Reducing Emissions from the Electricity Generation Industry: Can We Finally Do It?

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I. INTRODUCTION

The electricity generation industry has achieved substantial reductions in emissions of pollutants over the past several decades, but environmental progress in this industry has reached a plateau. Further reductions have proven elusive, as the surprising longevity of coal-fired power plants has confounded the expectations of environmental policymakers. The contribution of the electricity generation industry to persistent air pollution problems and high emissions of greenhouse gases has been traced to these older, high-emitting coal-fired power plants, the

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dinosaurs of this industry. Cleaner burning natural gas fired power plants appear to be the heir apparent to the immediate energy supply future. But while natural gas-fired plants have taken root, they have done so in disappointingly few numbers.[1] Meanwhile, investment in energy conservation and in renewable energy technologies, which hold the key to the long-term energy supply future, has sagged, as the low oil and gas prices of the 1980s and 1990s have pushed these still-developing industries into the recesses of the energy industry.[2] U.S. firms have shrunk from being leaders in renewable energy to net importers of superior foreign technologies. Precious time is being lost as persistent air pollution problems and increasingly grim predictions on global warming call for immediate policy action.[3] Additional emissions reductions may be even more difficult to achieve in a deregulated U.S. energy environment. A market-driven energy environment will probably lower energy costs in the long run,[4] but will probably offer little or no incentives for electricity generation firms to reduce or eliminate emissions. In particular, market conditions may push the renewable energy industries to the brink of extinction.[5] It is becoming increasingly

1. James McVeigh et al., *Winner, Loser or Innocent Victim: Has Renewable Energy Performed As Expected?*, 2 RENEWABLE ENERGY POL'Y PROJECT, RESEARCH REPORT NO. 7 (Mar. 1999), *available at* http://www.repp.org.

2. Oil and natural gas prices have increased quite dramatically in the past year, but will have to remain high for a sustained period in order to spur a comeback by renewable energy technologies. *Statement of Mark J. Mazur, Acting Administrator, Energy Information Administration, U.S. Department of Energy, Before the Committee on Energy and Natural Resources*, U.S. Senate, at 2, Fig. 1 (Dec. 12, 2000) [hereinafter *Mazur Testimony*], *at* http://www.eia.doe.gov/pub/oil_gas/natural_gas/presentations/2000/testimony_on_natural_gas_demand/1211sen-test.pdf.

3. The Intergovernmental Panel on Climate Change, a United Nations sponsored group of over 400 scientists from over 100 countries, has recently issued a series of drafts of their most recent assessment of the likelihood and impacts of global climate change, due for final publication in 2001. The drafts indicate that earlier estimates of the likelihood and impacts of climate change were too conservative. In addition to assigning higher levels of statistical confidence to larger changes in global mean temperatures, the Panel has also concluded that changes in temperature are linked to human activities such as the combustion of fossil fuels. *Draft Third Assessment Report from IPCC Working Group Obtained Oct. 30, 2000*, 31 ENV'T REP. 2340, 2341 (2000) [hereinafter *Draft Third Assessment*].

4. In a year of unprecedented natural gas prices, low energy prices seem remote. However, while natural gas prices are higher than they have historically been, they are expected to fall substantially, and keep electricity prices down at more reasonable levels. Spot market prices have historically been below $4/mmBtu. *Mazur Testimony*, *supra* note 2, at 1. In September 2000, prices rose above $5/mmBtu, and reached a high of $8.86/mmBtu in December. *Id.* California has been particularly hard-hit, experiencing spot prices higher than four times the national average. *Id.* This is not a trend that is expected to continue, however, as prices will hover slightly above $4/mmBtu. *Id.*

5. Karen Palmer, *Electricity Restructuring: Shortcut or Detour on the Road to Achieving Greenhouse Gas Reductions?* 7 (July 1999) (citing reasons why market conditions

clear that current policies are insufficient to accomplish further emissions reductions.

Achieving further emissions reductions from this sector is simple: retire coal-fired power plants and stimulate investment in a renewable energy technologies. This Article proposes the implementation of an emissions cap and allowance trading program coupled with a subsidy program to accomplish this as expeditiously as possible in a deregulated electricity generation industry. As previous experience has shown, an emissions cap and allowance trading program, or "cap-and-trade" program, provides a continuing incentive for emissions reductions, stimulates innovation in emissions reduction strategies, and lowers compliance costs.[6] However, acceptance of emissions cap-and-trade programs have proven elusive, even after a reasonably successful national debut with sulfur dioxide (SO_2) allowance trading under the Acid Rain Program of the 1990 Clean Air Act Amendments.[7] Despite the widespread belief that SO_2 allowance trading resulted in much lower compliance costs, opposition from the electric generation industry has quashed efforts to introduce cap-and-trade programs for emittants other than SO_2. After investing in compliance strategies for the Acid Rain Program, electricity generation firms have balked at the prospect of changing compliance strategies again to fit a new regulatory scheme. As a sugar pill for the electricity generation industry, this Article proposes a subsidy program to induce the retirement of high-emitting coal-fired power plants and to stimulate the development of renewable energy technologies. Both cap-and-trade programs and subsidies are infeasible as stand-alone options for encouraging the cleaner production of energy. Together, however, these two policy instruments may remedy the critical flaws in the individual programs and achieve much needed reductions in emissions of pollutants and greenhouse gases, by finally beginning an overdue conversion of our stock of coal-fired power plants to lower-emitting facilities.

II. BACKGROUND

A. The Air Pollution Problem Attributable to Electricity Generation

Retiring coal-fired power plants in the United States is essential to reducing emissions of pollutants and greenhouse gases from the

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may affect acceptance of natural gas plants), *at* http://www.rff.org/issue_briefs/PDF_files/ccbrf18.pdf.

