Union of Concerned Scientists

Gambling with Coal

How Future Climate Laws Will Make New Coal Power Plants More Expensive

by Barbara Freese and Steve Clemmer
Union of Concerned Scientists[1]
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Abstract
New conventional coal plants are an imprudent financial investment. The world scientific community warns that carbon dioxide (CO_2) emissions from our use of fossil fuels, especially coal, is leading to dangerous global warming. Policies to reduce CO_2 emissions are emerging at every level of government, including in the US Congress, which is actively considering several mandatory, market-based CO_2 proposals with increasing support from the private sector. Laws requiring coal plants to pay to emit CO_2 will be adopted in the next few years, substantially raising the costs of coal power.

Nevertheless, many utilities have proposed investing in new conventional coal plants that will operate for decades, ignoring the economic impact of these virtually inevitable CO_2 reduction laws, perhaps because they believe they will be able to pass these costs on to ratepayers. Utility managers and shareholders should reconsider the financial risks to their companies and customers. Regulators should prevent utilities from making these major investment mistakes by refusing to approve the construction of new conventional coal plants and by requiring them to invest in cleaner alternatives, or at the very least, by warning utilities that CO_2 costs must be borne by their shareholders, not by ratepayers.

Executive summary

It is now virtually inevitable that America will adopt a federal law limiting global warming pollution from power plants. Indeed, given the momentum of emerging policy responses to global warming on the local, state, and regional levels in the United States (as well as internationally), federal legislation will probably be adopted within the next five years. This document discusses why such a law is so likely, what kind of new costs coal plants will face as a result, and how these future costs make building new, conventional coal plants a reckless financial gamble.

[1] We would like to thank the Garfield Foundation for providing funding for this work.

The need for legal limits to America's global warming pollution is undeniable. Scientists have long known that the burning of fossil fuels releases heat-trapping carbon dioxide (CO_2) into the air, where it is building up. Scientific concern that this buildup could disrupt our climate has been growing steadily since the late 1980s. Every year, the science has become even more compelling: Earth continues to experience record-breaking warmth, humans' dominant role in this warming becomes clearer, and we see the planet reacting to the warming in troubling ways.

Most developed nations have responded to this evidence by ratifying the Kyoto Protocol, which requires them to reduce their CO_2 emissions. The United States has not ratified Kyoto, but as the world's largest emitter of heat-trapping gases by far, it is under increasing international pressure to act. Along with almost every other nation in the world, the United States did ratify the 1992 Framework Convention on Climate Change, a treaty with the objective of preventing dangerous global warming. And in 2005 the U.S. Senate passed a landmark resolution stating that mandatory federal CO_2 limits should be enacted. Several proposals establishing CO_2 limits are being considered by Congress, and a series of hearings have been held in the Senate to discuss the design of such limits.

The congressional response is being spurred in part by a growing policy response on the state and regional level, including the regional CO_2 limits and trading system being established by eight northeastern states. Within the last year or two, a substantial number of major companies—including half of America's 10 largest power companies—have called for such regulation, and most utility executives believe that such regulation is coming.

There is no doubt that the burden of future CO_2 regulations will fall heavily on coal plants. Power plants are the largest source of U.S. CO_2 emissions, accounting for 39 percent of the nation's energy-related emissions, and most of these emissions come from coal plants. In fact, coal plants produce one-third of America's CO_2 emissions—about the same amount as all our cars, SUVs, trucks, buses, planes, ships, and trains combined.[2]

Each new coal plant represents an enormous long-term increase in global warming emissions. A 500-megawatt (MW) plant, for example, produces the annual global warming emission equivalent of roughly 600,000 cars,[3] but unlike a car, a coal plant is designed to operate for 40 to 50 years (and they often operate even longer). Global warming cannot be effectively addressed without limiting coal plant emissions, so the congressional proposals under consideration all target coal plants.

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[2] U.S. Environmental Protection Agency (EPA), "Inventory of US Greenhouse Gas Emissions and Sinks: 1990-2004," April 2006. Online at *http://yosemite.epa.gov/oar/globalwarming.nsf/content/ResourceCenterPublicationsGHGEmissionsUSEmissionsInventory2006.html*. Also see U.S. Energy Information Administration (EIA), *Emissions of Greenhouse Gases in the United States 2004*, December 2005, 20–22. Online at *ftp://ftp.eia.doe.gov/pub/oiaf/1605/cdrom/pdf/ggrpt/057304.pdf*.

[3] Based on average annual emissions of 13,500 lbs/vehicle as estimated by the EPA (*http://yosemite.epa.gov/oar/globalwarming.nsf/content/ResourceCenterToolsGHGCalculator.html*) and annual emissions of 4.1 million tons from a 500 MW plant as estimated by the Public Service Commission of Wisconsin (*http://psc.wi.gov/utilityinfo/electric/cases/weston/document/Volume1/W4_FEIS.pdf*).

It is widely expected that future CO_2 regulations will take the form of a "cap-and-trade" system, similar to the national law for controlling the sulfur dioxide (SO_2) emissions that cause acid rain. Such a system would establish a national cap on CO_2 emissions, and power plant operators would have to own an "allowance" for each ton of CO_2 they emit. Operators could buy and sell these allowances for a price established by market forces. Economists believe such a cap-and-trade system would provide the flexibility and incentives to meet a given CO_2 cap at the lowest cost.

Utilities are increasingly quantifying the risk they face from future CO_2 allowance costs in their planning documents. In some cases, they do so because state regulators demand it, and in other cases they do it at their own initiative. Studies forecasting the price of future CO_2 allowances range widely, but useful estimates are emerging from the literature. These estimates indicate that coal plants face CO_2 costs that will increase the cost of coal power substantially and perhaps severely. Mid-range projections of CO_2 allowance prices could increase the cost of electricity from the average new coal plant by roughly half.[4] Because coal plants are designed to last for decades, these added financial costs—along with the environmental costs created by coal plants—will be borne by both the present and future generations.

These allowance price forecasts generally assume the adoption of federal policies that aim for modest CO_2 emission reductions at best. However, the science now indicates that if we hope to avoid dangerous global warming, developed nations will need to reduce their CO_2 emissions dramatically—as much as 60 to 80 percent or more—by 2050.[5]

This evidence has prompted governments including California, New Mexico, the New England states, the eastern Canadian provinces, the United Kingdom, and the European Union to adopt long-term CO_2 emission reduction targets in the 60 to 80 percent range. It is therefore reasonable to expect that even if the emission cap initially enacted establishes only modest, short-term targets, it will be followed with increasingly strict national caps in the decades ahead—that is, throughout the operating lifetime of coal plants proposed today.

Meanwhile, climate policies are likely to accelerate the development of energy resources that significantly reduce heat-trapping emissions (reducing the cost of these resources relative to coal) and the development of energy efficiency technologies (reducing electricity demand below currently projected levels). In all likelihood, these changes will improve the economics of coal alternatives just as ever-tightening emission caps are worsening the economics of coal plants.

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[4] For CO_2 price projections see Synapse Energy Economics, "Climate Change and Power: Carbon Dioxide Emissions Costs and Electricity Resource Planning," May 18, 2006. Online at *http://www.synapse-energy.com*.

[5] European Environment Agency, "Climate Change and a European Low-Carbon Energy System," Copenhagen, 2005. Online at *http://reports.eea.eu.int/eea_report_2005_1/en/Climate_change-FINAL-web.pdf*.

Given these highly foreseeable trends, why are so many utilities still proposing to lock themselves into capital-intensive coal plants rather than investing in options that do not expose them to such financial risk? These utilities may be betting on their ability to pass the risk on to ratepayers in the form of higher electric rates—the same way they routinely pass through environmental compliance costs today. Utilities holding this belief have little incentive to assess and avoid the risks of future CO_2 regulation. That places on state utilities regulators an enhanced responsibility to assess for themselves the risks associated with gambling huge amounts of money on a large, multi-decade source of CO_2 emissions just as the nation is about to launch a large, multi-decade effort to reduce CO_2 emissions that will surely target coal power.

Utilities may also be ignoring these political developments under the reckless assumption that any plant built before a federal CO_2 cap is adopted will be allocated allowances for free. This gamble ignores the growing opposition to granting such a windfall to utilities (particularly those that could avoid new allowance costs by simply investing in alternatives to coal). The Northeast Regional Greenhouse Gas Initiative (RGGI) model rule, for example, requires that at least 25 percent of allowances be auctioned rather than allocated,[6] and Vermont, the first Northeast state to pass enabling legislation, requires *all* allowances to be auctioned.[7] In fact, 28 different stakeholders in the RGGI model rule draft—including businesses, consumer groups, environmental organizations, state agencies, and an electricity distribution company—supported auctioning 50 to 100 percent of allowances.[8]

At the federal level, Senators Pete Domenici (R-NM) and Jeff Bingaman (D-NM) issued a white paper describing the design elements of a mandatory system to reduce emissions. The paper notes that auctioning off all allowances would minimize the costs to the U.S. economy as a whole, streamline the administrative process, and avoid unintended competitive advantages and windfall profits for certain market participants.[9] A recent Wall Street study also predicts that the United States will have an auction-based rather than allocation-based cap-and-trade system.[10]

If regulators do authorize the construction of a new coal plant, they should notify the utility up front that it will not be allowed to pass future CO_2 compliance costs on to ratepayers. The last time the nation's utilities embarked on a large-scale campaign to build new baseload plants (plants that operate most of the time) was the 1960s and 1970s; the result was scores of abandoned nuclear projects and a great deal of excess generating capacity. Disputes over whether ratepayers or utility shareholders should pay for these

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[6] Regional Greenhouse Gas Initiative (RGGI) Model Rule, subpart XX-5.3. Online at *http://www.rggi.org/docs/model_rule_8_15_06.pdf*.

[7] The Vermont law (H. 860) is online at *http://massclimateaction.org/RGGI/VTRGGISignedMay06.pdf*.

[8] Environment Northeast, Natural Resources Defense Council, and Pace Law School Energy Project, "Summary of Comments on the RGGI Model Rule Draft," 2006.

[9] Sen. Pete V. Domenici and Sen. Jeff Bingaman, "Design Elements of a Mandatory Market-Based Greenhouse Gas Regulatory System," February 2006.Online at *http://www.nam.org/s_nam/bin.asp?CID=43&DID=236483&DOC=FILE.PDF*.

[10] Hugh Wynne, "U.S. Utilities: The Prospects for CO_2 Emissions Limits in the United States and Their Implications for the Power Industry," Bernstein Research, April 19.

investment mistakes led to a series of decisions requiring shareholders to pay for at least a portion of the losses. Those decisions stressed the importance of forcing utilities to assume financial risk in order to give them an incentive to track events that could increase the cost of construction projects and to reassess the viability of those projects as conditions warrant.

Given the momentum now driving the nation toward CO_2 limits—and the substantial impact such limits will have on the cost of coal power—it has never been more critical to ensure that utility managers are staying abreast of current developments. Placing the financial risk of future CO_2 costs on shareholders, clearly and up front, will create that incentive. This regulatory approach is not only fully consistent with rate-making principles, but also builds on the lessons learned from the expensive investment mistakes of the past.

I. Scientific evidence clearly establishes the need for policies limiting CO_2 emissions now and reducing them dramatically over a period of decades.

A. The scientific consensus about the reality of global warming is strong and growing stronger.

The world scientific community spoke with one voice recently to deliver an unprecedented and remarkably pointed message to world leaders. Eleven of the world's most respected national science academies, including the U.S. National Academy of Sciences (NAS), issued this joint statement in anticipation of the 2005 G8 Summit:

> *"Climate change is real. There will always be uncertainty in understanding a system as complex as the world's climate. However, there is now strong evidence that significant global warming is occurring."*[11]

The statement called on world leaders to acknowledge that "the threat of climate change is clear and increasing," and urged all nations "to take prompt action to reduce the causes of climate change."[12]

The NAS is generally considered America's preeminent scientific association. It was chartered by Congress in 1863 and tasked with the role of advising the nation on scientific matters. Its 2,000 members—all elected to the academy in recognition of their distinguished achievements in original research—include the nation's most respected scientists; roughly 10 percent have won a Nobel Prize.[13] When the Bush administration

[11] The "Joint Science Academies' Statement: Global Response to Climate Change" was issued by the NAS and its counterpart academies in Brazil, Canada, China, France, Germany, India, Italy, Japan, Russia, and the United Kingdom. Online at *http://nationalacademies.org/onpi/06072005.pdf*.
[12] Ibid.
[13] See the NAS website: *http://www.nasonline.org/site/PageServer?pagename=ABOUT_main_page*.

took office in 2001, it asked the NAS for confirmation that our heat-trapping emissions are causing global warming, and it received that confirmation.[14]

This joint statement follows a growing number of statements and reports reflecting concern about global warming from the NAS, the American Geophysical Union, the American Association for the Advancement of Science, the American Meteorological Society—indeed every scientific association in the nation whose membership has expertise directly relevant to the issue.[15] The consensus on the reality of climate change is so strong that a review of 928 papers published in peer-reviewed scientific journals between 1993 and 2003 did not find a single paper that disagreed with the consensus view.[16]

The scientific consensus has been gaining strength at the international level as well. Since 1988, thousands of scientists have been part of a formal process—under the auspices of the Intergovernmental Panel on Climate Change (IPCC)—for methodically and collectively looking at the climate science and publishing reports to help the world's policy makers determine the scope of the global warming threat. The IPCC has published three major assessments to date (1990, 1995, and 2001), each time expressing greater concern about the certainty and potential danger of global warming.[17] Given the record-breaking warmth the planet has continued to experience since the 2001 IPCC report and subsequently published scientific assessments,[18] it is widely expected that the IPCC's upcoming 2007 report will continue that trend.[19]

Evidence that we are changing the climate and that the planet is responding in worrisome ways is now so strong that many who have dismissed global warming in the past have recently changed positions. Prominent members of the media who formerly declared themselves skeptical of the threat have quite publicly "switched sides."[20] Even

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[14] NAS, "Climate Change Science: An Analysis of Some Key Questions," 2001. Online at http://fermat.nap.edu/books/0309075742/html.

