regions	
		19	Grant Approval Notification	
	Feb	1	Allowance allocation to States	
		19	Grant Distribution	
	Mar	2	Allowance allocation to Facilities	
		9	Intent to sell deadline	
		26	Allowance Auction	
		31	1Q End	
2	Apr	2	Begin Allowance Transfers	Begin 1Q Data Reporting
	May	1	Close 1Q Data Reporting	
		16	Submit Data Reporting Errors	
	June	29	2Q End	
3	July	2	Begin 2Q Data Reporting	1Q Data Resubmission
		20	1Q EPA Administrator Report	
		31	1Q Interagency Meeting	Close 2Q Data Reporting
	Aug	12	Submit 2Q Data Reporting Errors	
	Sept	28	3Q End	
4	Oct	1	Begin 3Q Data Reporting	
		26	2Q EPA Administrator Report	2Q Data Resubmission
		30	2Q Interagency Meeting	
	Nov	1	Close 3Q Data Reporting	
		16	Submit 3Q Data Reporting Errors	
	Dec	31	4Q/Compliance Year End	3Q Data Resubmission
2008	Jan	2	Begin 4Q/Compliance Year Data Reporting	
1		25	3Q EPA Administrator Report	
		29	3Q Interagency Meeting	
	Feb	1	Close 4Q/Compliance Year Data Reporting	
		15	Submit 4Q Data Reporting Errors	
	Mar	3	2007 Allowance Transfer Deadline	
		14	Submit annual compliance certification	
		31	1Q End	
2	Apr	21	4Q/Compliance Year EPA Administrator	4Q Data Resubmission
		28	4Q/Compliance Year Interagency Meeting	
	May	1	2007 Performance Results Public Release	
		16	Submit Data Reporting Errors	
	June	29	2Q End	

Expanded Budget

EXPANDED ANNUAL BUDGET		PERSONNEL SERVICES	
Office	**Number**	**Expense**	**Expense Total**
CO2 Program Office	**10**		**$719,648**
GS 15	1	$126,064	$126,064
GS 12	2	$76,261	$152,522
GS 11	6	$64,610	$387,660
GS 9	1	$53,402	$53,402
Regional Offices	**10**		
GS 13	10	$81,778	**$817,780**
TOTAL Personnel Services	**20**		**$1,537,428**
OTHER THAN PERSONNEL SERVICES			
Allowance Tracking System	1	$25,000	**$100,000**
Equipment & Supplies			
Computers	20	$1,500	$30,000
Phones	20	$590	$11,800
Office	20	$200	$4,000
Postage	20	$100	$2,000
			$47,800
Travel Expenses			
Training- 2 3-day seminars			
Airfare	20	$400	$8,000
Per Diem	120	$25	$3,000
Hotel	40	$150	$6,000
Conferences - 2			
Airfare	20	$400	$8,000
Per Diem	120	$25	$3,000
Hotel	40	$150	$6,000
Site Visits			
Airfare	30	$400	$12,000
Per Diem	200	$25	$5,000
Hotel	200	$150	$30,000
Mileage (.3*400,000 miles)	400000	$0	$120,000
			$201,000
Conference Sponshorship			**$50,000**
Overhead/Admin			**$50,000**
Total OTPS	**685**	**$24,725**	**$448,800**
Total Operation Cost	**705**	**$426,840**	**$1,986,228**
Grants	**93**	**$1,096,261**	**$14,625,220**
Conservation Programs	50	$200,000	$10,000,000
Special Research	6	$300,000	$1,800,000
Pilot Programs	2	$500,000	$1,000,000
Special Staffing Needs	20	$76,261	$1,525,220
Discretionary	15	$20,000	$300,000
Contracts	**4**	**$100,000**	**$400,000**
Consulting/Expertise	4	$100,000	$400,000
Total Budget (Funding)			**$17,011,448**
Personnel/TOC	77.40%		
Grants/TOTAL BUDGET	84.29%		