6. *See generally* Byron Swift, *The Acid Rain Test*, 14 ENVTL. F. 17 (May/June 1997) (discussing the effects of emissions cap and allowance trading systems) [hereinafter Swift I].

7. *Id.* at 19.

electricity generation industry. In 1999, coal-fired power plants in the United States emitted 11.3 million tons of SO_2, 6.5 million tons of nitrogen oxides (NO_x), 1.9 billion tons of carbon dioxide (CO_2), and 43 tons of mercury.[8] This accounted for approximately 60% of all SO_2 emissions nationwide and 25% of all NO_x emissions nationwide.[9] Coal-fired power plants also accounted for 32% of all CO_2 emissions nationwide[10] and 21% of all airborne mercury emissions nationwide.[11] Emissions of particulate matter, SO_2, NO_x and mercury from coal-fired power plants have had well-documented adverse effects upon human health.[12] In addition, SO_2 and NO_x emissions have caused acid rain, the result of the chemical formation of sulfuric acid in the lower atmosphere and its subsequent deposition into the ecosystem.[13] Acid rain has caused widespread damage in numerous lakes and rivers, and stimulated the release of heavy metals into the environment.[14] Emissions of these pollutants have a number of other adverse environmental effects, including impacts on a wide variety of vegetation, agriculture, and visibility.[15] Finally, the disproportionately large contribution of coal-fired power plants to global warming is reason enough to induce their retirement.

There is now widespread agreement that the retirement of older coal-fired power plants would produce substantial health and

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8. U.S. ENERGY INFO. ADMIN., U.S. DEP'T OF ENERGY, ELECTRIC POWER ANNUAL 1999, VOL. II (2000), at 42, tbl. 25, [hereinafter ELECTRIC POWER ANNUAL 1999 II], *available at* http://www.eia.doe.gov/cneaf/electricity/epav2/epav2.pdf; EPA, *Fact Sheet, EPA to Regulate Mercury and Other Air Toxics Emissions from Coal- and Oil-fired Power Plants* 3 (Dec. 14, 2000), *at* http://www.epa.gov/ttn/oarpg/t3/fact_sheets/fs_util.pdf.

9. These figures are approximate, as precise 1999 emissions figures have not yet been published. *See* EPA, NATIONAL AIR QUALITY AND EMISSIONS TRENDS REPORT (1998), tbls. A-4 and A-8, http://www.epa.gov/oar/aqtrnd98/fr_table.html (last visited Dec. 20, 2000); *see also* EPA, *Latest Findings on Air Quality: 1999 Status and Trends, 16* (Aug. 2000), http://www.epa.gov/oar/aqtrnd99/brochure/brochure.pdf.

10. Total anthropogenic CO_2 emissions in the United States for 1999 were estimated to be 6.17 billion tons. U.S. ENERGY INFO. ADMIN., U.S. DEP'T OF ENERGY, EMISSIONS OF GREENHOUSE GASES IN THE UNITED STATES 1999, Report #EIA/DOE-0573 (99), at 1 (Oct. 31, 2000), http://www.eia.doe.gov/oiaf/1605/ggrpt/carbon.html [hereinafter *Greenhouse Gas Report*]. A conversion was made from metric tons to short tons, by multiplying the referenced figure by 1.1023.

11. EPA, BACKGROUND INFORMATION ON MERCURY SOURCES AND REGULATIONS tbl. 3, http://www.epa.gov/grtlakes/bnsdocs/mercsrce/images/mercsalb.pdf (last visited Dec. 20, 2000).

12. For a discussion of some of the environmental impacts of emissions from coal-fired power plants, see BYRON SWIFT, ENVTL. L. INST., CLEANER POWER: THE BENEFITS AND COSTS OF MOVING FROM COAL TO NATURAL GAS POWER GENERATION 1 (2000), *available at* http://www.eli.org/pdf/rrcleanerpowerØØ.pdf [hereinafter Swift II].

13. *See id.* (including such impacts as acid deposition, visibility impairments and eutrophication).

14. *Id.*

15. *Id.*

environmental benefits well in excess of the costs imposed.[16] Per unit of energy produced, natural gas-fired plants are considerably cleaner than coal-fired plants, emitting only 33% of the CO_2, 10% of the NO_x, and virtually none of the SO_2,[17] particulate matter, and mercury emitted by coal-fired plants.[18] Retiring 80% of the coal-fired power plants and replacing the lost generation capacity with natural gas-fired power plants, without any other policy measures, would accomplish the carbon dioxide emissions reductions necessary for the United States to meet its Kyoto Protocol targets of reducing emissions by 7% below 1990 levels.[19]

While the environmental difference between coal and natural gas points to a fuel switch-over as a desirable policy objective, there *must* also be investment in renewable energy technologies. First, surging natural gas prices throughout the United States have placed energy infrastructures under surprisingly sharp pressure, particularly in California.[20] While current estimates seem to indicate that supplies of

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16. Estimates of the health benefits alone of reducing SO_2 emissions are staggering. Estimates of the benefits of the SO_2 emissions reductions under the Acid Rain Program (discussed in text accompanying notes 109-115 *infra*) range from $12 to $78 billion in the United States, and $290 million to $1.8 billion in affected areas of Canada. LAURAINE G. CHESTNUT, EPA HUMAN HEALTH BENEFITS FROM SULFATE REDUCTION UNDER TITLE IV OF THE 1990 CLEAN AIR ACT AMENDMENTS, at 18, tbls. S-2 and S-3 (Nov. 10, 1995), http://www.epa.gov/airmarkets/articles/healtheffects/index.html. Compliance costs for the Acid Rain Program were estimated to be $832 million in 1995 and $1.04 billion in the long run. Curtis Carlson, *SO_2 Control by Electric Utilities: What Are the Gains from Trade?*, 66, 87 RESOURCES FOR THE FUTURE Discussion Paper 98-44 (1999), *available at* http://www.rff.org/disc_papers/PDF_files/9844rev.pdf. This does not take into account the ecological and recreational benefits of reducing acid rain resulting from SO_2 emissions. *See also* Swift II, *supra* note 12, at 13 (discussing the health, as well as social, economic and welfare benefits associated with reducing SO_2 emissions); Dallas Burtraw et al., *The Costs and Benefits of Reducing Acid Rain*, RESOURCES FOR THE FUTURE Discussion Paper 97-31-REV (1997) (benefit-cost ratio of between 7 and 13:1), *available at* http://www.rff.org/org/disc_papers/PDF_files/9731.pdf.