[15] Ibid. Also see NAS, "Understanding and Responding to Climate Change: Highlights of National Academies Reports," 2006 (online at http://dels.nas.edu/basc/Climate-HIGH.pdf); American Geophysical Union, "Human Impacts on Climate," December 2003 (online at http://www.agu.org/sci_soc/policy/climate_change_position.html); Atlas of Population and Environment by the American Association for the Advancement of Science, "Climate Change" (online at http://www.ourplanet.com/aaas/pages/atmos02.html); American Meteorological Society Council, "Climate Change Research: Issues for the Atmospheric and Related Sciences," February 9, 2003, *Bulletin of the American Meteorological Society* 84, 508–515 (online at http://www.ametsoc.org/POLICY/climatechangeresearch_2003.html).

[16] Naomi Oreskes, "Beyond the Ivory Tower: The Scientific Consensus on Climate Change," *Science*, December 3, 2004, 1686. Online at http://www.sciencemag.org/cgi/content/full/306/5702/1686.

[17] Intergovernmental Panel on Climate Change (IPCC), "16 Years of Scientific Assessment in Support of the Climate Convention," December 2004. Online at http://www.ipcc.ch/about/anniversarybrochure.pdf.

[18] For example, see Scientific Symposium on Stabilisation of Greenhouse Gases, "Avoiding Dangerous Climate Change," Executive Summary of the Conference Report, February 1-3, 2005, 2. Online at http://www.defra.gov.uk/environment/climatechange/internat/dangerous-cc.htm.

[19] Roger Harrabin, "Consensus Grows on Climate Change," BBC News, March 1, 2006. Online at http://news.bbc.co.uk/1/low/sci/tech/4761804.stm.

[20] Gregg Easterbrook recently wrote in the *New York Times*, "[a]s an environmental commentator, I have a long record of opposing alarmism. But based on the data I'm now switching sides regarding global

ExxonMobil, which has for years disputed the mainstream climate science more aggressively than any corporation in America, now admits "that the accumulation of greenhouse gases in the Earth's atmosphere poses risks that may prove significant for society and ecosystems. We believe that these risks justify actions now, but the selection of actions must consider the uncertainties that remain."[21] The company continues to exaggerate the uncertainties, to fund groups that cast doubt on the science (to the growing dismay of investors[22]), and to resist government regulation, but the science is now so strong that it can no longer deny that the risks justify an immediate response.[23]

B. The evidence establishes that global warming is already harming the planet, and that we face much greater levels of damage in the century ahead.

The basics of global warming science have been understood for a long time. Heat-trapping or "greenhouse" gases, of which CO_2 is the most important, allow the sun's light to penetrate to Earth's surface, where some of it is absorbed and converted into heat. These gases then prevent that heat from radiating back out to space, thereby keeping the planet warm enough to support life.

When we burn fossil fuels, the carbon in those fuels is converted into CO_2; since coal contains the most carbon, it creates the most CO_2 for every unit of energy released.[24] Humans have emitted enough CO_2 to raise background concentrations of this critical heat-trapping gas by about one-third above pre-industrial levels, and concentrations continue to rise.[25] Once concentrations rise, it takes centuries for natural processes to bring them back down again.[26]

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warming, from skeptic to convert." ("Finally Feeling the Heat," May 24, 2006. Online at *http://select.nytimes.com/gst/abstract.html?res=F40B1EF63B5A0C778EDDAC0894DE404482*; subscription required). A few days earlier, Michael Shermer wrote in *Scientific American*, "environmental skepticism [on climate change] was once tenable. No longer. It is time to flip from skepticism to activism." ("The Flipping Point: How the Evidence for Anthropogenic Global Warming Has Converged to Cause this Environmental Skeptic to Make a Cognitive Flip," June 2006, 28. Online at *http://www.sciam.com/article.cfm?articleID=000B557A-71ED-146C-ADB783414B7F0000&sc=I100322*.)

[21] ExxonMobil, 2005 Corporate Citizenship Report, May 2006, 22. Online at *http://www.exxonmobil.com/Corporate/Citizenship/citizenship.asp*.

[22] Andrew Logan and David Grossman, "ExxonMobil's Corporate Governance on Climate Change," CERES and Investor Network on Climate Risk, May 2006, 2. Online at *http://www.ceres.org/pub/docs/Ceres_XOM_corp_gov_climate_change_052506.pdf*.

[23] Other major oil companies publicly accepted the reality of climate change years ago, and are more direct in their recognition of the risks it poses. The head of BP Amoco said to the British House of Lords in 2002, "Very few people now deny that climate change is a serious risk to the whole of the world" (online at *http://www.bp.com/genericarticle.do?categoryId=98&contentId=2000291*). Also see the climate statements on the websites of Royal Dutch Shell (*www.shell.com*) and Chevron (*www.chevron.com*).

[24] Coal contains nearly 90 percent more carbon per unit of energy than natural gas. However, a new conventional (supercritical) coal power plant produces nearly 150 percent more CO_2 than a new natural gas combined-cycle power plant, which is much more efficient. Based on data from EIA, *Assumptions to Annual Energy Outlook 2006*, Table 38, March 2006, 73. Online at *http://www.eia.doe.gov/oiaf/aeo/assumption/pdf/0554(2006).pdf*.

[25] IPCC Third Assessment Report (TAR), Climate Change 2001: Report of Working Group 1, Summary for Policymakers, 7. Online at *http://www.ipcc.ch*.

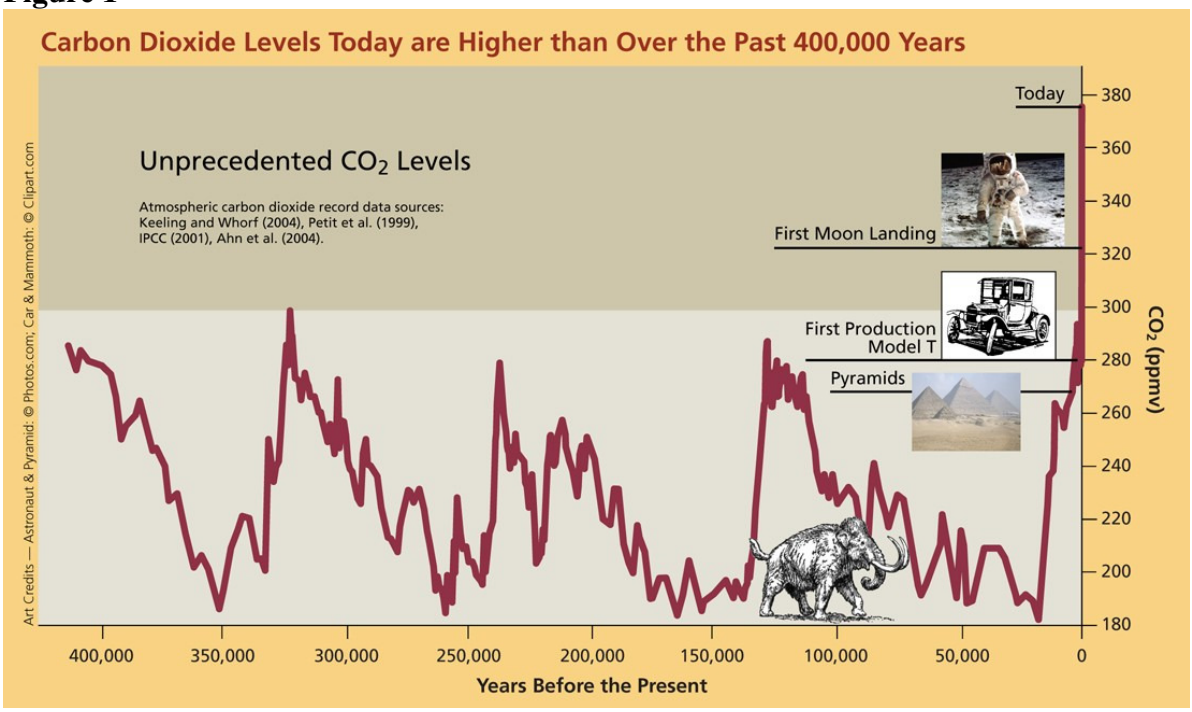
[26] Ibid, 17.

In recent years, scientific concern over global warming has grown both because our understanding of Earth's climate has improved and because the warming trend has continued. The National Aeronautics and Space Administration (NASA) reports that 2005 was the warmest year on record.[27] The five warmest years have all occurred since 1997 (including each of the last four years).[28] In 2001 the IPCC concluded that global average temperatures rose 0.6 degree Celsius (1.1 degrees Fahrenheit) in the twentieth century.[29] However, due to steady warming in this century, total warming over the last 100 years is now up to 0.8 degree Celsius (1.4 degrees Fahrenheit), with most of that increase (0.6 degree Celsius or 1.1 degree Fahrenheit) occurring in just the last 30 years.[30] Scientists have a high level of confidence that the present time is warmer than any period in at least 400 years.[31]

Scientists have been looking for natural causes that would explain the steep warming trend of recent years and have been unable to find them; indeed, it appears that natural causes alone (e.g., solar variation and volcanic activity) should have led to stable or slightly cooler average global temperatures in recent decades.[32] Computer models can only duplicate the recent warming by including today's phenomenally high concentrations of heat-trapping gases, especially CO_2.[33] Figure 1 compares today's CO_2 levels with those occurring over the last 400,000 years. New ice core data go back even further, and show that global CO_2 levels are 27 percent higher than they have been at any time in the past 650,000 years.[34]

[27] National Aeronautics and Space Administration (NASA), "2005 Warmest Year in Over a Century," January 24, 2006. Online at http://www.nasa.gov/vision/earth/environment/2005_warmest.html.
[28] Ibid.
[29] IPCC TAR, Summary for Policymakers, 2.
[30] NASA, 2006.
[31] National Research Council, *Surface Temperature Reconstructions for the Last 2000 Years*, National Academies Press, 2006, 3. Online at http://www.nap.edu/catalog/11676.html#toc.
[32] IPCC TAR, Summary for Policymakers, 10–11.
[33] Ibid.
[34] Urs Siegenthaler, et al., "Stable Carbon Cycle-Climate Relationship during the Late Pleistocene," 2005, *Science* 310:1313–1317.

Figure 1



Sources: UCS, "Past, Present and Future Temperatures: the Hockeystick FAQ," online at *http://www.ucsusa.org/global_warming/science/hockeystickFAQ.html*.

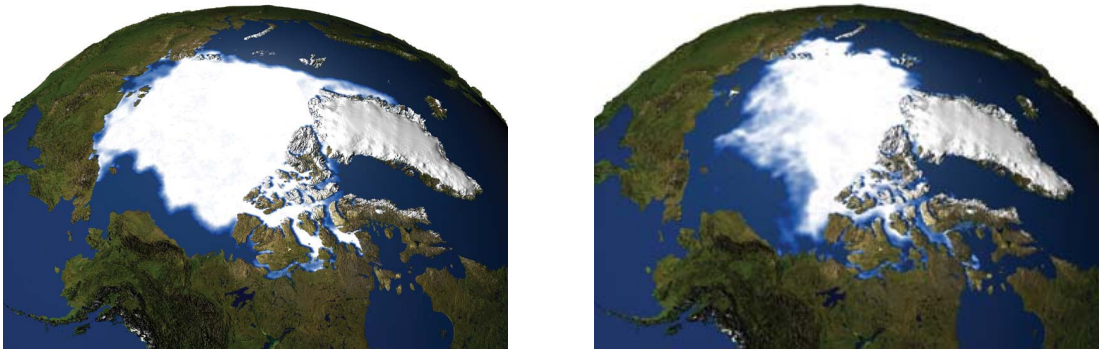
Other geologic evidence indicates that current CO_2 levels are probably higher than at any time in the last 20 million years.[35] Projections show that in the years ahead, unless actions are taken to reduce emissions, CO_2 levels could rise to 750 parts per million by volume (ppmv) or higher[36]—well beyond the scale used in Figure 1. In other words, we have already dramatically increased the atmospheric concentrations of a gas that plays a critical role in determining Earth's climate, and much more dramatic changes lie ahead if current trends continue.

The consequences of global warming are now evident around the world, and in many respects Earth is responding to the warming at a faster rate than scientists predicted just a few years ago. The effects of climate change are now visible in most ecosystems and appearing more rapidly than predicted.[37] Recent studies have suggested a link between global warming, higher sea surface temperatures, and an unexpected increase in hurricane strength.[38] Mountain glaciers are in widespread retreat, enormous ice shelves in

[35] IPCC TAR, Summary for Policymakers, 7.
[36] Ibid., 14.
[37] Hans Joachim Schellnhuber, ed., *Avoiding Dangerous Climate Change*, Chapter 12, Cambridge University Press, 2006. Online at *http://www.defra.gov.uk/environment/climatechange/internat/dangerous-cc.htm*.
[38] Kerry Emanuel, "Increasing Destructiveness of Tropical Cyclones Over the Past 30 Years," August 4, 2005, *Nature* 436:686 (online at *http://www.nature.com/nature/journal/vaop/ncurrent/abs/nature03906.html*); Georgia Institute of Technology, "Hurricanes are Getting Stronger, Study Says," press release, September 15, 2005 (online at

Antarctica have collapsed with surprising suddenness, and Arctic permafrost and northern polar sea ice are melting dramatically.[39] Satellites show that perennial sea ice in the Arctic shrunk at a rate of nine percent per decade between 1979 and 2003 (Figure 2).

Figure 2: Arctic Sea Ice Is Retreating



Arctic sea ice in 1979 **Arctic sea ice in 2003**

Source: NASA Goddard Space Flight Center, online at *http://earthobservatory.nasa.gov/Newsroom/NewImages/images.php3?img_id=16340*.

Earth's response to the warming we have experienced thus far increases concerns about how the planet will respond to the much greater warming expected in the century ahead. The IPCC's 2001 assessment predicts warming of another 1.5 to 5.8 degrees Celsius (2.7 to 10.4 degrees Fahrenheit) by 2100.[40] Figure 3 compares this warming with observed temperatures during the previous century and with estimated temperatures of the last 1,000 years.