EXPANDED ANNUAL BUDGET

PERSONNEL SERVICES

Office/Item	Number	Expense	Expense Total	Program Admin	Grants & Contracts	Budget	Program Development	Emissions Monitoring	Market Operations	Assessment & Communications	State Action Plan Review	Total
CO_2 Program Office												
GS 15	1	$126,064	$126,064	$126,064								$126,064
GS 12	2	$76,261	$152,522	$76,261	$7,626	$7,626	$15,252			$38,131	$7,626	$152,522
GS 11	6	$64,610	$387,660		$64,610		$64,610	$96,915	$96,915	$64,610		$387,660
GS 9	1	$53,402	$53,402	$7,629	$7,629		$7,629	$7,629	$7,629	$7,629	$7,629	$53,402
Regional Offices												
GS 13	10	$81,778	$817,780	$40,889			$40,889	$40,889	$327,112	$40,889	$327,112	$817,780
TOTAL Personnel Services	**20**	**$402,115**	**$1,537,428**	**$250,843**	**$79,865**	**$7,626**	**$128,380**	**$145,433**	**$431,656**	**$151,258**	**$342,367**	**$1,537,428**
Item/TPS				16.32%	5.19%	0.50%	8.35%	9.46%	28.08%	9.84%	22.27%	100.00%
ll Time Equivalents				**2.64**	**1.24**	**0.1**	**1.74**	**2.14**	**5.64**	**2.14**	**4.24**	
OTHER THAN PERSONNEL SERVICES												
Item		**% OTPS**	**Expense**									
ATS		22.28%	$100,000					$100,000				$100,000
Supplies		10.65%	$47,800	$5,975	$5,975	$5,975	$5,975	$5,975	$5,975	$5,975	$5,975	$47,800
Travel		44.79%	$201,000	$17,000			$60,000			$17,000	$60,000	$154,000
Conferences		11.14%	$50,000				$25,000			$25,000		$50,000
Overhead		11.14%	$50,000	$6,250	$6,250	$6,250	$6,250	$6,250	$6,250	$6,250	$6,250	$50,000
Total OTPS	**685**	**$24,725**	**$448,800**	**$29,225**	**$12,225**	**$12,225**	**$97,225**	**$112,225**	**$12,225**	**$54,225**	**$72,225**	**$401,800**
Total Operation Cost	**705**	**$29,115**	**$1,986,228**	**$280,068**	**$92,090**	**$19,851**	**$225,605**	**$257,658**	**$443,881**	**$205,483**	**$414,592**	**$1,939,228**
Grants	93	$1,096,261	$14,625,220									
Contracts	4	$100,000	$400,000									
Contingency	2%	$17,011,448	$340,229									
Total Budget (Funding)			**$17,351,677**									

Item	Number	Price	Revenue	Rationale
Allowance Auctioi	61,500,000	$10.00	$615,000,000	3% of cap to be sold through
Totals		**$10**	**$615,000,000**	
excess revenue				$597,988,552

Personnel/TOC	77.40%
Grants/TOTAL BUDGET	84.29%

Item	% OTPS	Expense
ATS	22%	$100,000
Supplies	11%	$47,800
Travel	45%	$201,000
Conferences	11%	$50,000
Overhead	11%	$50,000
Total	**100%**	**$448,800**

Grant Program

State Assistance	Available Number	Amount	Total	Rationale
Conservation Programs	50	$200,000	$10,000,000	To assist states with implementing programs
Special Research	6	$300,000	$1,800,000	To assist with funding for R & D
Pilot Programs	2	$500,000	$1,000,000	To fund pilot programs such as sequestration
Special Staffing Needs	20	$76,261	$1,525,220	To assist states with implementation, where needed
Discretionary	15	$20,000	$300,000	For states' specific needs, other than those defined above
Total	**93**	**$1,096,261**	**$14,625,220**	**This figure is well within projected revenues. Allocating these funds to the states enhances effective program implementation.**
Excess Revenue			$597,988,552	CO2 Program will create a trust fund will all excess revenue to provide low interest loans and tax credits to utilities struggling to meet required CO2 Reduction.