17. STATE AND TERRITORIAL AIR POLLUTION PROGRAM ADM'RS & ASS'N OF LOCAL AIR POLLUTION CONTROL OFFICIALS, REDUCING GREENHOUSE GASES & AIR POLLUTION: A MENU OF HARMONIZED OPTIONS 3 (Oct. 1999), http://www.4cleanair.org/reference.html. This assumes that the natural gas-fired power plants are of the "combined cycle" variety, which involves the recovery of waste heat to power a separate turbine.

18. Unlike other emitters of hazardous air pollutants, power plants may be exempted from emissions standards by the U.S. EPA, the agency responsible for regulating emissions of air pollutants under the Clean Air Act. Clean Air Act § 112(c)(6), 42 U.S.C. § 7412(c)(6) (1994).

19. The Kyoto Protocol calls for the United States to reduce carbon emissions to 93% of the level of carbon emissions in 1990, which would be 5.08 billion tons. *Greenhouse Gas Report*, *supra* note 10, at 1 (showing that 1990 carbon dioxide emissions were 5.598 billion metric tons minus 0.646 billion metric tons = 4.952 billion metric tons, or 5.459 billion tons). Meeting the Kyoto Protocol targets would require a reduction from 6.17 to 5.08 billion tons, a reduction of 1.09 billion tons. Conversion of all coal-fired plants to natural gas-fired plants alone would accomplish a reduction of 1.33 billion tons. This calculation makes the assumption that every coal-fired power plant could and should be retired.

20. *Mazur Testimony*, *supra* note 2, at 1 (stating that California has been experiencing natural gas prices more than four times as high as national averages).

natural gas should be sufficient to meet even a sharply increased U.S. demand,[21] too abrupt of a switch from all coal-fired capacity to natural gas may result in energy shortages or high electricity prices. To help avoid fuel-supply problems, and to minimize the environmental disruption resulting from natural gas extraction, some lost coal-fired capacity must be replaced by renewable energy capacity. Second, natural gas reserves are finite. Although reserves seem vast, relying too heavily on supply assumptions would be imprudent, and insuring against supply disruptions with renewable energies is the soundest strategy. Third, the emissions from natural gas-fired power plants will someday also be intolerably high. With a substantial portion of the world's population still in developing countries, world energy needs are likely to continue to grow for decades to come. Even in the United States, energy consumption grew by 22% from 1990 to 1999,[22] while the population grew by only 12%.[23] As the demand for energy grows, so does the need to minimize the environmental consequences of producing it. For the long term, the need to *immediately* resume development of renewable energy technologies is clear.

The preceding discussion is not intended to be a comprehensive argument for retiring coal-fired power plants or for stimulating investment in renewable energy technologies, which would exceed the intended scope of this Article. The purpose of this Article is to propose the use of a cap-and-trade program and a subsidy program as a package of policy instruments to induce the cleaner production of electricity. This Article proposes a three-part strategy for reducing emissions from the electricity generation industry: (1) a phased cap-and-trade program to make more costly the continued operation of coal-fired power plants, (2) a subsidy to hasten the retirement of coal-fired power plants, and (3) a subsidy to stimulate investment in renewable energy technologies.[24]

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21. Despite an expected tripling of demand for natural gas used for power generation up to 2020, the Energy Information Administration projects that gas reserves and imports will be sufficient to meet this increased demand. U.S. ENERGY INFO. ADMIN., U.S. DEP'T OF ENERGY, ANNUAL ENERGY OUTLOOK 2001, at 4, 29, 32 (Dec. 2000), http://www.eia.doe.gov/oiaf/aeo/pdf/0383(2001).pdf [hereinafter AEO2001]. The supply issue is discussed in further detail in the text accompanying notes 131-133 *infra*.

22. U.S. ENERGY INFO. ADMIN., U.S. DEP'T OF ENERGY, ELECTRIC POWER ANNUAL 1999, Vol. I, at 31, tbl. A2 (Aug. 2000), http://www.eia.doe.gov/cneaf/electricity/epav1/epav1.pdf [hereinafter ELECTRIC POWER ANNUAL 1991 I]. Total energy demand is expected to increase at a rate of 1.8% per year through 2020. AEO2001, *supra* note 21, at 4.

23. The 2000 population estimate of 276 million is 11% more than the 1990 estimate of 249 million. *See* U.S. BUREAU OF THE CENSUS, U.S. DEP'T OF COMM., *Resident Population Estimates of the United States by Age and Sex*, *at* http://www.census.gov/population/estimates/nation/intfile2-1.txt (last visited Jan. 19, 2001).

24. Possibly quite useful, but excluded from this discussion for reasons of tractability, are nonfinancial incentives such as renewable portfolio standards, which require electricity producers

In light of worsening air pollution and greenhouse gas emission problems, a strategy of inducing a fuel-switch from coal to natural gas must be accompanied by a simultaneous strategy of developing renewable energy technologies. While natural gas has been touted as the "bridge" to an energy future dominated by renewable energy technologies,[25] this bridge must be a short one; for renewable energy technologies, the future is now.