The range of warming estimates for the next century reflects uncertainties about Earth's climate system as well as uncertainty about the future rate at which heat-trapping gases will be emitted. Recent studies of how natural systems release more heat-trapping gases in response to warming, amplifying the effect of human-made emissions, suggest the 2001 predictions may be conservative.[41]

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http://www.gatech.edu/news-room/release.php?id=654); National Center for Atmospheric Research, "Global Warming Surpassed Natural Cycles in Fueling 2005 Hurricane Season, NCAR Scientists Conclude," press release, June 22, 2006.

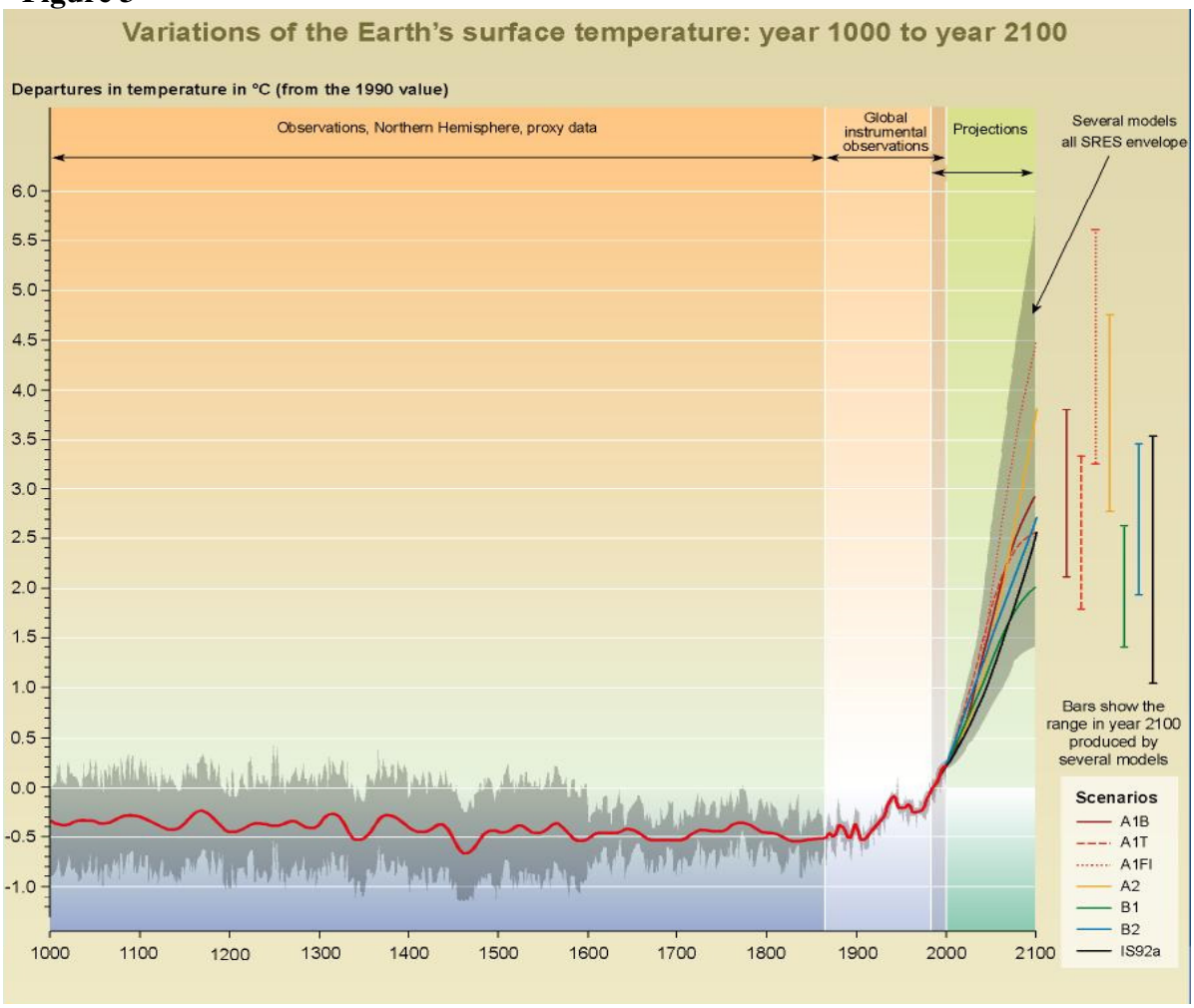
[39]IPCC TAR, Summary for Policymakers, 4; Arctic Climate Impact Assessment: Impacts of a Warming Arctic, Cambridge University Press, 2004 (online at *http://amap.no/acia*); Ice shelf collapses described by the National Snow and Ice Data Center (online at *http://nsidc.org/sotc/iceshelves.html*).

[40] IPCC TAR, Summary for Policymakers, 13.

[41]Margaret S. Torn and John Harte, "Missing Feedbacks, Asymmetric Uncertainties, and the Underestimate of Future Warming," 2006, *Geophysical Research Letters* 33:L10703; Lawrence Berkeley National Laboratory, "Feedback Loops in Global Climate Change Point to a Very Hot 21st Century," press release, May 22, 2006 (online at *http://www.lbl.gov/Science-Articles/Archive/ESD-feedback-loops.html*); American Geophysical Union, "Greenhouse Gas/Temperature Feedback Mechanism May Raise Warming Beyond Previous Estimates," press release, May 22, 2006 (online at *http://www.agu.org/sci_soc/prrl/prrl0617.html*).

Moreover, the NAS and others warn that future warming could occur in abrupt and unpredictable ways. Evidence of past climate changes show the planet has a history of quickly lurching from one climate pattern to another in a way that would make it far harder for nature and society to adapt.[42]

Figure 3



Source: IPCC, "Climate Change 2001:Synthesis Report," Summary for Policymakers, 34.

C. Evidence indicates that dramatic reductions in CO_2 levels will be required in the decades ahead.

Currently, much of the scientific and policy discussion occurring globally focuses on how deeply and quickly CO_2 emissions need to be cut in order to avoid triggering dangerous global warming.[43] The international community has been treaty-bound to work

[42]National Research Council, *Abrupt Climate Change: Inevitable Surprises*, National Academies Press, 2002. Online at http://www.nap.edu/catalog/10136.html?onpi_newsdoc121101.
[43] Scientific Symposium on Stabilisation of Greenhouse Gases, 2005.

toward this goal since the Framework Convention on Climate Change was adopted in 1992 and ratified by 188 nations (including the United States).[44]

Evidence of the dangers associated with warming greater than two degrees Celsius above pre-industrial levels has been compelling enough to persuade the European Union (EU) to adopt the goal of limiting planetary warming to this level.[45] Studies show that to have a reasonable chance of achieving this goal, net heat-trapping emissions for both developed and developing countries must be reduced at least 15 to 50 percent below 1990 levels by 2050.[46] The European Parliament has adopted a resolution pushing for developed nations to reduce emissions 30 percent by 2020 and 60 to 80 percent by 2050.[47] The United Kingdom adopted a similar target in 2003: 20 percent reductions by 2010 and 60 percent by 2050.

In this country, two states have already adopted similarly ambitious goals. California has adopted a target of reducing heat-trapping emissions by 80 percent (below 1990 levels) by 2050,[48] and New Mexico seeks a 75 percent reduction (below 2000 levels) by 2050.[49] A regional goal was set in 2001 when the Conference of New England Governors and Eastern Canadian Premiers adopted a long-term target of reducing global warming emissions 75 to 85 percent below 2001 levels.[50]

In the discussion that follows it is important to keep this science in mind. Most of the policies currently in place or being debated, internationally and domestically, aim to achieve relatively modest targets that will have to be followed with more aggressive reductions in the years ahead if we are to avoid dangerous warming over the long term. Today's policy proposals must therefore be seen as the first steps in a much longer global process.

Ultimately, emission reductions of the magnitude needed will require a historic, worldwide transition away from the energy technologies that we rely on today, and particularly away from conventional coal plants, during the next four and a half decades—roughly during the operating lifetime of a new coal plant.

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[44] Framework Convention on Climate Change," Article 2. Online at *http://unfccc.int/resource/docs/convkp/conveng.pdf*.
[45] European Environment Agency, 2005, 10.
[46] European Environment Agency, 2005, 7 and Chapter 3.
[47] European Parliament Resolution on Climate Change, January 18, 2006. Online at *http://www.europarl.europa.eu/omk/sipade3?PUBREF=-//EP//TEXT+TA+P6-TA-2006-0019+0+DOC+XML+V0//EN&L=EN&LEVEL=1&NAV=S&LSTDOC=Y&LSTDOC=N*.
[48] Executive Order S-3-05, June 1, 2005. Online at *http://www.climatechange.ca.gov/index.html*.
[49] Office of Governor, State of New Mexico, "Governor Bill Richardson Announces Historic Effort to Combat Climate Change," press release, June 9, 2005. Online at *http://www.governor.state.nm.us/press/2005/june/060905_3.pdf*.
[50] New England Governors/Eastern Canadian Premiers, "Climate Change Action Plan 2001," August 2001. Online at *http://www.neg-ecp-environment.org/page.asp?pg=46*.

II. The global warming policy response is mounting at every level.

A. Other developed nations are deepening their commitments to emission cuts.

The global policy response to climate change has increased along with scientific concern. As noted above, in 1992 the United States and most other nations entered into the Framework Convention on Climate Change. That treaty commits developed nations to adopt policies limiting global warming emissions, but its emission reduction target is not binding.[51] The world community then negotiated the Kyoto Protocol, under which developed nations must reduce their emissions an average of five percent below 1990 levels by the period 2008 to 2012. The protocol went into effect in February 2005 despite the United States' refusal to ratify it.

Almost every other developed nation did ratify Kyoto, so that currently nearly half of the global economy is committed to emission reductions under its provisions.[52] Many nations, particularly within the EU, have already adopted mandatory emission limits. The EU itself is limiting CO_2 emissions with a multinational cap-and-trade system, a market-based regulatory approach pioneered in the United States (see part II, section C), and the European Parliament has also endorsed steep, long-term emission reductions.

The United States' refusal to ratify Kyoto or otherwise limit its global warming emissions leaves it nearly isolated within the developed world—a conspicuous position for a country that is the world's richest and also emits roughly one-quarter of the world's heat-trapping emissions, far more than any other nation.[53] The only other developed country that has refused to be bound by Kyoto is Australia.[54]

Over the years, pressure has mounted on the United States to reduce its emissions. At the 2005 G8 Summit, climate change was at the top of the agenda, and the United States was persuaded to sign a statement pledging to "act with resolve and urgency" in reducing emissions.[55] In November 2005, the European Parliament passed a resolution stating that it "[d]eplores the non-implementation by the current U.S. administration" of the Framework Convention and America's failure to ratify Kyoto.[56]

Industrial nations currently subject to the Kyoto limits helped sustain the protocol's momentum by agreeing in December 2005 to negotiate deeper cuts in global

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[51] Framework Convention on Climate Change, article 4, section 2(a).
[52] Innovest Strategic Value Advisors, "Carbon Disclosure Project 2005," 19. Online at *http://www.cdproject.net/aboutus.asp*.
[53] EPA, Global Warming Emissions: Inventory. Online at *http://yosemite.epa.gov/OAR/globalwarming.nsf/content/EmissionsInternationalInventory.html*.
[54] The status of each nation's ratification of the Kyoto Protocol is available on the United Nations Framework Convention on Climate Change website (*http://unfccc.int/essential_background/kyoto_protocol/status_of_ratification/items/2613.php*).
[55] Gleneagles Communiqué, "Climate Change, Energy, and Sustainable Development," July 2005. Online at *http://www.fco.gov.uk/Files/kfile/PostG8_Gleneagles_Communique.pdf*.
[56] European Parliament, "Winning the Battle Against Global Climate Change," (2005/2049(INI)), November 16, 2005. Online at *http://www.europarl.eu.int/news/expert/infopress_page/064-2439-320-11-46-911-20051117IPR02438-16-11-2005-2005-false/default_en.htm*.

warming emissions for the years after Kyoto compliance ends in 2012.[57] As these and other nations deepen and extend their commitments to mandatory emission cuts, pressure will continue to increase on the United States to do likewise.

B. U.S. states, regions, and cities are enacting their own climate policies.

In the absence of federal limits on heat-trapping emissions, many states have moved forward with their own climate-related policies, including cap-and-trade systems now emerging on both coasts. The most developed of these is the Regional Greenhouse Gas Initiative (RGGI) being undertaken by several northeastern and mid-Atlantic states. In December 2005, Connecticut, Delaware, Maine, New Hampshire, New Jersey, New York, and Vermont formally agreed to launch the nation's first regional program imposing a mandatory cap on heat-trapping emissions from power plants.[58] In April 2006, Maryland joined RGGI as well.[59] Under the agreement, beginning in 2009, the states will stabilize power plants' CO_2 emissions and then cut them 10 percent by 2019.[60] The RGGI model rule was adopted in August 2006 to implement the agreement.[61]

On the West Coast, the California legislature passed a bill on August 31, 2006 that sets in place the nation's most comprehensive, economy-wide global warming emissions reduction program. The bill requires the state's global warming emissions to be reduced to 1990 levels by 2020. This reduction will be accomplished through an enforceable statewide cap on global warming emissions that will be phased in starting in 2012. The bill would also coordinate the efforts of various state agencies, including a pending proceeding at the Public Utilities Commission to establish a load-based cap on the three large investor-owned utilities as well as other jurisdictional utilities in the state. Governor Schwarzenegger has indicated that he will sign the bill into law.[62]

California has also taken the lead in fighting climate change by requiring utilities to make aggressive investments in energy efficiency as well as factor future CO_2 regulatory costs into their resource choices (see part V, section A) and by pursuing a performance standard for global warming emissions that would prevent the procurement of power from conventional coal plants.[63] Other efforts California has taken to reduce global warming emissions include the adoption of motor vehicle standards requiring a 30

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[57] Union of Concerned Scientists, "World Moves Forward on Global Warming, Bush Administration Stays Behind," press release, December 10, 2005. Online at *http://www.ucsusa.org/news/press_release/world-moves-forward-on-global-warming-MONTREAL.html*.
[58] See the RGGI website (*www.rggi.org*).
[59] *New York Times*, "Pollution Pact Gets Maryland as 8th Member," April 7, 2006. Online at *http://select.nytimes.com/search/restricted/article?res=FA0E15FD3A540C748CDDAD0894DE404482*.
[60] RGGI Memorandum of Understanding.
[61] Regional Greenhouse Gas Initiative (RGGI) Model Rule. Online at *http://www.rggi.org/docs/model_rule_8_15_06.pdf*.
[62] *Sacramento Bee*, "Schwarzenegger, lawmakers strike deal on greenhouse gases," August 31, 2006. Online at http://www.sacbee.com/content/politics/story/14312261p-15214839c.html.
[63] California PUC, "Policy Statement on Greenhouse Gas Performance Standards," April 12, 2006. Online at *http://www.cpuc.ca.gov/word_pdf/REPORT/50432.doc*.

percent reduction in CO_2 emissions from vehicles by the period 2013 to 2016.[64] As of June 2006, 10 other states plus Canada—representing approximately one-third of automobile sales in North America—had adopted California's standards.[65]

These efforts are part of a wider trend among states to respond to global warming. Twenty states and the District of Columbia, for example, have already adopted renewable energy standards covering approximately 40 percent of the electricity used in the United States,[66] partly in response to global warming. Massachusetts, New Hampshire, Oregon, and Washington have already passed laws limiting power plant CO_2 emissions or requiring plant owners to purchase offsets.[67] California, Oregon, and Washington have also joined forces on the West Coast Governors' Global Warming Initiative, which involves a variety of steps for reducing global warming emissions.[68]

The policy response to climate change is also accelerating at the local level. Mayors of more than 270 cities, representing more than 48 million Americans, have endorsed the US Mayors Climate Protection Agreement. Under this agreement they commit to working within their own communities to achieve the emission reduction targets of the Kyoto Protocol, and to urge the federal government to adopt a global warming emission trading system.[69] More than 150 local governments participate in another initiative to inventory their heat-trapping emissions, develop emission reduction targets, and implement policies to meet them.[70]

All of these state and local efforts increase the calls for and the likelihood of a climate response at the federal level, which would avoid a patchwork of different standards around the nation.