Expanded Federal Rulemaking Process

The Federal Rulemaking Process is an important component of the process by which the Clean Power Act of 2003 would be enacted. Once the Clean Power Act of 2003 is passed and submitted to EPA, the agency would have to work within the constraints of existing budget and full-time employee equivalent (FTE) caps when completing most of the tasks of the process. The federal government would accommodate some work by shifting responsibilities within the involved offices; however, contracted consultants would provide most of the necessary rule-drafting and economic modeling activities. The Office of Acquisition Management within the Office of Administration and Resources Management would handle all private/public contracts for EPA and hire consultants for this process.

In particular, the Office of Air & Radiation's Policy Office would be responsible for facilitating the discourse and supplying the technical analyses necessary to draft the proposed rule. These include (but are not limited to) an economic impact analysis, determination of regulatory flexibility, an information collection clearance package, unfunded mandates, a federalism summary impact statement, and an environmental assessment. Including these analyses prompts the Office of Management & Budget (OMB) to consider the rule significant, or a "Tier One" priority, requiring additional scrutiny of the rule. After OMB review, there would be a formal discussion period, involving interagency collaboration with the departments of Commerce, Energy, Agriculture, Defense, and State.

Following OMB review, the rule is placed on the Federal Register. At this point, public comment would be permitted for up to 90 days. The review and reply period following the public comment period would be the most time-consuming portion of the Federal Rulemaking process; we expect that EPA would review more than 300,000 comments on the rule during this phase, based on the large public response to previous pollution legislation. This review and response period typically lasts 60 days, but we expect it would be lengthened by an additional 30 days due to the large volume of anticipated comments, as EPA is required to respond to all comments, in block or individual communication, before the final rule is revised and submitted.

All federal agencies taking part in the federal registry process must simplify and organize all rules into a six-step process outlined below. The steps include Prioritization; Planning, Analysis and Evaluation; Development of the Preamble and Rule; Decision – Final Agency Review; Collaboration and Communication; and Discussion.

Prioritization

Because regulating the electric power industry's carbon emissions is so controversial, the EPA would designate a *Tier One* priority status to the impending Carbon Rule of the Clean Power Act. This designation indicates that (1) the rule is complex, precedent-setting, and controversial; (2) the rule's development must have ongoing and active involvement from the Administrator's office; (3) the formation of a formal workgroup consisting of core group representatives is required. The EPA would form a Carbon Task Force of 20 individuals from various departments within EPA, including the Office of Air & Radiation, to deal specifically with the Air Quality, Planning, & Standards and Atmospheric Programs, in collaboration with the offices of Policy, Economics and Innovation (OPEI), Research and Development (ORD), Enforcement and Compliance Assistance (OECA), and General Counsel (OGC). The Office of the Chief Financial Officer, the ten Regional EPA Representatives, and the Office of Administration and Resources Management would also participate in the Carbon Task Force.

In addition, the existing Clean Air Act Advisory Committee of external stakeholders, which reports directly to the Air and Radiation Assistant Administrator, would participate. This committee is comprised of a senior-level policy board established to advise the EPA on issues related to implementing the Clean Air Act Amendments of 1990, and it provides input regarding stakeholder, state, and local government concerns. The Federal Advisory Committee Act established the charter for this committee, and its membership includes approximately 60 senior managers and experts representing state and local government, environmental and public interest groups, academic institutions, unions, trade associations, utilities, industry, and other experts.