B. *The Failure to Switch from Coal to Natural Gas*

A new power plant constructed today is much more likely to utilize natural gas as a fuel source than coal.[26] Apart from the environmental benefits of using natural gas instead of coal, natural gas-fired power plants present significant economic advantages for the electricity generation industry.[27] Natural-gas fired power plants generally have a smaller generating capacity than coal-fired power plants, but on a per-megawatt capacity basis, are much less expensive to construct.[28] Over the lifetime of a newly-constructed plant, the total cost of producing electricity from a natural gas-fired power plant (including capital costs) is estimated to be three to three and one-half cents per kilowatt-hour (3¢ to 3.5¢/kWh),[29] while the total cost of producing electricity from a new

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to generate some portion of that electricity from renewable energy sources. Massachusetts has a requirement that retail electricity suppliers must meet a portfolio standard that includes renewable energy sources. MASS. ANN. LAWS ch. 25A, § 11F(a) (1996). A number of European countries have also adopted some form of a renewable energy portfolio standard. Curtis Moore & Jack Ihle, *Renewable Energy Policy Outside of the United States*, ISSUE BRIEF NO. 14, at 3 (1999), http://www.repp.org.

25. Adam Serchuk & Robert Means, *Natural Gas: Bridge to a Renewable Energy Future*, ISSUE BRIEF NO. 8 (May 1997), http://www.repp.org. To some extent, these dual goals are synergistic, as the sporadic nature of wind and solar resources makes them better supplemental energy sources for natural gas-fired plants, which can fire up and shut down much more quickly than coal-fired plants.

26. About 92% of new power plants built in the next twenty years are expected to be powered by natural gas. AEO2001, *supra* note 21, at 73.

27. *Id.* at 77.

28. The average capital cost of constructing a combined-cycle natural gas-fired power plant is estimated to be $450 per kilowatt of capacity. By comparison, the estimated capital cost of constructing a coal-fired plant is $1100 per kilowatt. *Id.* A typical natural gas-fired plant with a 50 MW generating capacity would thus cost approximately $22.5 million, while a typical coal-fired plant with a 300 MW generating capacity would cost approximately $330 million.

29. U.S. ENERGY INFO. ADMIN., U.S. DEP'T. OF ENERGY, ANNUAL ENERGY OUTLOOK 2000, at 67, tbl. 9 (Dec. 1999), *available at* http://www.eia.doe.gov/oiaf/archive/aeo00/pdf/0383(2000).pdf. [herein-after AEO2000]. Estimated costs range from 3.1¢ to 6.1¢ per kWh, depending upon the capacity factor. Bruce Biewald et al., NAT'L ASS'N REG. UTIL. COMM'RS, *Grandfathering and Environ-mental Comparability: An Economic Analysis of Air Emission Regulations and Electricity Market Distortions* 24 (1998), *available at* http://www.synapse-energy.com/publications/htm. Natural gas prices have increased significantly in the last year, possibly skewing these estimates. However, the long-term outlook for natural gas prices has not

coal-fired power plant is estimated to be 4.1¢/kWh.[30] Moreover, the smaller natural gas-fired power plants, in requiring a fraction of the capital commitments, provide electricity generation firms with much more financial flexibility.[31] While natural gas-fired plants still face hurdles,[32] the economics of new plants clearly point to natural gas as the preferred fuel source. In an increasingly deregulated electricity generation industry, even this small cost difference between coal and natural gas should be enough to provide gas with a decisive competitive advantage.

However, the happy coincidence of good business and good environmental policy has not resulted in a wholesale conversion of the fleet of coal-fired power plants into natural gas-fired power plants. In 1999, 51% of U.S. energy needs were met by coal-fired power plants, while natural gas-fired power plants accounted for only 15% of all U.S. energy needs.[33] This is scarcely different than the energy picture ten years ago, when coal accounted for 53% of U.S. energy needs, and natural gas accounted for 13%.[34] Worse still, most of the electricity produced by coal-fired power plants is produced by plants that were built before 1980,[35] and emit more pollution than newer coal-fired power plants. What's the problem?

The problem is that environmental laws have "grandfathered" these older coal-fired power plants so that they do not have to comply with many stringent environmental regulations that apply to new plants.[36] This provides a strong incentive to keep old coal-fired power plants operating. While these older plants are less efficient than newer plants

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changed substantially, as higher gas prices are expected to stimulate more exploration and recovery. *See Mazur Testimony*, *supra* note 2, at 5.

30. AEO2000, *supra* note 29, at 67, tbl. 9.

31. Swift I, *supra* note 6, at 20.

32. Natural gas-fired plants still face more stringent environmental standards than do coal-fired plants, and still face the usual hurdles involved with siting decisions. In addition, natural gas-fired plants must also be located close to existing natural gas pipelines. Palmer, *supra* note 5, at 7.

33. U.S. ENERGY INFO. ADMIN., U.S. DEP'T OF ENERGY, ANNUAL ENERGY REVIEW 1999, at 213, tbl. 8.2 (2000), http://www.eia.doe.gov/pub/pdf/multi.fuel/aer1999/sec8_7.pdf (last visited Jan. 15, 2001) [hereinafter AER1999].

34. Figures are for 1990. *Id.*

35. Nearly four-fifths of the coal-fired power plants in the United States were constructed before the 1977 implementation of New Source Review, and are thus "grandfathered" out of emissions controls required for plants built thereafter. These plants thus emit pollution that is orders of magnitude greater than plants that are required to meet New Source Review. Pamela Najor, *Government Sues Electric Companies Over New Source Review at 17 Power Plants*, 30 ENV'T REP. 1269, 1269 (1999) [hereinafter Najor I].