C. Congress is moving toward mandatory cap-and-trade CO_2 limits.

Momentum behind mandatory federal limits on CO_2 emissions continues to grow in Congress. In 2005, the Senate (with bipartisan support) passed a resolution finding that accumulating global warming emissions are causing temperatures to rise beyond natural variability and posing a "substantial risk" of rising sea levels and more frequent and severe droughts and floods. It states that "mandatory steps will be required to slow or stop the growth" of global warming emissions and that "Congress should enact a

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[64] California Air Resources Board, "Climate Change Emission Control Regulations." Online at *http://www.arb.ca.gov/cc/factsheets/cc_newfs.pdf*.
[65] See the California Clean Cars Campaign website (*http://www.calcleancars.org/news.html#senators*).
[66] Minnesota also has a renewable energy requirement for one utility, Xcel Energy (see *http://www.ucsusa.org/clean_energy/renewable_energy/page.cfm?pageID=47*). Also see Ryan H. Wiser, "Meeting Expectations: A Review of State Experience with RPS Policies," Lawrence Berkeley National Laboratory, March 2006. Online at *http://eetd.lbl.gov/ea/ems/reports/awea-rps.pdf*.
[67] Massachusetts Department of Environmental Protection, "Emissions Standards for Power Plants," 310 CMR 7.29; New Hampshire Revised Statutes Annotated. "Multiple Pollutant Reduction Program," Chapter 125-O; Washington Revised Code, "Carbon Dioxide Mitigation," Chapter 80.70; Oregon Revised Statutes, Carbon Dioxide Emissions Standard, § 469.503.
[68] West Coast Governors' Global Warming Initiative. Online at *http://www.ef.org/westcoastclimate*.
[69] US Mayors Climate Protection Agreement. Online at *http://www.seattle.gov/mayor/climate/*.
[70] Cities for Climate Protection. Online at *http://www.iclei.org/index.php?id=1118*.

comprehensive and effective national program of mandatory, market-based limits and incentives on emissions of greenhouse gases." The program goal would be to eventually reverse the growth of such emissions in a way that would not harm the U.S. economy and would encourage comparable action by major trading partners.[71] In May 2006, an identically phrased resolution was adopted with bipartisan support by the powerful House Appropriations Committee.[72]

It is widely understood that by using the phrase "mandatory, market-based limits," the Senate was referring to a particular kind of regulatory approach known as cap-and-trade. Under such a program, a cap would be established limiting how many tons of CO_2 could be emitted nationwide, and the same number of "allowances" would be issued, each one granting its owner the right to emit one ton of CO_2.

A market price for CO_2 allowances would emerge as operators begin buying and selling them. In practice, power plants that could reduce CO_2 emissions at a lower cost than the market price of an allowance would do so; those that could not would purchase additional allowances to cover their emissions. This system of regulation was pioneered in 1990 to reduce power plants' emissions of sulfur dioxide and other pollutants that cause acid rain, and it proved so successful and efficient that virtually every proposal to regulate CO_2—whether international, regional, or federal—has included some form of cap-and-trade.[73]

As of July 2006, there are at least seven proposals[74] under consideration that would establish a cap-and-trade system for CO_2, including the Climate Stewardship and Innovation Act (S. 1151) introduced by Senators John McCain (R-AZ) and Joseph Lieberman (D-CT) and a proposal sponsored by Senator Jeff Bingaman (D-NM) modeled after a proposal of the National Commission on Energy Policy (NCEP).[75] The Senate Energy and Natural Resources Committee also conducted extensive hearings on the design features of a cap-and-trade system based on the NCEP model in April 2006, accepting comments from many different stakeholders. Many members of the power industry participated in these hearings, including companies that support mandatory regulations and those that, while still opposed to mandatory limits, now consider them inevitable and want to have a say in shaping them (see part III). Two of the most

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[71] Sense of the Senate on Climate Change, H.R.6 §1612, Energy Policy Act of 2005. This resolution passed by a vote of 54-43.

[72] See Senate Committee on Energy and Natural Resources, "Chairman Domenici and Senator Bingaman React to House Committee Vote on Climate Change," press release, May 10, 2006. Online at *http://energy.senate.gov/public/index.cfm?FuseAction=About.Subcommittee&Subcommittee_ID=7*.

[73] Another regulatory option, though one with much less political momentum, is enactment of a carbon tax. By setting a price on CO_2 emissions, the effect on coal plant risks would be the same as a cap-and-trade system that results in equivalent allowance prices, and the arguments in this paper would still apply.

[74] In addition to those mentioned in the text, these proposals include the Clean Air Planning Act of 2006 (S. 2724) introduced by Senator Thomas Carper (D-DE); the Keep America Competitive Global Warming Policy Act of 2006 (H.R. 5049), introduced by Representatives Tom Udall (D-NM) and Tom Petri (R-WI); and the Strong Economy and Climate Protection Act, announced and circulated for discussion by Senator Dianne Feinstein (D-CA) but not yet introduced.

[75] The NCEP proposal is set forth in "Ending the Energy Stalemate" (online at *http://www.energycommission.org/site/page.php?report=13*).

ambitious bills -- the Global Warming Pollution Reduction Act (S. 3698) introduced by Senator Jim Jeffords (I-VT) and the Safe Climate Act (H.R. 5642) introduced by Representatives Henry Waxman (D-CA) and Maurice Hinchey (D-NY)-- would aim to reduce heat-trapping emissions 80 percent below 1990 levels (in line with scientific estimates of what is needed to avoid dangerous global warming).[76]

Political support for a cap-and-trade system is extremely broad, encompassing major U.S. environmental advocacy groups and those in industry that support CO_2 regulation in general. This method of regulation has even been explicitly endorsed by a substantial segment of the U.S. evangelical Christian movement. Several dozen evangelical leaders recently issued a statement declaring that the need for action on global warming is urgent and calling for national legislation requiring CO_2 reductions through "cost-effective, market-based mechanisms such as a cap-and-trade program." They stress that we need urgent action because we are making long-term decisions today that will determine CO_2 emissions in the future, including "whether to build more coal-burning power plants that last for 50 years rather than investing more in energy efficiency and renewable energy."[77]

Utilities may be ignoring these political developments under the reckless assumption that any plant built before a cap-and-trade system is adopted will be allocated allowances for free. This gamble ignores the growing opposition to granting such a windfall to utilities (and particularly those who could avoid new allowance costs by simply investing in alternatives to coal).

The RGGI model rule, for example, requires that at least 25 percent of allowances be auctioned rather than allocated, and Vermont, the first Northeast state to pass enabling legislation, requires auctioning 100 percent of allowances.[78] In fact, 28 different stakeholders in the RGGI model rule draft, including businesses, consumer groups, environmental organizations, state agencies, and an electricity distribution company, supported auctioning 50 to 100 percent of allowances.[79] The proceeds from such an auction would be used to fund investments in energy efficiency, renewable energy, and other low-carbon energy technologies, as well as direct rebates to consumers.

On the federal level, Senators Bingaman and Pete Domenici (R-NM) issued a white paper describing the design elements of a mandatory system to reduce CO_2 emissions. The paper notes that auctioning off all allowances would minimize the costs to the U.S. economy as a whole, streamline the administrative process, and avoid unintended competitive advantages and windfall profits for certain market participants.[80]

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[76] See Senator Jeffords' website (*http://jeffords.senate.gov/~jeffords/press/06/07/072006climatebill.html*) and Representative Waxman's website (*http://www.house.gov/waxman/safeclimate/index.htm*).
[77] Evangelical Climate Initiative, "Climate Change: An Evangelical Call to Action." Online at *http://www.christiansandclimate.org/statement*.
[78] RGGI Model Rule. A bill pending in Massachusetts would begin with 50 percent auctioning and increase 10 percent a year (reaching 100 percent auctioning in year six). New York Attorney General Eliot Spitzer is calling for 100 percent auctioning. For more information, see *http://massclimateaction.org/RGGI.htm*.
[79] Environment Northeast, Natural Resources Defense Council, and Pace Law School Energy Project, 2006.
[80] Domenici and Bingaman, 2006.

A recent Wall Street study further predicts that the United States will have an auction-based rather than allocation-based cap-and-trade system.[81]

In short, not only is it now virtually inevitable that a federal program limiting CO_2 emissions will be approved in the next few years, but it is also fairly certain that this program will take the form of a cap-and-trade system under which every ton of CO_2 emitted will come with a cost, determined by the forces of supply and demand for CO_2 allowances.

D. Coal plants will certainly be covered by future climate regulations.

While the scope of a federal program limiting global warming emissions is under active discussion, every climate bill that has been proposed would cover CO_2 emissions from coal plants—for good reason. Coal plants are by far the largest individual sources of CO_2 emissions, representing nearly one-third of U.S. energy-related CO_2 emissions (the entire power sector accounts for 39 percent of such emissions). Coal plants emit about the same amount of CO_2 as all petroleum-based emissions from cars, trucks, trains, and planes combined, which represent another third of U.S. energy-related CO_2 emissions. The remaining third comes from a variety of technologies and sources including, most notably: industrial use of petroleum, natural gas, and coal; residential use of natural gas; and the electricity sector's use of natural gas.[82]

Not only are coal plants a dominant source of CO_2, but they are also relatively few in number compared with the millions of sources in other sectors, making them far easier for any federal program to regulate. A single new 500 MW conventional coal plant, for example, can emit the annual CO_2 equivalent of more than 600,000 cars.[83] All of the federal regulatory proposals described above would limit CO_2 emissions from coal plants; the only question is whether they would also attempt to regulate other sectors of the economy as well.

Additionally, analysis by the U.S. Energy Information Administration (EIA) shows that the electricity sector accounts for many of the most cost-effective reduction options.[84] While power plants account for 39 percent of U.S. energy-related CO_2 emissions, they have the potential to account for somewhere between 66 and 85 percent

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[81] Wynne, 2006.

[82] EPA, 2006; EIA, 2005. Energy-related emissions of CO_2 represent 97 percent of total U.S. emissions of CO_2.

[83] According to the EPA, annual vehicle emissions are about 13,500 lbs/vehicle; see the EPA Personal Greenhouse Gas Calculator (*http://yosemite.epa.gov/oar/globalwarming.nsf/content/ResourceCenterToolsGHGCalculator.html*). Power plant CO_2 emissions of 4.1 million tons for a new 500 MW plant are based on the Public Service Commission of Wisconsin's Final Environmental Impact Statement for Weston Unit 4 Power Plant, Volume 1, July 2004, 145 (online at *http://psc.wi.gov/utilityinfo/electric/cases/weston/document/Volume1/W4_FEIS.pdf*).

[84] EIA, "Energy Market Impacts of Alternative Greenhouse Gas Intensity Reduction Goals," March 2006. Online at *http://www.eia.doe.gov/oiaf/servicerpt/agg/pdf/sroiaf(2006)01.pdf*.

of energy-related CO_2 emission reductions according to computer models designed to show the least expensive options for complying with various CO_2 regulations.[85]

The most significant change from the EIA's "business-as-usual" scenario to its carbon reduction scenarios is the resulting impact on coal generation. In the business-as-usual scenario, approximately 174 gigawatts (GW) of new coal capacity (the equivalent of 290 new 600 MW coal plants) are added by 2030. By contrast, in the two deepest carbon reduction scenarios EIA analyzed, *not a single new conventional coal plant is added beyond those already under construction*.[86] In other words, the construction of any additional conventional coal plants would make it more expensive to achieve the carbon reduction targets.[87]

III. The power industry increasingly supports federal CO_2 limits.

Over the years, most of the power industry has been strongly opposed to federal CO_2 limits from power plants, but that attitude has been changing rapidly, especially in 2006. Many prominent power companies now openly support the federal regulation of CO_2 from coal plants. The chief executive of Duke Energy, one of the nation's largest coal-burning utilities, has said of global climate change, "From a personal perspective I can think of no more pressing global issue." He went on to say:

> *"From a business perspective, the need for mandatory federal policy in the United States to manage greenhouse gases is both urgent and real. In my view, voluntary actions will not get us where we need to be. Until business leaders know what the rules will be—which actions will be penalized and which will be rewarded—we will be unable to take the significant actions the issue requires."*[88]

Duke's website states, "Congress needs to establish a national, economy-wide greenhouse gas mandatory program as soon as possible."[89]

The head of Exelon has stated, "We accept that the science on global warming is overwhelming. There should be mandatory carbon constraints."[90] And the head of PNM

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[85] Ibid., 18.