Planning, Analysis, & Evaluation

The Clean Air Advisory Committee would develop the requisite analytic blueprint for the program to guide data collection, help solicit early guidance from senior officials, and plan for the various analyses as required by Executive Orders and the Federal Regulatory Plan. These analyses essentially fill in the gaps in providing information necessary for stakeholder, economic, and governmental considerations. This formal economic analysis, prepared by EPA, would be mandatory because the regulation has an economic impact greater than $100 million. It would address the policy’s impacts on social welfare and industry by performing a benefit-cost analysis for the regulatory options created by the workgroups. This period also sets the resources available to promulgate the rule and determined next year’s schedule.

Development of the Preamble and Rule

EPA would hire a team of consultants to write the proposed rule itself. The universal standardization of the regulatory process has led to the development of specialized rule-writing consultants, which can efficiently and effectively produce legally-mandated regulations.

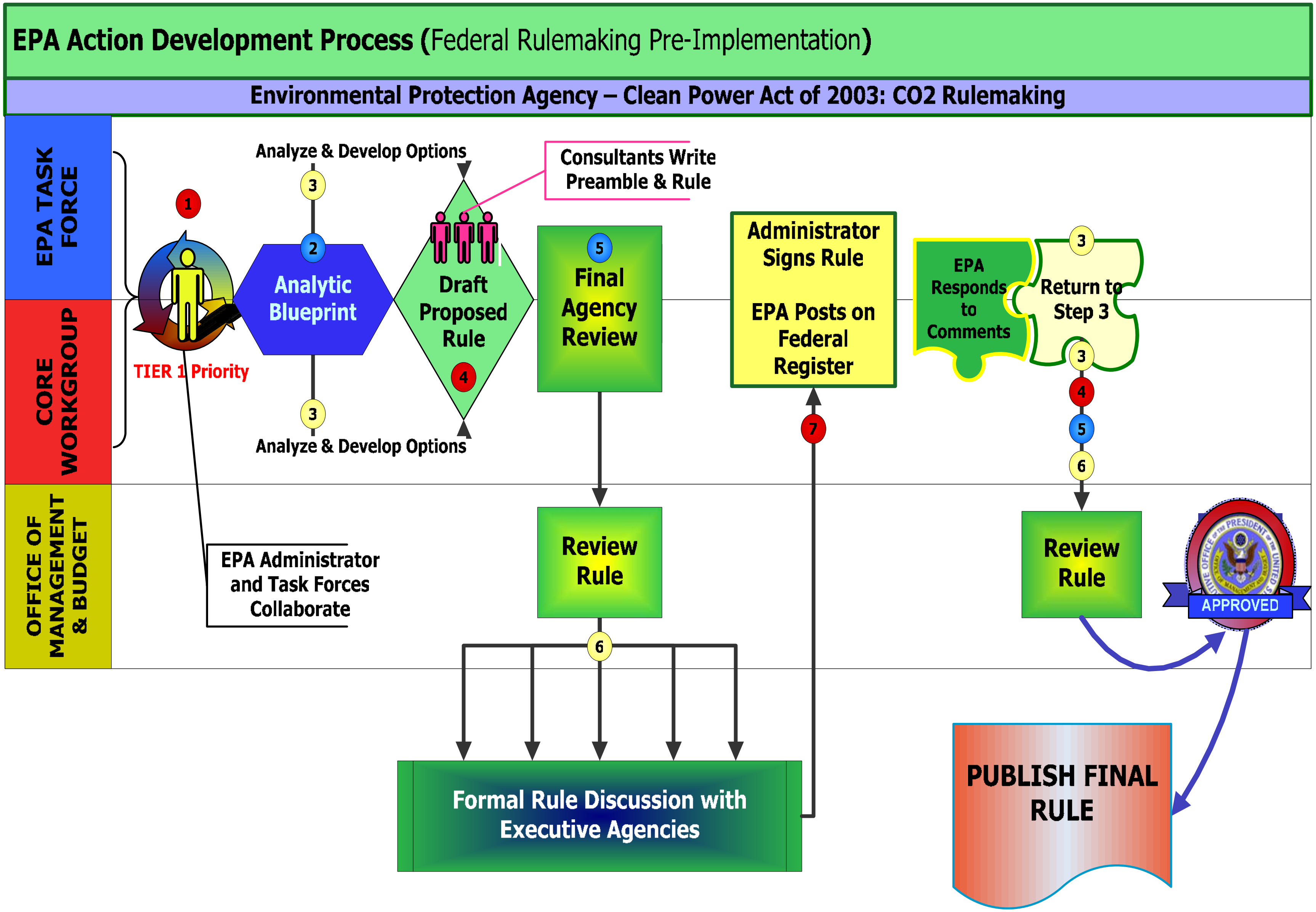
Decision – Final Agency Review

After the draft rule is written, EPA would circulate the document throughout the agency to receive approval from the various intra-agency collaborators. Upon final approval, the Administrator would sign the rule and send it to the White House for interagency collaboration.

Collaboration and Communication

Following White House interagency collaboration, EPA would submit a draft of the proposed rule to the OMB for initial review and a formal interagency discussion period moderated by this office. EPA would then make adjustments to the rule in response comments from other federal agencies. Then EPA would post the draft on the Federal Register for a public comment period of the maximum 90 days.

Upon receiving and addressing each posted comment after the summation of the public comment period, EPA would make revisions to the proposed bill and resubmit the bill with revisions to the OMB for final budgetary approval. When the Federal Rulemaking Process has been completed with OMB sign-off, the law will take effect. A simplified flow chart of the Federal Rulemaking Process is depicted on the following page.



Federal Registry Process Working Towards Rule Promulgation

Budget Narrative

Line Item Budget:

Personnel – A Director of Operations based in Washington, D.C. will head the CO2 program. Two assistant directors, each with a staff of three and based in the main office, will report to the Director. One assistant will be available to both groups and the Director to assist in miscellaneous tasks. One regional officer will be based in each of the ten regional offices of the EPA to facilitate program operations between state departments of environmental protection and utilities based in each respective region.

Allowance Tracking System – EPA will monitor a tracking system, consisting of computer hardware and software, to track the distribution and trading of allowances between the states, the utilities, and other parties participating in the allowance trading system. Contracted technical assistance will provide maintenance and operational support for the system.

Equipment & Supplies – EPA will purchase a computer for the each program employee. A cell phone and phone plan will be provided to each FTE working on the program. Office supplies and postage will be purchased to meet the needs of program staff.

Travel Expenses – Two three-day training seminars will be held in Washington D.C. to provide assistance and common direction for all program staff. Two additional 3-day seminars will be held in Washington D.C. for program staff and state officials and industry personnel to assist in the cooperation and implementation of the CO_2 program. Air travel, hotel accommodation, and per diem amounts will be provided for all regional staff. Funds will be allocated for site visits to state DEP's as well as individual utilities over the course of the year. This includes airfare, mileage driven by car, hotel expenses and per diem rates.

Conference Sponsorship – Covers the expenses of hosting two conferences for all parties affected by the CO_2 program.

Overhead/Administration – The portion of the regional and head offices expenses of the EPA allocated to the CO_2 program, covering rent, utilities, etc.

Grants – The funds provided to the states to assist with conservation programs, pilot programs, research and development, and other implementation needs.

Contracts – Contracted financial experts will establish and manage the revolving loan program funded from the excess revenue generated from the auction and collected fines. The Director will provide oversight to ensure proper management of the program.

<u>Program Budget:</u>

Program Administration – The total costs associated with the overall administration activities of the CO_2 program.

Grants & Contracts – The portion of staff time spent on reviewing grant and contract requests from state officials, prioritizing the requests, and submitting recommendations to the assistant directors for approval.

Budget – The portion of the assistant directors' time dedicated to developing the annual budget for the program.