36. *Id.*

being built today, the costs of inefficiency have not yet been enough of an incentive to induce firms to retire their older plants.[37]

This situation derives from an assumption in U.S. environmental policy that there would inevitably occur a natural turnover of power plants.[38] Power plants have typically been built to last thirty to forty years, and environmental policy has been developed with the assumption that thirty-year-old plants would be soon phased out of production.[39] This assumption ignores the economics of operating these older plants, and the cost advantage enjoyed by continuing operation of these plants over building new ones. In 1977, the Clean Air Act was amended to provide for New Source Review standards, stringent emissions standards that apply to any new construction of a facility that emits criteria air pollutants.[40] It was believed that the United States Environmental Protection Agency could insist upon stringent standards because new power plant construction was inevitable.[41] This was not so, as coal-fired power plants persisted throughout the 1980s. In 1990, the Clean Air Act was amended again to include the Acid Rain Program, which provided for tradable permits for emissions of SO_2—permits to emit one ton of SO_2, tradable primarily among the electricity generation firms.[42] It was expected that by sending a price signal to electricity generation firms, the firms would finally retire their coal-fired power plants.[43] Instead, only seven of the original 263 coal-fired plants originally subject to the Acid Rain Program were retired in the entire decade of the 1990s.[44] Evidently, the price signal was not strong enough.

An examination of the economics of power plant operation reveals why the expected retirement of old coal-fired power plants has not occurred. While natural gas-fired plants are much cheaper to build and only slightly more expensive to operate and maintain, older coal-fired plants have no capital costs at all because they have been fully amortized.[45] Also, an unexpectedly low price and easy availability of

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37. Tina Kaarsberg et al., *The Clean Air-Innovative Technology Link: Enhancing Efficiency in the Electric Industry*, NORTHEAST-MIDWEST INST. 65 (1999), *available at* http://www.nemw.org/energy_linx.htm (last visited Feb. 12, 2001).

38. Biewald et al., *supra* note 29, at 2.

39. *Id.*

40. Clean Air Act § 111(f), 42 U.S.C. § 7411(f) (1994).

41. Biewald et al., *supra* note 29, at 2.

42. Clean Air Act § 403(b), 42 U.S.C. § 7651b(b).

43. Kaarsberg et al., *supra* note 37, at 65.

44. These seven units total only 1.5% of the total plant capacity that was originally included in the Acid Rain Program. An additional number of generally smaller substitution units were also retired. EPA, 1998 COMPLIANCE REPORT: ACID RAIN PROGRAM, EPA-430-R-99-010 at 11, app. B-3 (1999).

45. For a general cost comparison, see Palmer, *supra* note 5.

low-sulfur coal,[46] as well as some surprising advances in SO_2 emissions control technology[47] and a variety of subsidies available to firms with coal-fired power plants[48] have all kept operating costs low for electricity generation firms, and given them good reason to keep running their old coal-fired power plants. While the per-kWh capital and operating costs of natural gas-fired plants have been as low as 3¢/kWh, the operating cost of old coal-fired power plants is estimated to be, on average, a paltry 2.1¢/kWh.[49] This cost advantage has tilted the playing field in coal's favor.

Congressional bills have been introduced that would remove the grandfathered status of coal-fired power plants and require them to meet New Source Review standards, as well as bills that would introduce cap-and-trade programs to cover emittants other than SO_2.[50] These bills have withered in the face of opposition from electricity generation firms that had just gotten used to the SO_2 cap-and-trade program. The

46. The coincidence of unexpectedly low rail shipping rates brought on by railroad deregulation and the unexpectedly low cost of mining low sulfur coal in Wyoming has led many electricity generation firms to abandon plans to install emissions control technology, and instead to simply reduce emissions by utilizing the low sulfur Wyoming coal. Swift I, *supra* note 6, at 23.

47. SO_2 emissions are dramatically reduced by the use of a technology known as "flue gas desulfurization," which involves a chemical reaction forced on the emissions of the power plant. This chemical reaction removes the SO_2 from the resulting emissions. These large and expensive devices are also known as "scrubbers." While innovation in this area was stagnant for a number of years, recent improvements in scrubber technology have made scrubber installation almost as inexpensive as the use of low-sulfur coal. A. DENNY ELLERMAN ET AL., MARKETS FOR CLEAN AIR: THE U.S. ACID RAIN PROGRAM 7, 241-42 (2000).

48. For example, § 415 of the Clean Air Act (42 U.S.C. § 7651n) provides for federal funding for demonstration projects involving the use of coal-fired power plants that achieve substantial emissions reductions through scrubber technology. Also, § 404(a)(2) of the 1990 Clean Air Act (42 U.S.C. § 7651c(a)(2)) provides an extra 3.5 million SO_2 emission allowances to firms with coal-fired power plants that install new emissions control technology.

49. Biewald et al., *supra* note 29, at 24.

50. For example, S. 2636, introduced in October 1998 by Sen. Leahy (D-VT) would have required existing generating units to meet New Source Review within ten years, as well as meet other emissions and efficiency standards for NO_x, CO_2, and mercury. S. 2636 105th Cong. (1998). H.R. 2980, introduced in October 1999 by Rep. Allen (D-ME) and S. 2610, introduced in October 1998 by Sen. Lieberman (D-CT) would also have required grandfathered generating units to meet New Source Review. H.R. 2980 105th Cong. (1997); S. 2610 105th Cong. (1998). The bills that have sought to introduce cap-and-trade programs for CO_2, NO_x, and mercury include S. 172, introduced by Sen. Moynihan (D-NY) in January 1999, and S. 1369, introduced by Sen. Jeffords (R-VT) in July 1999. S. 172 106th Cong. (1999); S. 1369 106th Cong. (1999). Also, H.R. 25 introduced in January 1999 by Rep. Boehlert (R-NY) would have implemented a NOx cap-and-trade program similar to S. 172, as would H.R. 2909, introduced November 1997 by Rep. Pallone (D-NJ). H.R. 25 106th Cong. (1999); H.R. 2909 105th Cong. (1997). Some states have attempted to force grandfathered power plants to meet more stringent regulations. For example, a structuring law passed in Texas requires grandfathered power plants built before 1971 to reduce NO_x emissions by 50% and SO_2 emissions by 25%. TEX. UTIL. CODE ANN. § 39.264 (Vernon 1999).