[86] Ibid., 22. In the deepest carbon reduction scenario, approximately 103 GW of existing coal capacity (171 plants) is retired, and 17 GW of new integrated-gasification combined-cycle (IGCC) capacity with carbon capture and sequestration equipment is added.

[87] UCS does not consider all of EIA's assumptions and methods realistic, nor do we believe its scenarios achieve the lowest possible cost. EIA has typically underestimated the potential of energy efficiency, combined heat and power, and renewable energy to reduce emissions at lower costs (see UCS, *Clean Energy Blueprint*, 2001). However, EIA's modeling is still useful for demonstrating how changes in one variable (e.g., imposition of carbon reduction targets) affect the economics of another (e.g., building new conventional coal plants) under a consistent set of assumptions.

[88] Paul Anderson, "Being (and Staying in Business): Sustainability from a Corporate Leadership Perspective," speech to CERES Annual Conference, April 6, 2006. Online at *http://www.duke-energy.com/news/mediainfo/viewpoint/PAnderson_CERES.pdf*).

[89] "Climate Change: Duke Energy Position on U.S. Climate Change Policy." Online at *http://www.duke-energy.com/environment/policies/climate_change*.

Resources said at Senate hearings, "We believe now is the time for a healthy debate at the federal level on climate change, and we support the move to a mandatory program."[91]

Many other power companies have expressed their support for federal CO_2 limits through coalition statements. In 2003, for example, Calpine, Con Edison, Keyspan, Northeast Utilities, PG&E Corporation, PPL Corporation, Public Service Enterprise Group, and Wisconsin Energy signed onto the CERES Consensus Statement, which called on the federal government to "develop a national, mandatory, market-based program" limiting global warming emissions.[92] In April 2006, the Clean Energy Group's Clean Air Policy Initiative submitted comments to the Senate Committee on Energy and Natural Resources supporting the adoption of a cap-and-trade program for the electricity sector.[93] Entergy, Exelon, and Florida Power & Light thereby added their names to those publicly calling for such a law.[94]

In sum, five of the nation's 10 largest private power producers (Calpine, Duke, Entergy, Exelon, and Florida Power & Light), accounting for more than 15 percent of U.S. electricity generation,[95] now support mandatory limits on CO_2 from power plants. Another (Progress) acknowledged in a 2006 special report to shareholders that the evidence for climate change is sufficient to warrant "action" by the "public sector," which the company believes should cover all sectors of the economy.[96] Executives from three of the remaining companies in the top 10 (American Electric Power, Southern Company, and Xcel), accounting for another 12 percent of U.S. power generation, have acknowledged that federal limits on CO_2 are coming, even if they do not support them.[97]

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[90] John W. Rowe, August 16, 2004, quoted in *Business Week*. Online at http://www.businessweek.com/print/magazine/content/04_33/b3896001_mz001.htm?gl.

[91] Jeff Sterba, April 4, 2006, quoted in the *Albuquerque Tribune*. Online at http://www.abqtrib.com/albq/nw_national_government/article/0,2564,ALBQ_19861_4594645,00.html.

[92] CERES, "Electric Power, Investors and Climate Change: A Call to Action," September 2003. Online at http://www.ceres.org/pub/docs/Ceres_electric_power_calltoaction_0603.pdf.

[93] Michael J. Bradley, April 4, 2006. Online at http://energy.senate.gov/public/_files/ExecutiveSummariesforwebsite.pdf.

[94] In addition, three signatories of the CERES Consensus Statement (Calpine, PG&E, and Public Service Enterprise Group) are part of the Clean Energy Group Clean Air Policy Initiative.

[95] The nation's 10 largest private power producers in 2004, in order of megawatt hours produced, were American Electric Power, Southern Company, Exelon, FPL Group, Entergy, Dominion, Duke Energy, Progress Energy, Calpine, and Xcel Energy. (Duke Energy has since moved up in the rankings by merging with Cinergy). See CERES, NRDC, and PSEG, "Benchmarking Air Emissions of the 100 Largest Electric Power Producers in the United States—2004," April 2006. Online at http://www.nrdc.org/air/pollution/benchmarking/default.asp.

[96] Progress's vague statement on the need for action on global warming has been interpreted by the trade press as a call for carbon regulation. See "Progress Energy calls for US carbon regulation," March 31, 2006, *Carbon Finance Online* (online at www.carbonfinanceonline.com; subscription required); also see "2006: Progress Energy's Report to Shareholders: An Assessment of Global Climate Change and Air Quality Risks and Actions" (online at http://www.progress-energy.com/environment/climatechange.asp).

[97] See Dale E. Heydlauff (American Electric Power), quoted in "Global Warming," August 16, 2004, *Business Week* (online at http://www.businessweek.com/print/magazine/content/04_33/b3896001_mz001.htm?gl); David Ratcliffe (Southern Company), quoted in "U.S. Utilities Urge Congress to Establish CO_2 Limits," Bloomberg.com (online at http://www.bloomberg.com/apps/news?pid=10000103&sid=a75A1ADJv8cs&refer=us); and

This expectation is widely shared in the industry: a 2004 national survey of electricity generating companies found that 60 percent of respondents expected mandatory limits on CO_2 within 10 years, and about half expected such limits within five years.[98]

The industry leaders quoted above echo the rising call for CO_2 limits by companies in other industries, including some of the nation's largest corporations. Wal-Mart calls climate change "an urgent threat not only to our business but also to our customers, communities, and the life support systems that sustain our world."[99] Both Wal-Mart and GE expressed support for CO_2 limits in April 2006 Senate hearings,[100] and Ford Motor Company and Hewlett-Packard joined 22 other multinational corporations in a 2005 statement urging leaders of the G8 nations to adopt cap-and-trade or other market-based mechanisms to limit global warming emissions.[101]

When a significant share of industry speaks out in favor of environmental regulations, including several major companies in the industry sector likely to be most heavily regulated, it is a strong sign that such regulations are near at hand. It is quite possible that CO_2 limits will be in place and operational before the same could be said for a proposed coal plant currently in the regulatory approval process.

IV. The private financial community is pushing companies to disclose and reduce their exposure to future climate regulation.

Concern is undeniably growing among investors and lenders over the financial risks of future CO_2 constraints. For example, the Investor Network on Climate Risk (INCR) was launched in 2003 as a coalition of institutional investors managing $600 billion in assets; by early 2006, it included a much wider array of investors managing more than three trillion dollars in assets.[102] The Carbon Disclosure Project, an investor coalition undertaken on the international level to obtain global warming emission data from 1,900 multinational corporations, now represents investors managing $31 trillion in assets—three times more than in 2003.[103]

The INCR stresses the regulatory risk faced by U.S. companies with high global warming emissions, calling federal carbon constraints "only a matter of time."[104] It has

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Wayne Brunetti (Xcel), quoted in "Xcel Energy expects US carbon regulations," September 9, 2004, PointCarbon (online at http://www.pointcarbon.com/article.php?articleID=4459&categoryID=147).

[98] PA Consulting Group, "PA survey finds that US generating companies expect mandatory carbon dioxide regulations within 10 years," press release, October 22, 2004. Online at http://www.paconsulting.com/news/press_release/2004/pr_carbon_dioxide_regulations.htm.

[99] Wal-Mart website (http://walmartstores.com/GlobalWMStoresWeb/navigate.do?catg=347).

[100] Raymond Bracy (Wal-Mart) and David Slump (GE Energy), comments to Senate Energy and Natural Resources Committee, April 4, 2006. Online at http://energy.senate.gov/public/_files/ExecutiveSummariesforwebsite.pdf.

[101] "Statement of the G8 Climate Change Roundtable," World Economic Forum, June 9, 2005. Online at http://www.weforum.org/pdf/g8_climatechange.pdf.

[102] Investor Network on Climate Risk (INCR) website (http://www.incr.com/index.php?page=2).

[103] Carbon Disclosure Project website (http://www.cdproject.net/aboutus.asp).

[104] INCR website, "INCR Overview." Online at http://www.incr.com/index.php?page=9.

called on companies in the electricity sector to estimate how future heat-trapping emission limits will affect their businesses and to identify steps they are taking to reduce those effects.[105] In doing so, a board member of the nation's largest public pension fund said, "Ignoring the impact of carbon on the environment and on corporate bottom lines would be fiscally irresponsible and a disservice to investors, taxpayers and the environment."[106]

Investors are particularly concerned with the financial wisdom of building new coal plants in the United States given the growing momentum here for federal CO_2 limits. Several of the nation's largest institutional investors recently warned TXU that the "future cost of carbon could alter the prudence" of the utility's plan to invest in new coal plants, and that TXU was "potentially exposing itself to unprecedented compliance costs" given the long lifespan of coal plants. It urged TXU to disclose to shareholders "how it has accounted for the 'future cost of carbon' in its resource planning for these plants."[107]

Many of the nation's largest banks and investment firms have recently announced more aggressive climate policies. Bank of America, for example, has launched a formal effort to assess and limit its risk from financing emission-intensive industries, including a commitment to reduce emissions from its public energy and utility portfolio seven percent by 2008.[108] JP Morgan Chase sees climate change as a "critical issue" with "potentially very serious consequences for both ourselves as well as our clients." In a recent speech, its director of environmental affairs said, "for the new power projects we are beginning to quantify the financial costs of those greenhouse gas emissions and incorporating that into our financial analysis of the transaction," and went on to note that looking at those costs is "going to have a big impact."[109] The head of global projects for Lehman Brothers has also addressed a cap on global warming emissions by saying, "There's a consensus that something's coming," adding that, "people are very much focused on how that's going to affect economics."[110]

Wall Street is also beginning to assess the impact new laws would have on particular power companies. Bernstein Research recently released a report describing the growing momentum toward CO_2 regulation, concluding that, "Regardless of which party wins the 2008 presidential elections . . . it is probable that the next administration will favor mandatory national limits on CO_2 emissions."[111] The report went on to identify the

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[105] INCR website, "Ten Point Investor Action Plan." Online at *http://www.incr.com/index.php?page=20*.
[106] Phil Angelides, quoted in "Investors Call on Power Sector and Wall Street to Focus Attention on Financial Risks From Climate Change," CERES website, April 13, 2005. Online at *http://www.ceres.org/news/news_item.php?nid=108*.
[107] INCR website, "Investors Concerned About TXU's Aggressive Coal Strategy," May 16, 2006. Online at *http://www.incr.com/index.php?page=ia&nid=178*.
[108] Bank of America website, "Bank of America Climate Change Position." Online at *http://www.bankofamerica.com/newsroom/presskits/view.cfm?page=climateandforests*.
[109] Amy Davidson, "Financial Institutions: Challenges and Opportunities," speech to the Earth Institute, Columbia University, March 29, 2006. Online at *http://www.earthinstitute.columbia.edu/sop2006/transcripts/tr_davidsen.html*.
[110] John Veech, quoted in "Analysts View Energy Policy Act through Climate Change Lens," August 30, 2005, *SNL Generation Markets Week*.
[111] Wynne, 2006.

utilities facing the greatest financial risk: "unregulated coal-fired generators supplying markets where gas is the predominant price setting fuel,"[112] which cannot pass the added costs of an emission cap on to consumers. The assumption, of course, is that regulated utilities *will* be able to pass future compliance costs on to ratepayers—an assumption we challenge below (see part VI), but which does reflect current regulatory practice.

This attitude reveals why, at least for the moment, some sectors of the financial community are still willing to help regulated utilities build new coal plants even when they know that such plants will be substantially more expensive in the carbon-constrained world ahead. Wall Street is not concerned with protecting ratepayers—that will be a job for state regulators.

V. Future costs of CO_2 regulation must be part of any realistic estimate of a new coal plant's operating costs.

A. CO_2 costs are increasingly factored into risk planning by utilities, regulators, and regional planners.

Representatives of three utilities explained in a 2005 trade journal article the importance of assessing and managing CO_2 risk:

> *"The financial risk associated with likely future regulation of carbon dioxide emissions is becoming a focus of utilities' and regulators' risk management efforts, as they recognize the imprudence of assuming that carbon dioxide emissions will not cost anything over the 30-year or longer lifetime of new investments. Utilities can help protect their customers and shareholders from this financial risk by integrating an estimated cost of carbon dioxide emissions into their evaluation of resource options, and selecting the overall least-cost portfolio of resources. Utilities can learn from the experience that some utilities have gained at managing this risk to ensure that today's investments do not lock customers or shareholders into much higher costs tomorrow if greenhouse gases are regulated."*[113]

A recent Lawrence Berkeley National Laboratory analysis of western U.S. utilities' resource planning practices found the practice of quantifying CO_2 risk to be widespread: "Given the potential for future carbon regulations to dominate environmental compliance costs, seven of the twelve utilities in our sample . . . specifically analyzed the risk of future carbon regulations on portfolio selection."[114] State regulators have since ordered three additional utilities to include CO_2 costs in their planning, leaving only two

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[112] Ibid, 2.
[113] Karl Bokenkamp (Idaho Power), Hal LaFlash (Pacific Gas & Electric), Virinder Singh (Pacificorp), and Devra Bachrach Wang, "Hedging Carbon Risk: Protecting Customers and Shareholders from the Financial Risk Associated with Carbon Dioxide Emissions," July 2005, *The Electricity Journal* 18(6): 11–24.
[114] Mark Bolinger and Ryan Wiser, "Balancing Cost and Risk: The Treatment of Renewable Energy in Western Utility Resource Plans," Lawrence Berkeley National Laboratory, August 2005. Online at *http://eetd.lbl.gov/ea/EMS/reports/58450.pdf*.

utilities (out of the 12 sampled) that continue to ignore CO_2 risks.[115] In its most recent resource plan, Northwestern Energy (formerly Montana Power) says it is "the mainstream practice of utility planners to factor a carbon tax into their models."[116]

California, Oregon, and Washington require utilities to factor CO_2 costs into their resource plans, and Montana ordered one utility, Northwestern Energy, to do so in its 2005 plan.[117] The California PUC actually chose a specific CO_2 value and requires the three investor-owned utilities in the state to use that value when evaluating bids (which has a direct, ongoing effect on resource selection outside the planning context).[118]

In 2005, the Northwest Power and Conservation Council (often referred to as the Northwest Council) issued a resource plan that incorporates estimates of future CO_2 values beginning in 2008.[119] This is worth noting not only because the 20-year plans developed by this federally created regional agency cover the entire Northwest, but also because most energy planning is conducted by utilities rather than independent planners who have no financial incentive to select one type of resource over another.