Program Development – The costs allocated to cost-effective development and enhancement of the CO_2 program, which lessens the administrative burden for sources and regulators.

Emissions Monitoring – Total costs associated with analyzing the data calculated by the CEM monitors to determine overall compliance with the program as well as providing guidance to States and industry and ensures that CO_2 emissions are accurately and cost-effectively measured and reported on time.

Market Operations – Costs (including staff time) dedicated to day-to-day functions will cover operating market-based emission reduction programs, such as recording allowance transfers, receiving emission reports, and working with stakeholders to ensure that the markets operate efficiently.

Assessment & Communications – The portion of staff time spent on meetings with state and industry representatives to assess the progress of the program and to receive feedback for potential changes and improvements to the system. After weighing costs and benefits (environmental, human health, and economic) of the CO_2 program, the information will be communicated to decision makers and other customers.

State Action Review Plan – The costs and staff time allocated to reviewing and approving the action plans submitted by the states in relation to the distribution of allowances.

Glossary of Terms

Abatement- the reduction of the degree or intensity of emissions

Allocation - the division of emissions permits or allowances among greenhouse gas emitters for the purpose of establishing a market in tradable permits. There are several possible methods for allocating permits, including "grandfathering" and permit auctioning.

Allowances – a permit that grants power plants (or other buyers, including individuals or other entities) the right to emit (or retire) one ton of a pollutant. One ton of an emitted pollutant, as defined by CPA, is equivalent to one allowance.

Banking- entails saving emissions permits or Certified Emissions Reductions for future use in anticipation that these will accrue value over time.

Benefit-cost analysis - an economic technique applied to public decision making that attempts to quantify in dollar terms the advantages (benefits) and disadvantages (costs) associated with a particular policy. For example, a policy that requires a power plant near the Grand Canyon to install pollution abatement equipment would reduce air emissions from the plant and improve the visibility at the Grand Canyon for visitors (a benefit), but would increase the cost of electricity to customers (a cost).

Best Available Control Technology (BACT) – emission controls that will achieve the lowest achievable emission rate for the source to which it is applied.

Cap-and-trade – a system by which aggregate emission levels are limited or “capped” by a federal or state regulatory agency, after which emission permits totaling the amount of the emission cap are distributed to polluting entities. These entities may then trade these permits on the open market in order to achieve emission compliance.

Carbon dioxide (CO_2)– a gas that occurs naturally in the Earth's atmosphere and significant quantities are also emitted into the air by fossil fuel combustion and deforestation.

Carbon sequestration – capturing carbon in carbon sinks such as the oceans, forests or soils to reduce the amount of carbon released into the atmosphere.

Carbon sink - Any reservoir that takes up carbon released from some other part of the carbon cycle may be referred to as a carbon sink; for example, vegetation, soils, the atmosphere, and oceans are major carbon sinks because much of the carbon dioxide produced elsewhere on the Earth ends up in these bodies. (See Figure below).

Climate change - a significant change (such as a change having important economic, environmental and social effects) in the mean values of a meteorological element (in particular temperature or amount of precipitation) in the course of a certain period of time, where the means are taken over periods of the order of a decade or longer.