Environmental Protection Agency has thus launched a legal offensive, suing electricity generation firms with coal-fired plants and alleging that these plants underwent such substantial modifications that they should be subject to New Source Review, the stringent emissions standards applicable to new plants.[51] The suits have resulted in three settlements already, and may draw in others.[52] There is some instability in the legal climate in which electricity generation firms operate coal-fired power plants, but economic considerations still point to their continued operation.

C. *The Failure to Develop Renewable Energy Sources*

It has been less surprising that renewable energy technologies have failed to take root except in specialized applications. The renewable energy industry received a boost in the 1970s during the energy crisis, but mostly because renewables were a means of increasing energy supply, not because they were a way of reducing emissions of pollutants or greenhouse gases.[53] As oil prices plummeted, so did the viability of renewable energy technologies, and interest in curbing emissions from the electricity generation industry was crushed under the weight of economic realities.

Nevertheless, significant technological progress has resulted in lower production costs for the five major nonhydroelectric renewable energy technologies: wind, solar photovoltaic, solar thermal,

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51. The EPA originally filed suit on November 3, 1999, against seven electric utilities owning seventeen coal-fired plants in the Midwest and the South that EPA argues should be subject to New Source Review. Najor I, *supra* note 35, at 1269. The suit was later joined by several northeastern states that have long been in favor of curbing emissions at these midwestern and southern plants, arguing that these utilities have been exporting their air pollution into the northeast region. *New Jersey Joins Suit Against Power Plants for Transported Pollution*, 30 ENV'T REP. 1446, 1446 (1999). The EPA's theory is that over the years, coal-fired power plants undertook so many modifications to their operations that they have in effect been equivalent to a new reconstruction of a power plant. Under section 111 of the Clean Air Act, new sources as well as sources that have been subject to modifications are subject to New Source Review. 42 U.S.C. § 7411(b) (1994).

52. The three firms that have settled with the EPA are Tampa Electric Company, Virginia Electric Power Company, and Cinergy Corporation. Tampa Electric Company reached settlement on February 29, 2000, agreeing to install emissions controls and phase in a conversion of their plants to natural gas-fired. Pamela Najor, *EPA Settles with One of Seven Utilities Sued for New Source Review Violations*, 31 ENV'T REP. 375, 375 (2000). Virginia Electric Power Company reached settlement in principle in November 2000. Brian Broderick, *Ohio-Based Utility to Reduce Emissions at 10 Coal-Fired Plants in Air Act Settlement*, 32 ENV'T REP. 10, 11 (2001). The Ohio electric generating firm Cinergy Corp. also settled with the EPA, agreeing to spend $1.4 billion to reduce emissions at ten of its plants. *Id.* at 10.

53. McVeigh et al., *supra* note 1, at 2.

geothermal, and biomass.[54] While the declines in production costs have met and even exceeded expectations,[55] the costs of electricity generation from these technologies are still higher than the cost of new coal and natural gas-fired technologies.[56] The current trend towards a deregulated market and an increased emphasis on low-cost production may further hamper development of renewable energy technologies.[57] Given the right market conditions, deregulation could present an opportunity to market renewable energy directly to consumers, especially in light of the recent skyrocketing natural gas prices in California.[58] Decisive policy actions are needed, however, to ensure that the renewable energy industries can survive the energy industry shakeout. A complete loss of the renewable energy industry would strike a crippling blow to development of a long-term energy strategy.

Table 1 below provides some summary statistics for five major nonhydroelectric renewable energy technologies in the United States, and shows that with one exception, all of the renewable energy technologies have drawn to within striking range of becoming competitive with fossil fuels.

TABLE 1. COMPARISON OF RENEWABLE ENERGY TECHNOLOGIES[59]

	Biomass	Geothermal	Wind	Solar Thermal	Solar Photovoltaic
Capacity (MW)	4,250	2,890	1,990	330	89
Energy produced (billion kWh)	53.1	14.7	3.0	0.89	0.01
1998 Production cost (¢/kWh)	7	5-8	4.5-6.5	8	27

54. *Id.* (analyzing the production and costs of each of the five renewables). This Article will not address the potential of fuel cells, another highly promising energy technology. Fuel cells are devices that convert hydrogen directly into electricity without combustion and thus also achieve zero emissions. For a general discussion of this and other technologies, see John DeCicco et al., *Energy Innovations: A Prosperous Path to a Clean Environment Executive Summary* (1997), *available at* http://www.tellus.org/ei/eiexec.html (summarizing study sponsored by Alliance to Save Energy, American Council for an Energy-Efficient Economy, Natural Resources Defense Council, Tellus Institute, and Union of Concerned Scientists).

55. *Id.*; *see also* Kaarsberg et al., *supra* note 37, at 12.

56. McVeigh et al., *supra* note 1, at 2.

57. Palmer, *supra* note 5, at 9.

58. *Mazur Testimony*, *supra* note 20, at 1.