B. A useful range of CO_2 price forecasts is emerging from the literature.

Over the last few years, federal cap-and-trade proposals before Congress have spawned numerous analyses using computer models to simulate the market response to these regulations. For example, the EIA, the U.S. Environmental Protection Agency, the Massachusetts Institute of Technology (MIT), and the Tellus Institute have all modeled the effects of proposed legislation resulting in varying CO_2 cost projections.[120] The

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[115] Ibid., 62.

[116] Northwestern Energy, "2005 Electric Default Supply Resource Procurement Plan," Volume 2, Chapter 1, 25.

[117] See Bolinger and Wiser, 2005, 57 (note 75) and 60; Washington Administrative Code, section 480-100-238; and California PUC, "Interim Opinion on E3 Avoided Cost Methodology," April 22, 2004 (online at *http://www.cpuc.ca.gov/PUBLISHED/AGENDA_DECISION/45195.htm#TopOfPage*).

[118] California PUC, "Interim Opinion on E3 Avoided Cost Methodology," Decision 05-04-024, Proceeding 04-04-025, 29 and 89. Online at *http://www.cpuc.ca.gov/PUBLISHED/AGENDA_DECISION/45195.htm*. Also see UCS testimony submitted in this proceeding (online at *http://www.ucsusa.org/clean_energy/clean_energy_policies/testimony-on-accounting-for-californias-global-warming-gas-costs.html*).

[119] Northwest Power and Conservation Council, "The Fifth Northwest Electric Power and Conservation Plan," 2005, Volume 1, 19. Online at *http://www.nwcouncil.org/energy/powerplan/plan/Default.htm*.

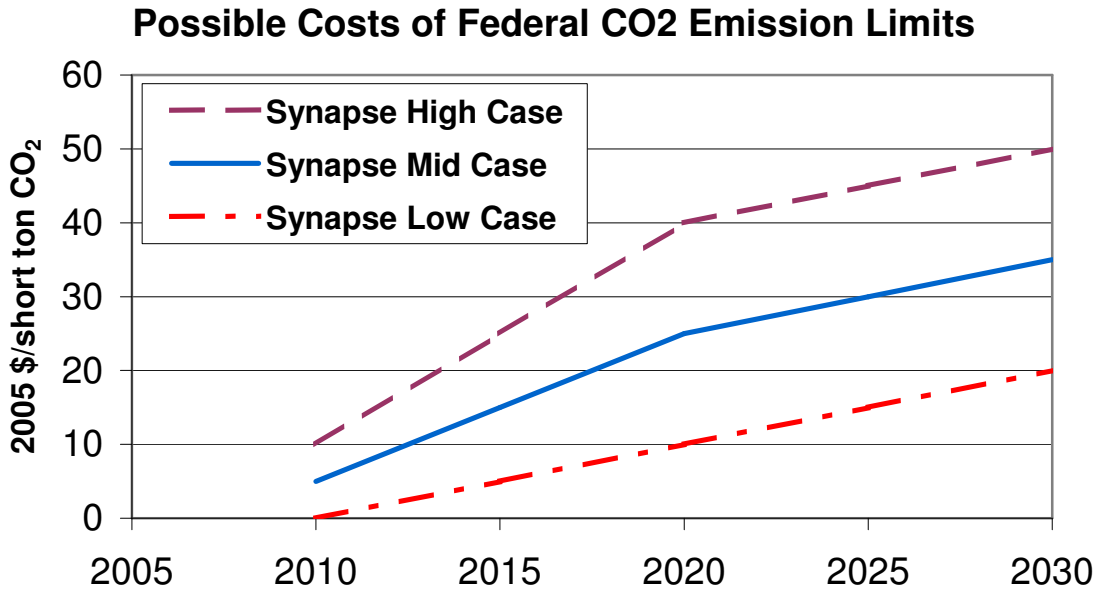
[120] See EIA, "Energy Market Impacts of Alternative Greenhouse Gas Intensity Targets," March 2006; "Impacts of Modeled Recommendations of the National Commission on Energy Policy," April 2005; "Analysis of Senate Amendment 2028, the Climate Stewardship Act of 2003," May 2004; "Analysis of S.139, the Climate Stewardship Act of 2003," June 2003;(online at *http://www.eia.doe.gov/oiaf/service_rpts.htm*); EPA, "Multi-Pollutant Legislative Analysis: The Clean Power Act," October 2005; and "Multi-Pollutant Legislative Analysis: The Clean Air Planning Act," October 2005 (online at *http://www.epa.gov/airmarkets/mp/index.html*); Massachusetts Institute of Technology Joint Program on the Science and Policy of Global Change, "Emissions Trading to Reduce Greenhouse Gas Emissions in the United States: The McCain-Lieberman Proposal," June 2003 (online at *http://web.mit.edu/globalchange/www/MITJPSPGC_Rpt97.pdf*); Tellus Institute, "Analysis of the Climate Stewardship Act Amendment," June 2004 (online at *http://www.tellus.org/energy/publications/McCainLieberman2004.pdf*).

domestic policy option that has been subjected to the most analysis is the Climate Stewardship Act proposed by Senators McCain and Lieberman.

Another more recent policy proposal analyzed by the EIA is one developed by the NCEP. This approach focuses on reducing emission "intensity" (emissions per dollar of gross domestic product) rather than total emissions, but like all cap-and-trade proposals it would still impose a cost on CO_2 emissions.

In May 2006, Synapse Energy Economics conducted a review of the cost projections of 10 such modeled analyses, as well as the emerging policy response to climate change and recent scientific and political developments.[121] This review resulted in the high, mid-range, and low CO_2 cost projections shown in Figure 4.

Figure 4



Source: Johnston et al., 2006. [122]

While Synapse warns that the real cost of CO_2 is unlikely to follow a smooth path, the company believes its projections "represent the most reasonable range to use for planning purposes, given all of the information we have been able to collect and analyze bearing on this important cost component of future electricity generation."[123] When

[121] Lucy Johnston, Ezra Hausman, Anna Sommer, Bruce Biewald, Tim Woolf, David Schlissel, Amy Roschelle, and David White, "Climate Change and Power: Carbon Dioxide Emissions Costs and Electricity Resource Planning," Synapse Energy Economics, May 18, 2006. Online at *http://www.synapse-energy.com*.
[122] Ibid., p. 40.
[123] Ibid., 39.

Synapse's cost projections are levelized[124] over 30 years to 2005 dollars, the low CO_2 cost projection is $8.50/ton, the mid-range projection is $19.60/ton, and the high projection is $30.80/ton.[125]

Estimates of the price of future CO_2 allowances vary depending on a variety of factors, including the emission reduction target, the availability of offsets, whether international trading is allowed, the implementation timeline, and the existence of complementary policies such as energy efficiency programs and renewable electricity standards.[126] Two assumptions are particularly important and merit additional discussion here: the emission reduction target and the rate of technological progress.

First, all the analyses are based on relatively modest changes in U.S. emissions. The Climate Stewardship Act, for example, aims to return U.S. CO_2 emissions to 2000 levels over the period 2010 to 2015.[127] The NCEP proposal, which has been at the forefront of Senate hearings to design a cap-and-trade system, would slow the rate of emission growth but not reverse it.[128] None of the federal proposals that underlie these CO_2 cost estimates actually claim to deliver emission cuts sufficient to stabilize global CO_2 concentrations at a level that would avoid dangerous climate change.[129] Even the Kyoto Protocol, which would have required the United States to cut emissions seven percent below 1990 levels by the period 2008 to 2012, is only intended to be a first step leading to greater reductions later.[130]

As discussed in part I, section C, the science indicates that in order to prevent dangerous climate change, developed nations will need to reduce CO_2 emissions as much as 60 to 80 percent by 2050. Therefore, whatever federal policy to limit CO_2 emissions is initially adopted will have to be quickly followed with increasingly tighter caps if we are to put ourselves on a path toward climate stabilization in the decades ahead.

Much tighter national caps than those that have been analyzed would—all other things being equal—have the effect of driving CO_2 prices higher than the studies project. However, at some point, rising CO_2 prices would make low- or zero-carbon technologies competitive, leveling out the increase in CO_2 costs. How quickly that point is reached depends on a second important assumption**:** how quickly these technologies will develop. Most of the studies that provide the basis for the published cost projections (particularly

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[124] "Levelized" cost means "The present value of the total cost of building and operating a generating plant over its economic life, converted to equal annual payments. Costs are levelized in real dollars (i.e., adjusted to remove the impact of inflation)." EIA Glossary, *http://www.eia.doe.gov/glossary/glossary_l.htm*.

[125] Johnston, et al., 2006,, 41.

[126] Ibid, 35–39.

[127] See Pew Center on Global Climate Change, "Summary of the 2003 Climate Stewardship Act." Online at *http://www.pewclimate.org/policy_center/analyses/s_139_summary.cfm*.

[128] Johnston et al., 2006, Figure 5.1.

[129] The newly introduced bills discussed in part II.C aiming for 80 percent reductions below 1990 levels by 2050 have not yet been the subject of analysis and are not reflected in cost projections.

[130] Climate Change Secretariat, "Caring for Climate: A Guide to the Climate Change Convention and the Kyoto Protocol," United Nations Framework Convention on Climate Change, 2003, 25. Online at *http://unfccc.int/resource/cfc_guide.pdf*.

those by the EIA) make very pessimistic assumptions about the cost and performance of renewables, efficiency, and other alternative technologies, both today and in the years ahead.[131] Moreover, they assume that there will be no new policies requiring or providing incentives for greater use of these technologies, despite growing support for such policies at both the state and federal level.

Using more optimistic assumptions about the costs, performance, and policy support for these clean energy technologies would have the effect of reducing CO_2 prices below projected levels (or keeping them from rising as much as they otherwise would in response to ever-tightening caps).[132] In this way, the rapid development of coal alternatives would have the paradoxical effect of reducing the future costs of coal power. Of course, if utilities and regulators use these more optimistic assumptions about the development of low-carbon energy in forecasting CO_2 prices, they must use the same assumptions when determining whether it would be cheaper in the long run to simply invest in low-carbon alternatives rather than building new coal plants. Optimism about alternative technologies to coal may reduce the estimated cost of coal plants by keeping future CO_2 allowance prices low, but that same optimism undermines the economic logic of building a new coal plant in the first place.

The CO_2 price projections by Synapse are roughly consistent with the range of projections being used by utilities and the Northwest Council in their resource plans, though without encompassing the highest and lowest of those values. Table 1 shows the range of numbers in use.[133] (In some cases, these values are discounted by the utility with a probability weighting when actually used in planning.)

Table 1: CO_2 Emission Trading Assumptions for Various Years (in 2005 dollars)

PG&E*	$0-9/ton (start year 2006)
Avista 2003*	$3/ton (start year 2004)
Avista 2005	$7 and $25/ton (2010) $15 and $62/ton (2026 and 2023)
Portland General Electric*	$0-55/ton (start year 2003)
Xcel-PSCCo	$9/ton (start year 2010) escalating at 2.5%/year
Idaho Power*	$0-61/ton (start year 2008)
Pacificorp 2004	$0-55/ton
Northwest Energy 2005	$15 and $41/ton
Northwest Power and Conservation Council	$0-15/ton between 2008 and 2016 $0-31/ton after 2016

Source: Johnston et al., 2006, Table 6.1.

[131] For example, see Steve Clemmer (Union of Concerned Scientists), "Renewable Energy Modeling Issues in the National Energy Modeling System," presentation at the National Renewable Energy Laboratory Energy Analysis Seminar, Washington, DC, December 9, 2004. Online at http://www.nrel.gov/analysis/seminar/docs/2004/ea_seminar_december_9.ppt.

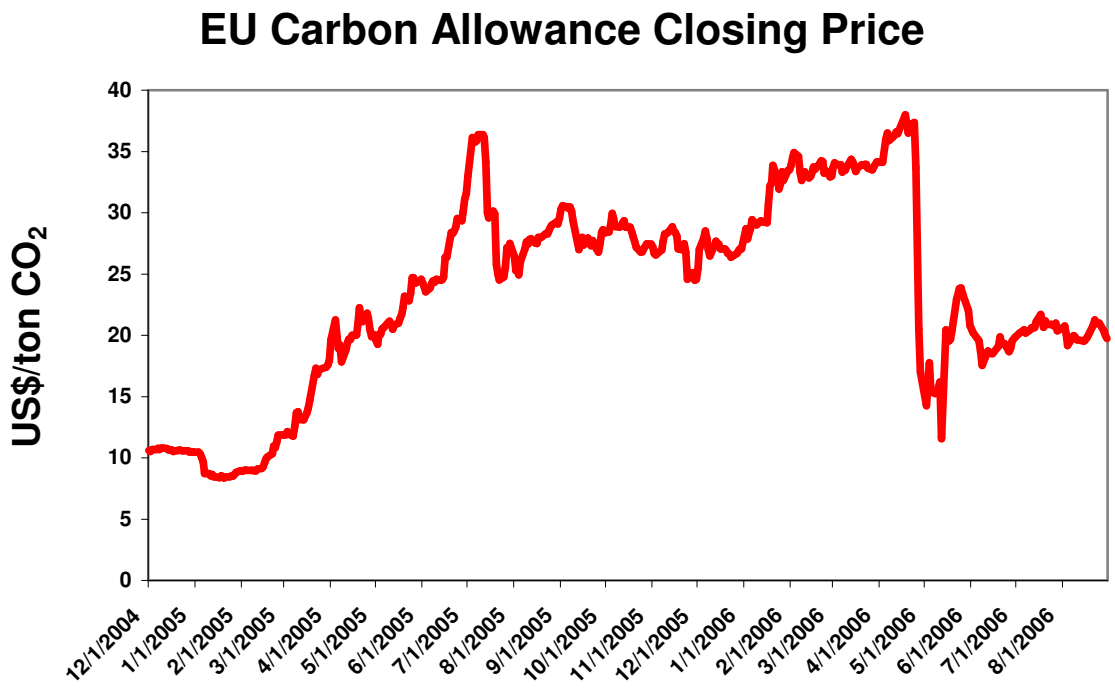
[132] The studies reviewed by the Tellus Institute used more optimistic assumptions and included complementary policies for energy efficiency and renewable energy technologies. The resulting CO_2 cost projections were closer to the Synapse mid-range projections and leveled off more in the later years of the forecast. See Tellus Institute, 2004.