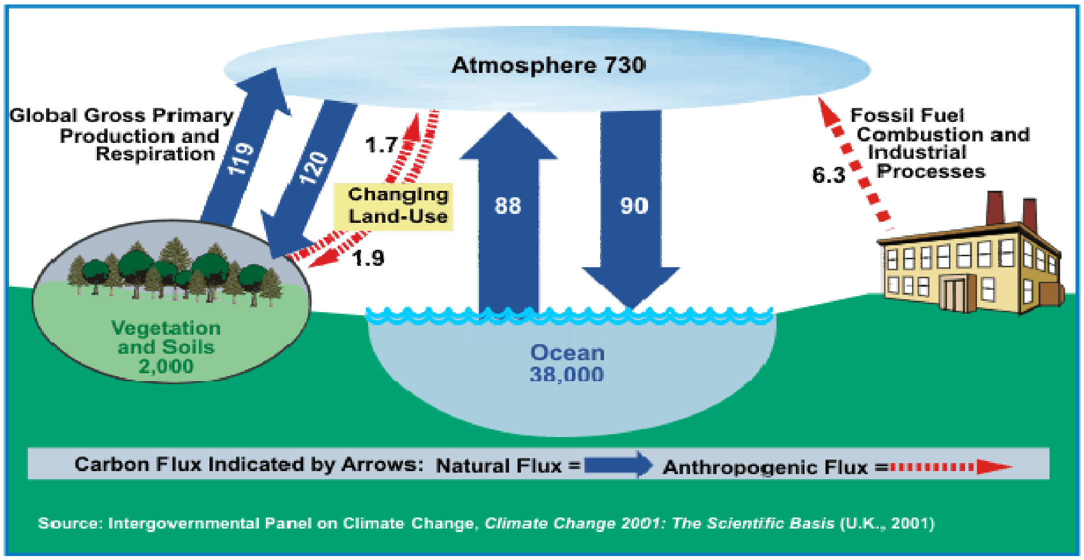


Figure A. Global Carbon Cycle (Billion Metric Tons Carbon) [IPCC 2001]

Coal gasification – process by which coal is converted into synthetic natural gas.

Command-and-control regulation - requires polluters to meet specific emission-reduction targets and often requires the installation and use of specific types of equipment to reduce emissions.

Clean coal (Low Sulfur Coal/Anthracite) – a material formed in ancient fresh water river basins has low concentrations of inorganic sulfur.

Decomposition rates- the pace at which organic material becomes inorganic. This can occur by means of both physical and biological processes.

Dirty coal (High Sulfur Coal) – a material formed from plant matter and deposited in marine settings has high organic sulfur concentrations.

Emissions permits – the sources of the pollutant to be regulated (most often an air pollutant) are given permits to release a specified number of tons of the pollutant. The government issues only a limited number of permits consistent with the desired level of emissions. The owners of the permits may keep them and release the pollutants, or reduce their emissions and sell the permits. The fact that the permits have value as an item to be sold gives the owner an incentive to reduce their emissions.

Emissions trading – is an economic incentive-based alternative to command-and-control regulation. In an emissions trading program, sources of a particular pollutant (most often an air pollutant) are given permits to release a specified number of tons of the pollutant. The government issues only a limited number of permits consistent with the desired level of emissions. The owners of the permits may keep them and release the pollutants, or reduce their emissions and sell the permits. The fact that the permits have value as an item to be sold or traded gives the owner an incentive to reduce their emissions

Externalities – occur when the activity of one person has an inadvertent impact on the well-being of another person. Many aspects of environmental degradation, such as air pollution, climate change, loss of wilderness, and contamination of water bodies, are viewed as externalities of economic transactions.

Federal Registry Process – the process through which a federal agency turns a ratified bill into an enforceable rule.

Fluidized bed coal combustion – crushed coal particles are suspended in the boiler on upward-blowing jets of air. This allows the particles to move about dynamically in a fluidized state.

Fossil fuels – include coal, petroleum and natural gas.

Gas reburning – process of burning coal in a low oxygen environment, then injecting part of the fuel into a separate zone where fuel-rich conditions break apart NO_x and reburn at low temperatures.

Grandfathering – of emissions permits is a method by which permits for greenhouse gas emissions may be allocated among emitters and firms in a domestic emissions trading regime according to their historical emissions. Supporters of this method of emissions trading assert that this would be administratively simple but some critics argue that this method would reward firms with high historical emissions and unfairly complicate entry into markets by new firms and emitters

Greenhouse gases – gases such as carbon dioxide, methane, water vapor, nitrous oxide, ozone and halocarbons in the atmosphere that trap heat from the sun and warm the Earth.