59. All figures are for 1998. ENERGY EFFICIENCY AND RENEWABLE ENERGY NETWORK, U.S. DEP'T OF ENERGY, GEOTHERMAL ENERGY PROGRAM, http://www.eren.doe.gov/geothermal. geoelectprod.html (last visited Feb. 12, 2001); AER1999, *supra* note 33, at 213, tbl. 8.2; McVeigh et al., *supra* note 1, at 5. *See generally* Frank Muller, *Tax Credits and the Development of Renewable Energy in California*, *in* GREEN BUDGET REFORM: AN INTERNATIONAL CASEBOOK OF LEADING PRACTICES (1995) (discussing the generation of renewable electricity).

Biomass energy production, which involves the burning of organic or waste material to create pressure to drive turbines, is currently the most productive renewable energy source, largely because of its twenty-four-hour availability (as opposed to intermittent wind and solar resources) and its ability to co-fire with conventional fuels.[60] Geothermal energy may be the most mature of the renewable energy technologies, but this also means that this industry may have less upside in terms of potential for innovation.[61] Wind energy is currently the least expensive and may ultimately prove to be the most promising renewable energy source, as it has been estimated that the Central Plains states contain sufficient wind resources to meet total U.S. energy demand several times over.[62] Wind energy is also promising because wind turbines can share land dedicated to agriculture, a dominant land use in the wind-rich Central Plains states.[63] Solar thermal energy, which uses sunlight to heat water and create steam to drive a turbine, was surprisingly successful in its only large-scale experience, steadily achieving production cost decreases.[64] Solar photovoltaic, which uses sunlight to stimulate an electrical current in a semiconductor device, remains considerably more expensive than other renewable energy technologies,[65] but may still offer greater potential. A substantial amount of research and development would be needed to make solar photovoltaic energy competitive.

Wind, geothermal and solar thermal power can only be exploited in certain types of locations, but may be quite competitive with fossil fuels, and may be able to achieve parity with fossil fuels with a relatively modest subsidy. The same can be said for biomass, which does not have locational limitations. For solar photovoltaic energy, it is clear that even substantial additional subsidization will not do the trick. Developing solar photovoltaic energy is a long-term project that requires stronger and longer-term governmental intervention. With the exception of solar photovoltaic, however, all of these renewable energy technologies may

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60. McVeigh et al., *supra* note 1, at 13.

61. Future price projections for geothermal energy operations indicate that future project prices will range from 4¢ to 5.5¢/kWh, still above the competitive range of current conventional fuel sources. *Id.*

62. Muller, *supra* note 59, at 36.

63. John R. Dunlop, *Wind Clusters: Expanding the Market Appeal of Wind Energy Systems*, ISSUE BRIEF NO. 4 (1996), http://www.repp.org.

64. A California entrepreneur developed a solar thermal plant over the course of ten years, achieving lower production costs with each new module, until the production cost reached 8¢/kWh. Muller, *supra* note 59, at 50.

65. Kaarsberg et al., *supra* note 37, at 37.

be competitive with fossil fuels, as the estimated future costs of electricity production using fossil fuels is expected to be over 4¢/kWh.[66]

The short history of renewable energy development in the United States augurs well for a subsidy program to stimulate research and development of renewables. California, with its oil-fired power plants in the 1970s, absorbed one of the hardest hits among the U.S. states during the energy crisis, and thus took the lead in promoting renewable energy technology development.[67] California adopted a 25% investment tax credit for the costs of capital equipment for capital-intensive solar energy systems and wind-powered systems.[68] California also adopted a property tax exemption for solar facilities, again aimed at defraying the expensive front end-loaded capital expenditures.[69] To encourage development of wind power, the California Energy Commission even took the step of mapping out wind resources throughout the state, to aid in siting decisions.[70]

The result of this state-funded support, and of substantial federal tax credits, was a dramatic increase in the development of solar and wind power in California. Between 1983 and 1992, wind energy production increased from 52 million kWh to 2707 million kWh.[71] Solar energy production increased from 2 million kWh to 700 million kWh.[72] In that same time period, nonhydroelectric renewable energy supply in California increased overall from approximately eight gigawatt-hours to more than twenty-five gigawatt-hours, or 11% of all 1992 electricity supply in California.[73] Yet, just as regulatory uncertainty has led to a shortage of electricity generation in California, uncertainty with respect to the continuation of subsidies has stalled development of renewable energy technologies. California's present energy shortage is thus doubly regrettable, but with Californians still desperately in search of additional capacity, this moment in history may represent a unique opportunity to ramp up renewable energy development once again. It is thus particularly short-sighted for the current administration to pursue an energy strategy that flatly rejects renewable energy technologies.

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66. It has been estimated that the average costs of producing electricity using advanced coal-fired and natural gas-fired technology will be 4.32¢/kWh and 4.16¢/kWh, respectively. AEO2001, *supra* note 21, at 75.

67. *See* Muller, *supra* note 59, at 31, 38.

68. *Id.* at 33.

69. *Id.* at 41.

70. The California experience with subsidies and renewable energy is chronicled in Muller, *supra* note 59.

71. *Id.* at 47.

72. *Id.*

73. *Id.* at 49.