[133] Ibid., 30.

Not included in Table 1 is the estimate of future CO_2 regulatory costs that California requires its utilities to assume in resource selection. At eight dollars per ton in 2004, rising by only five percent annually (less than the rate at which Synapse's projections rise), California's estimate begins near the high end of the Synapse analysis but move toward the low end in later years.[134]

Wall Street analysts Bernstein Research recently modeled the impact of a CO_2 allowance requirement on the earnings of several U.S. coal-fired generators, choosing nine dollars per ton of CO_2 as the price on which to base its analysis. It also considered a $28/ton CO_2 price based on the allowance prices recently prevalent under the European Union's cap-and-trade system, which reached levels as high as $35/ton during the past year.[135] As Figure 5 shows, CO_2 prices dropped sharply in May on news that many companies emitted less CO_2 than expected, suggesting that large emitters had been allocated too many allowances.[136] Prices have since partially rebounded.

Figure 5



Source: EU: PointCarbon.com using an average exchange rate for 2005 of 1.25 U.S. dollars per euro.

There are great uncertainties associated with predicting the future cost of CO_2 allowances, but this holds true for many other aspects of utility planning—especially

[134] See Bolinger and Wiser, 2005, 60.
[135] Wynne, 2006, 11–17.
[136] Reuters, "EU undershoots emissions cap that critics call lax," May 12, 2006. Online at *http://today.reuters.com/News/CrisesArticle.aspx?storyId=L12101022*.

when considering the wisdom of investing in capital-intensive power plants that typically operate for a half-century or more in a rapidly changing world. The most prudent way to assess and minimize this risk is to consider the impact of a reasonable range of CO_2 cost projections (such as those described above) on a proposed coal plant. The one CO_2 price projection certain to be wrong is zero.

C. Reasonable projections of CO_2 prices would greatly increase the cost of coal power.

CO_2 allowance prices in the ranges discussed above would significantly increase the price of power from new coal plants. How much CO_2 allowance prices raise the cost of generating electricity from coal depends on the efficiency of the plant in question, but generally speaking, new coal plants emit roughly one ton of CO_2 per megawatt hour (MWh) of electricity produced.[137] This means, for example, that a CO_2 price of $10 per ton would increase a plant's costs by $10/MWh (or one cent per kilowatt-hour). Figure 6 shows how the cost of coal-fired electricity would rise in response to different CO_2 prices, starting with the EIA's estimated average base price of $47.50/MWh for new pulverized coal plants placed into service in the upper Midwest in 2015.[138]

Applying the Synapse levelized CO_2 cost projections to a coal plant increases the cost of energy from the EIA's average coal plant by the amounts and percentages shown in Table 2. For example, the cost of energy from an average coal plant would be 40 percent higher over its operating lifetime assuming mid-range CO_2 costs starting at five dollars per ton in 2010 and rising to $35 per ton by 2030.

Table 2: Increase in Energy Cost Based on Projected CO_2 Cost

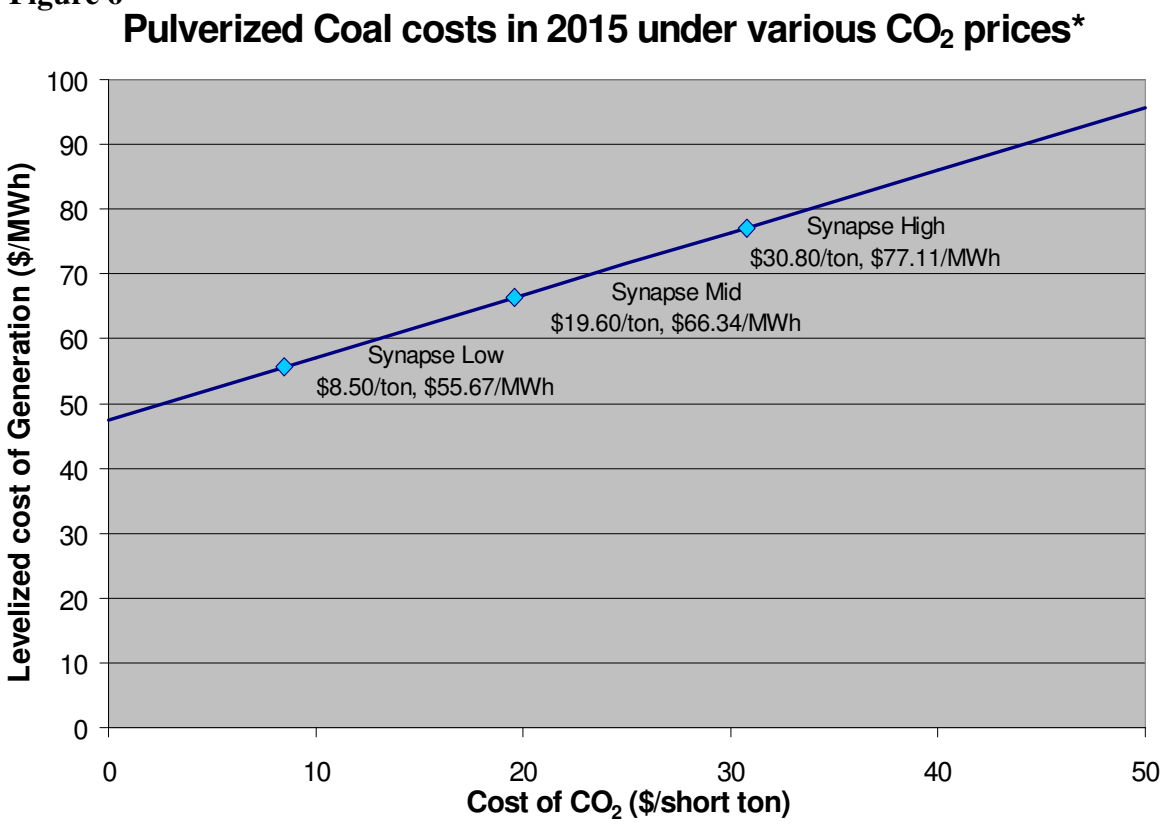
Price of CO_2 Allowance (levelized)	Cost of energy	Percent increase above base price
Base price (no CO_2 cost)	$47.50/MWh	–
Low projection: $8.50/ton	$55.67/MWh	17%
Mid-range projection: $19.60/ton	$66.34/MWh	40%
High projection: $30.80/ton	$77.11/MWh	62%

[137] Coal has a carbon intensity of 220 pounds per million British thermal units (Btu) and a new supercritical pulverized coal plant has a heat rate of 8,742 Btu per kilowatt-hour in 2005 (220 lbs/million Btu x 8,742 Btu/kWh/2,000 lbs/ton x 1,000 kWh/MWh/1,000,000 = 0.96 ton of CO_2 per MWh). See EIA, *Assumptions for Annual Energy Outlook 2006*, 2006.

[138] EIA, "NEMS EMM Factors for AEO06," spreadsheet, 2006. The costs are representative of a new coal plant built in the Midwest. Recent data indicates that EIA's base price for coal may be low. EIA's figure assumes overnight capital costs of $1,235/kW for a new plant. By comparison, the engineering firm Black and Veatch assumes overnight capital costs of $1,730/kW, based on the average cost of over 60 coal plant projects under construction or with air permits. (Source: Personal Communication with Ric O'Connell, Black and Veatch, August 20, 2006.) Using these capital costs, along with EIA's other assumptions, would raise the base cost of energy to $58/MWh.

Any utility proposing to build a coal plant would be reckless to make such a long-term investment without fully assessing a variable that could easily increase costs by $86 million per year on average, or $4.3 billion over a 50-year period, for a 600 MW coal plant.[139] The risk of future carbon constraints is far too great to ignore.

Figure 6



Source: EIA, "NEMS EMM Factors for AEO06," spreadsheet, 2006, and Johnston et al., 2006. The costs are representative of a new coal plant built in the Midwest.

D. Given the carbon-constrained world ahead, renewables and efficiency will generally be a much better investment than new coal plants.

In many cases, coal plants are already more expensive than cleaner options. This is particularly true with respect to investments in energy efficiency and wind turbines (in locations with favorable winds). With mid-range estimates of future CO_2 costs adding close to $20/MWh (or two cents per kilowatt-hour) to the cost of energy from a coal plant, cleaner options will cost less than coal in an even wider range of cases.

[139] Based on an estimate by Synapse for the Big Stone II coal plant under a mid-range CO_2 cost projection. See David A. Schlissel and Anna Sommer, direct testimony to the South Dakota PUC, case no. EL05-022, May 19, 2006, 24. Online at *http://www.state.sd.us/puc/commission/dockets/electric/2005/el05-022/testimonyschlisselsommer.pdf*.

While the exact cost comparisons will vary by location, two recent analyses compare coal plants with cleaner options in a carbon-regulated world, and in these analyses new conventional coal plants cannot compete. The first such analysis is a massive exercise in regional resource planning recently conducted by the Northwest Council.[140] With no financial stake in the outcome to skew its planning judgment, the council's fifth 20-year plan (adopted in December 2004) is a useful contribution to resource planning.

Among other things, the plan ranks various supply- and demand-side options on a cents-per-kilowatt-hour scale. The Northwest Council identifies 25 different conservation and renewable options that cost less than the cheapest new coal plant (even in Montana, a coal-producing state).[141] The plan looks at many different scenarios and various price estimates for future CO_2 costs (though these estimates pre-date recent developments such as the Senate resolution calling for carbon regulation).[142]

The plan concludes that much more investment in conservation is warranted even though the Northwest has already made relatively high investments in conservation over the years.[143] Overall, the Northwest Council's approach of identifying options that are both low-cost and low-risk yielded a plan that greatly increases investment in conservation and wind and *does not include any new conventional coal plants* for the region throughout the 20-year planning period.[144] While the council's cost estimates may not directly apply to other regions, they provide a valuable example of how conventional coal plants become uncompetitive compared with energy efficiency and renewable energy when independent resource planners use realistic assumptions about the future and factor in carbon risk.

The second relevant analysis was conducted by Synapse Energy Economics, which in May 2006 submitted testimony critiquing a resource comparison that a coalition of utilities seeking to build a conventional coal plant submitted to South Dakota regulators.[145] The utilities did not compare the proposed 600 MW Big Stone II plant with a comparable investment in energy efficiency, nor did Synapse. However, the utilities did compare Big Stone II with the alternative of building 600 MW of wind power along with a 600 MW natural gas combined-cycle plant. Not surprisingly, the utilities' wind/gas alternative was more expensive than Big Stone II, since it assumed only 600 MW of wind power and unnecessarily assumed that the wind turbines required 100 percent backup from natural gas to compensate for the wind's intermittent nature.

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[140] Northwest Power and Conservation Council, 2005.
[141] Ibid., Table OV-2, 26–27.
[142] Ibid., 19. The Northwest Council assumes CO_2 costs of between zero and $15 per ton beginning in 2008, and between zero and $30 per ton beginning in 2016.
[143] Ibid., 4, 29–31.
[144] Ibid., 29.
[145] David A. Schlissel and Anna Sommer, direct testimony to the South Dakota PUC, case no. EL05-022, May 26, 2006. Online at *http://www.state.sd.us/puc/commission/dockets/electric/2005/el05-022/testimonyschissel052606.pdf*.

Synapse reworked the comparison by increasing the amount of wind power to 800 and 1200 MW, reducing the amount of natural gas to levels that would be needed to provide an equivalent amount of electric generation and capacity (300 to 480 MW) as the coal plant,[146] and factoring in its low, mid-range, and high CO_2 cost estimates (described in part V, section B). Synapse also completed a sensitivity analysis of a few key variables including the continued existence of the federal production tax credit for wind, a capacity value for wind (which affects the amount of natural gas capacity needed), and whether the utilities were investor-owned or publicly owned.

Under all of the CO_2 price forecasts, the analysis showed that all of the high-wind (1,200 MW) scenarios were approximately the same or less costly than the 600 MW coal plant, even without the federal production tax credit and using a very conservative capacity value for wind. Under the most likely mid-range CO_2 price forecast, Big Stone II cost 27 to 71 percent more than the high-wind scenarios, across the entire range of assumptions.[147]

The analysis also showed that all of the wind/gas alternatives had lower costs than the 600 MW coal plant under both the mid-range and high CO_2 price forecasts. Coal fared remarkably poorly in these comparisons even though Synapse did not correct all of the utilities' assumptions that underestimated the cost of coal and overestimated the cost of wind.[148] In addition, the Big Stone II co-owners recently announced that the capital costs for the project have increased by 50 percent—from $1.2 billion to $1.8 billion.[149] Using these new costs, and incorporating energy efficiency into the alternatives analysis, would make the alternatives even more economically viable than described above.