Greenhouse effect – the rise in the Earth's temperature as a result of certain gases in the atmosphere (including water vapor, carbon dioxide, nitrogen oxide, and methane) trapping energy from the Sun. Without these gases and the greenhouse effect, heat would escape back into space and Earth's average temperature would be about 58°F colder.

Injected activated carbon – a process where activated carbon, along with sulfur or iodine, is injected into the flue gas of a spray dryer to form a stable mercury compound, causing 90 percent of Hg to precipitate out so it can be removed.

Long-wave radiation – heat radiation with wavelengths greater 4 mm; the heat released from the earth's surface.

National Ambient Air Quality Standards (NAAQS) – standards established by the EPA to reduce the concentrations of six criteria pollutants: ozone, particulate matter, carbon monoxide, sulfur dioxide, nitrogen oxide and lead because they are considered harmful to public health and the environment.

New Source Performance Standards (NSPS) - are federal standards adopted by the U.S. Environmental Protection Agency (EPA) to regulate air emissions by many types of industrial facilities

New Source Review - requires stationary sources of air pollution to receive permits prior to construction. NSR is also referred to as construction permitting or preconstruction permitting. There are three types of permits - for new major sources, modifications to major sources, and for non-attainment areas.

Nitrogen oxides (NO_X) – compounds of nitric acid (NO), nitrogen dioxide (NO_2), and other oxides of nitrogen typically created during combustion processes, and are major contributors to smog formation and acid deposition and may result in numerous adverse health effects and reduces visibility.

Radiative forcing – the change in the balance between the incoming and outgoing radiation; positive radiative forcing, which warms the Earth, occurs because greenhouse gases prevent some radiation from escaping back into space.

Renewable energy – can be used to create electricity without the release of emissions into the atmosphere includes wind, hydro, solar, fuel cell and biomass power.

Residence time – the amount of time that carbon is present in the atmosphere, or ocean before it is incorporated into biomass.

Scrubbing – an add-on control device that injects a mixture of limestone and water into the flue gas and reacts with SO_2 to form calcium sulfate. Also called Flue Gas Desulfurization (FGD).

Selective Catalytic Reduction (SCR) – an add-on control device that reduces NO_X emissions by converting them to nitrogen and water through the intervention of ammonia and a non-reacting catalyst that remains in place for continued reuse. The NO_X reduction reactions occur in a narrow temperature range, generally 550-900° F. SCR is capable of NOx emission reductions of 90 percent or greater. This results in pollution reductions as high as 90 percent.

Selective Non-Catalytic Reduction (SNCR) – an add-on control device that reduces NO_X emissions by converting them to nitrogen and water using ammonia or urea injection without a catalyst. In the absence of a catalyst, higher temperatures in the range 1600 to 2000° F are required for ammonia to selectively react with nitric oxide to form molecular nitrogen and water.

Smog – pollution formed by the interaction of pollutants and sunlight in the lower atmosphere, restricting visibility, and potentially hazardous to health.

State Implementation Plans (SIPs) – an enforceable plan developed at the state level that explains how the state will comply with air quality standards according to the federal Clean Air Act.

Sulfur dioxide – a gas produced by burning coal, most notably in power plants and plays an important role in the production of acid rain.

Technology transfer – the process by which energy-efficient technologies (in the context of climate change prevention) and processes developed by industrialized nations are made available to the less-industrialized nations. These transfers may be conducted solely through the efforts of private parties or may involve governments and international institutions

Wet deposition – pollution that falls to the ground in the form of rain, snow, or fog.

Vector (as in vector-borne disease) – an organism, such as a mosquito or tick, that carries disease-causing microorganisms from one host to another of a different species.

Volatile Organic Compounds (VOCs) – compounds that have a high vapor pressure and low water solubility and react readily with NO_X to form ozone in the atmosphere.

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