Both the Northwest Council and Synapse analyses show coal unable to compete financially with other options available today when future carbon constraints are considered. In the future, coal is likely to be even less competitive, because policies designed to combat global warming will not just make coal more expensive but will surely accelerate improvements in cleaner technologies. Unlike conventional coal plants, many energy efficiency and renewable energy technologies are still relatively new. As they break out of niche markets and achieve greater economies of scale, improvements in price and performance will follow. Utilities that invest heavily in coal today are therefore

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[146] Ibid., 14. Synapse explains in its testimony that, by accepting the utilities' assumption that any dedicated backup plants would be built to support wind power, its analysis overstates the cost of the wind options.
[147] Ibid., Tables 1 and 2, 17. (A corrected version of these tables with slight alterations to the originally-filed numbers is online at *http://www.state.sd.us/puc/commission/dockets/electric/2005/el05-022/corrected062306.pdf*.)
[148] Ibid., 13–16. Synapse explains in its testimony its decision not to correct several of the utilities' original assumptions that bias the analysis against wind. For example, while the tax and financing advantages of public utilities were reflected in the cost of Big Stone II, they were not reflected in the cost of wind. Synapse corrected the utilities' assumption that wind had zero capacity value, but it conservatively assumed that wind resources have a capacity value of only 15 or 25 percent (despite recent utility studies showing that wind in the region has a capacity value between 27 and 34 percent). Synapse also used the utilities' value of $12/MWh for the production tax credit, despite data from the EIA showing a value of $21/MWh.
[149] Associated Press, "Higher cost for SD power plant won't help ND chances, exec says," August 4, 2006. Online at *http://www.kxma.com/getARticle.asp?ArticleId=30517*.

not only running unnecessary financial risks, but also losing the flexibility to take full advantage of the technological opportunities ahead.

E. Retrofitting a pulverized coal plant to limit CO_2 emissions is feasible, but will be very expensive.

Coal plants emit far more CO_2 than any pollutant that is federally regulated today. By way of example, the Final Environmental Impact Statement for the Weston 4 coal plant in Wisconsin lists potential mercury emissions of 78 pounds per year, sulfur dioxide emissions of about 2,300 tons per year, and nitrogen oxide emissions of about 1,600 tons per year. CO_2 emissions, by comparison, are projected to be 4,100,000 tons per year.[150] Collecting and disposing of CO_2 emissions therefore pose much greater technological challenges than those faced by coal plants to date.

It is considered technologically possible to capture 80 to 90 percent of the CO_2 from a conventional coal plant by scaling up methods currently in use to produce CO_2 for beverage and chemical applications.[151] However, the costs—in terms of energy consumed by the capture process and added capital and operating expenses—would be very high. The energy penalty of adding such technology to the plant would equal 24 to 40 percent of the energy produced by the plant.[152] A recent MIT study estimates that adding CO_2 capture technology to a conventional coal plant and disposing of the CO_2 in geological formations would increase the plant's levelized cost by nearly $30/MWh or 74 percent.[153]

Thus, there is no technological solution that can be reasonably expected to buffer a conventional coal plant from the financial risk associated with CO_2 regulation. Whether the plant operator ultimately pays for emission allowances or installs technology to capture and dispose of the CO_2, it runs a high risk of greatly increased costs.

VI. Regulators should protect ratepayers from future CO_2 costs by refusing to authorize new coal plants; alternatively, they should clearly place the risk of future CO_2 costs on utility shareholders rather than on ratepayers.

Currently, a utility's environmental compliance costs are routinely passed through to ratepayers as a cost of providing electricity. In particular, costs of buying pollution allowances (such as the sulfur dioxide allowances coal operators purchase today) are considered operating expenses recoverable through rates. This regulatory pattern of

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[150] Public Service Commission of Wisconsin, Weston Unit 4 Power Plant Final Environmental Impact Statement, Volume 1, July 2004, 134 and 145. Online at http://psc.wi.gov/utilityinfo/electric/cases/weston/document/Volume1/W4_FEIS.pdf.

[151] IPCC, "Carbon Dioxide Capture and Storage," 121. Current unit capacities would have to be increased by a factor of between 20 and 50 for deployment at a 500 MW coal plant.

[152] Ibid, Summary for Policymakers, 4.

[153] Ram C. Sekar, John E. Parsons, Howard J. Herzog, and Henry D. Jacoby, "Future Carbon Regulations and Current Investments in Alternative Coal-Fired Power Plant Designs," MIT Joint Program on the Science and Policy of Global Change, December 2005, 4.

treating pollution allowance costs as operating expenses means that utilities may feel confident that they can also recover any future CO_2 allowance costs through their rates.

Such confidence, however, means a utility operating in a regulated environment has little incentive to assess CO_2 allowance costs in a serious way, even when contemplating major new long-term investments. From a societal standpoint, this is a financial disaster waiting to happen; the financial risks of building a new coal plant are very high, but the party making the investment is not deterred because it does not feel at risk.

It is, of course, up to state regulators to make sure this financial disaster is avoided and that ratepayers are protected. By far the best way to do that is to deny approval of the proposed coal plant and encourage the utility to pursue less financially risky alternatives.

However, if regulators do approve construction of a proposed plant, they should ensure that the utility has an incentive to minimize this risk as it emerges by warning it that future CO_2 allowance costs will not be recoverable through rates. This is particularly important given how rapidly climate change policy is evolving and how long it takes to build a coal plant. Because utilities would for some time have the ability to cancel or downsize new plants in response to the growing risk of CO_2 costs, regulators should give them the incentive to monitor and respond to that risk. Shifting the risk of future CO_2 regulations onto utilities may be inconsistent with current rate treatment of pollution allowances, but it is fully consistent with underlying ratemaking principles and the case law related to investments in new baseload plants.

In the late 1960s and 1970s, many of the nation's utilities believed two things that turned out to be wrong: that electricity demand would keep growing at a fast rate and that nuclear power would be an inexpensive way to meet that demand. These mistaken beliefs resulted in substantial excess baseload capacity in the early 1980s (largely from unneeded coal plants), many abandoned nuclear plants, and disputes around the nation about whether the costs of these mistakes should be paid by utility shareholders or ratepayers.

The regulatory decisions made during this era typically allocated at least a share of excess costs to shareholders, and articulated standards intended to give utilities a stronger incentive to avoid such unwise investments in the future.[154] Now that utilities are again in the midst of a baseload power plant construction boom based on risky assumptions, these standards are again highly relevant.

Two complementary regulatory approaches emerge in these disputes: the "prudent investment approach" and the "shared costs approach." Both approaches are intended, in part, to create incentives for utilities to continually rethink their investment decisions in

[154] For overviews of these cases see Richard J. Pierce, Jr., "The Regulatory Treatment of Mistakes in Retrospect: Canceled Plants and Excess Capacity," 132 *U. Pa. L. Rev*. 497 (1984); "Abandoned Nuclear Plant Recovery," 83 *ALR*4th 183 (1991); and Roger D. Colton, "Excess Capacity: Who Gets the Charge from the Power Plant?" 34 *Hastings L.J*. 1133 (1983).

light of emerging events (rather than sticking to a chosen path even when subsequent developments clearly make that path unwise).

Under the prudent investment approach all or part of a utility's investment can be excluded from rates if any decision made by the utility in relation to that investment is found to be imprudent. This could include the decision to build a power plant and the subsequent decision not to cancel it after changing circumstances show the project to be unwise.[155]

While this principle has often been invoked by utilities seeking to recover from unsuccessful investments that appeared to be prudent when they were initially made,[156] the principle is also intended to protect ratepayers from unwise utility decisions.[157] Over the years, regulators have denied rate recovery for some enormous investments judged to be imprudent, including costs related to abandoned nuclear power plant construction plans[158] and coal plants that were built but created excess capacity.[159]

To determine whether an investment was prudent, courts consider what a utility knew or should have known when the investment was made, and any alternative generating options that were available at the time. The inquiry not only focuses on the initial decision to build a plant, but also on the subsequent, ongoing decisions to continue pursuing construction even after events such as the adoption of a new regulatory approach greatly increased cost estimates beyond those originally projected. As parts I through V show, building a coal plant without reasonably factoring in the substantial financial risk associated with coming climate laws is clearly imprudent. On these grounds alone, regulators would be justified in disallowing rate recovery of CO_2 costs.

However, an investment need not be deemed imprudent for recovery to be disallowed. The U.S. Supreme Court has explicitly upheld the authority of state regulators to limit a utility's recovery for an investment that appeared prudent at the time it was made but ultimately proved unwise.[160] States have considerable discretion to set rates that appropriately balance the interests of shareholders and ratepayers, and some have adopted approaches that divide financial risks between these parties. State regulators have particularly used this shared costs approach in cases of excess capacity built as a result of inaccurate demand forecasts, because they concluded that placing all the risk on ratepayers is unfair and creates the wrong incentives for utility management. In 1982, for example, Iowa regulators refused to pass on to ratepayers all the costs a utility incurred in building what later proved to be excess generating capacity, even though the decision to build was reasonable when made. The Iowa commission explained its reasoning this way:

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[155] See Pierce, supra, p. 7.
[156] See Duquesne Light Co. v. Barasch, 488 U.S. 299, 109 S.Ct. 609 (1989).
[157] Verizon Communications Inc. v. FCC, 535 U.S. 467, 122 S.Ct. 1646, 1659 (2002).
[158] See e.g., Association of Businesses Advocating Tariff Equity v. Public Service Commission, 527 N.W.2d 533 (Mich. App. 1994); In Re Interstate Power Company, 416 NW2d 800 (Minn. App. 1987); Re Boston Edison Co., 46 PUR4th 431 (Mass DPU, 1982), aff'd 455 NE2d 414.
[159] Gulf Power Company v. Florida Public Service Commission, 453 So.2d 799 (Fla. 1984);
[160] Duquesne Light Co. v. Barasch, 488 U.S. 299, 109 S. Ct. 609 (1989).

"In the real world of competitive enterprise, management officials must continuously rethink prior decisions as new events unfold. Those who fail to stay on top of current events lose out to their competition. Iowa utilities should also maintain surveillance over costs associated with a particular decision, and in the absence of the kind of incentive provided by a competitor, the responsibility falls upon us to provide the requisite incentive."[161]

The Wisconsin Supreme Court agreed with Iowa's shared costs approach and recognized the authority of Wisconsin regulators to apply it in the same context.[162] Pennsylvania regulators applied similar reasoning in an excess capacity case, noting that while the investments were prudent and the excess capacity was no fault of the utility or its investors, "neither was it the fault of ratepayers. Under these circumstances there must be some sharing of the risk associated with bringing these large plants on line."[163]

North Dakota regulators took a similar approach in response to excess capacity created by a coal plant, refusing to allow all the costs to be passed on to ratepayers. Though they did not deem the utility's investment imprudent, regulators felt it was "unreasonable to expect ratepayers to completely absorb the risk" of excess capacity, and that "there must be some risk placed on the utility and there must be some incentive for the pool and the individual utility member to continuously strive for accurate and precise management" of investments in baseload capacity. [164]

Both the prudent investment approach and the shared costs approach recognize the importance of giving utilities a strong incentive to avoid making investment mistakes, especially when building expensive, long-lived baseload plants. And both lines of cases stress how important it is for utility management to keep track of changes that affect the wisdom of the utility's investment during the period after a plant receives regulatory approval but before construction is completed.

These cases grew out of an era (the 1970s) when utilities making large investments in baseload capacity were surprised by events beyond their control—primarily the OPEC embargo, which led to slower growth in energy demand, and the Three Mile Island accident, which resulted in stricter safety standards and higher construction costs. Once again, utilities are making huge investments in baseload power, but this time the global changes that threaten the economic viability of these investments are far more predictable than they were in the past. Indeed, they are looming, and they threaten to substantially increase the cost of energy from new coal plants. It is even more critical today that utilities be given a strong incentive to track regulatory developments and continually re-examine their construction decisions in light of those developments.

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[161] Re Iowa Public Service Company, 46 PUR4th 339, 368-69 (IA Commerce Commission, 1982).
[162] Madison Gas and Electric Company v. Public Service Commission of Wisconsin, 325 N.W.2d 339 (Wis. 1982).
[163] Pennsylvania Public Utility Commission v. Philadelphia Electric Co., 37 PUR4th 381, 387 (Pa. Public Utility Commission, 1980).
[164] Re Montana-Dakota Utilities Co., 44 PUR4th 249, 255 (N.D. PSC 1981); see also Re Otter Tail Power Company, 44 PUR4th 219 (N.D. PSC 1981).

Regulators can create such an incentive by determining, as a condition of plant approval, that future CO_2 costs will be borne by utility shareholders rather than ratepayers.

VII. Conclusion

The fight against global warming will unquestionably change the laws, economics, and technology of power production and use. Many different groups have a role to play in helping ensure our society responds sensibly to these changes.

- Utilities should factor future CO_2 costs into their resource planning and procurement, aggressively pursue conservation, efficiency and renewable energy, and at the very least defer making major coal plant construction decisions until they have a clearer picture of the regulatory risks and technological opportunities ahead.

- Regulators should insist that utilities take the above steps. They should also protect ratepayers by refusing to authorize the construction of new conventional coal plants, which are premised on the regulatory conditions of the past, not those of the future. At the least, they should warn utility managers that shareholders will bear the risk that coal investments will result in excess carbon costs.

- Investors and shareholders should recognize the inevitability of CO_2 regulations and understand that utilities that behave imprudently by building coal plants despite these costs would, under existing regulatory principles, be prevented from recovering at least a portion of such costs in their rates. Shareholders should question utility management closely on how they are assessing and managing carbon risks, and require reporting and accountability. Long-term investors should favorably regard companies who are proactively considering and managing these risks effectively.

- Ratepayers and consumer groups should realize that the utilities building new coal plants will seek to recover all their costs, including CO_2 regulatory costs, from ratepayers. While legal principles support denying rate recovery of these costs, history shows that these cases are extremely contentious and expensive. A far better way for ratepayers and consumer groups to protect themselves from such financial risk is by resisting the construction of new conventional coal plants in the first place and by supporting investments in cleaner alternatives such as efficiency and renewable energy.

Building a major energy resource – especially one that costs as much and lasts as long as a coal plant -- is unavoidably an exercise in predicting the future. It cannot be prudently done without objectively analyzing the trends and potential risks that will shape the decades ahead. In the case of new coal plants, the critical trends are undeniable and moving with unstoppable momentum: CO_2 levels are rising to levels unseen on the planet in millions of years, global temperatures are setting new records, scientific

evidence showing that our current energy path is leading to dangerous climate changes is mounting, and the policy response at every level of government is accelerating. To assume in the face of these trends that a new coal plant could be put into service and allowed to emit millions of tons of CO_2 for free for the next few decades is reckless, to say the least. New conventional coal plants in the age of global warming are not just bad policy – they are a bad investment, and one we cannot afford to make.