Other nations have reaped benefits from investing in development of renewable energy technologies. For example, Denmark has been rewarded for earmarking 10% of its energy research budget for wind energy, with 1830 gigawatt-hours of wind-generated electricity, accounting for approximately 4.6% of Denmark's total energy supply in 1998.[74] Denmark's investments are illustrative. In addition to a 30% capital investment subsidy, wind energy was aided both by a governmental effort to ensure that electricity produced by wind turbines could be distributed on the national energy grid, and by establishment of a central test station for wind turbines as a condition to grid connection.[75] These investments have removed some of the nonfinancial barriers to adoption of wind energy and stimulated its development. In addition to meeting a high percentage of its energy needs by windpower, Denmark has established itself as a global leader in windpower technology, accounting for 58.5% of 1997 global windpower sales.[76]

Current U.S. law provides some modest subsidies for the development and deployment of renewable energy technologies. Some states offer investment tax credits (against state income tax liability), sales and use tax exemptions, franchise tax exemptions, or reduced property tax valuation.[77] At the federal level, wind and solar facilities can be depreciated over an accelerated five-year schedule.[78] The Acid Rain Program allocates some SO_2 emissions allowances to electricity generating firms that adopt energy conservation measures or renewable energy technologies, which are awarded on the basis of the amount of emissions avoided.[79] The Public Utility Regulatory Policies Act of 1978 (PURPA) requires electric utilities to purchase energy produced by renewable energy sources at the utilities' cost of production.[80] Although the actual cost of producing electricity using renewable energy sources is

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74. U.S. ENERGY INFO. ADMIN., U.S. DEP'T OF ENERGY, COUNTRY ENERGY DATA REPORT—DENMARK, *at* http://www.eia.doe.gov/emeu/world/country/cntry_DA.html (last visited Jan. 11, 2001). The database shows that overall 1998 energy production for Denmark was 0.8310 quadrillion Btu, and "geothermal and other [energy sources]" accounted for 0.0381 quadrillion Btu. *Id.*

75. Moore & Ihle, *supra* note 24, at 8.

76. *Id.*

77. J. Andrew Hoerner, *Harnessing the Tax Code for Environmental Protection: A Survey of State Initiatives*, CTR. FOR A SUSTAINABLE ECON., at 1 (1998), *available at* http://www.me3.org/projects/greentax/index.html (last visited January 11, 2001). Most recently, the North Dakota Senate approved measures to provide use tax and property tax relief to wind turbines and an investment tax credit for wind, geothermal and solar energy facilities constructed in the state. *North Dakota: Bills to Encourage Wind Power Farms by Changing Tax Law Signed by Governor*, DAILY ENVT. REP., Mar. 30, 2001, at A7, *available at* WL 62 DEN A-7, 2001.

78. 26 U.S.C. § 168(e)(3)(B)(vi) (1994).

79. Clean Air Act § 404(f), 42 U.S.C. § 7651c(f) (1994).

80. PURPA § 210, 6 U.S.C. § 824a-3 (1994).

typically higher, this provision at least provides some assurance against a complete loss. The 1992 Energy Policy Act[81] enacted a per-unit production tax credit of 1.5¢/kWh for wind and "closed-loop" biomass energy, which was recently extended to 2002.[82] The Energy Policy Act also made permanent a ten percent investment tax credit for solar and geothermal energy.[83] Significantly and unfortunately, this investment tax credit is not available to "public utility property,"[84] excluding many firms in the electricity generation industry. This prohibition has no doubt contributed to the hostility of the electricity generating industry towards renewable energy technologies, and should be repealed.

Except for California's initiatives in the 1970s and 1980s, efforts to stimulate development of renewable energy technology in the United States have been too modest. In 1999, nonhydroelectric renewable energy accounted for 82.9 billion kWh of electricity generation, a mere 2.2% of total energy produced in the United States.[85] A long-term energy policy cannot be so feckless. Fortunately, with the production cost gap between renewables and fossil-fueled electricity generation so narrow, relief may not be prohibitively expensive.

III. THE CASE FOR A CAP-AND-TRADE PROGRAM COUPLED WITH A SUBSIDY PROGRAM

A. *Subsidies*

Subsidies can serve dual purposes: to induce the retirement of coal-fired power plants and to stimulate development of, and investment in, renewable energy technologies.[86] These goals are, of course, related.

81. Energy Policy Act of 1992, 42 U.S.C. § 13201 (1994).

82. Tax Relief Extension Act of 1999, Pub. L. No. 106-170, 113 Stat. 1860 § 507(a)(3) (1999) (codified as amended in scattered sections of 26 U.S.C.).

83. 26 U.S.C. § 46 (1994) (referencing 26 U.S.C. § 48(a)(3)(A)(i) (1994)).

84. 26 U.S.C. § 48(a)(3)(D).

85. AER 1999, *supra* note 33, at 213, tbl. 8.2.

86. The following is a list of subsidies that may be used to promote cleaner energy production. The list is not meant to be exhaustive, but is illustrative of the kinds of approaches that are commonly used to subsidize certain activities. There are many additional tools that might be available to promote cleaner energy production, especially at the state and local level, such as property tax exemptions and sales tax exemptions.

> *Investment tax credits*. Investment tax credits are credits against income tax liability based upon the amount of investment made by the firm or individual, and typically amount to some fraction of the cost of the qualifying equipment or facilities, up to a limit.
>
> *Production tax credits*. Production tax credits are also credits against tax liability, but are typically based upon the energy produced by a renewable energy production facility. This typically takes the form of a per-kilowatt-hour monetary amount.
>
> *Accelerated depreciation*. Capital expenditures are usually deducted from income over the useful life of the asset, but some jurisdictions allow a larger deduction over fewer

While the retirement of most coal-fired capacity will be replaced by natural gas, a subsidy must encourage the replacement of some of that capacity with renewable energy.

As policy instruments to address pollution externalities, subsidies have never been as popular with economists as emission taxes.[87] Although a per-unit production subsidy is the mirror image of an emission tax,[88] economists have disfavored subsidies because they are harder to implement than taxes.[89] A second reason that subsidies are disfavored vis-à-vis emission taxes is that once a subsidy is in place, it becomes politically difficult to remove. A sense of entitlement seems to grip those that receive a subsidy, who thereafter vigorously resist any

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years for capital expenditures made on renewable energy or cleaner energy technologies. This has the effect of deferring tax liability for the investor and encouraging investment.

Funding for research and development. Governmental agencies commonly solicit research proposals to pursue research projects to further some goals of the agency.

Grants. Outright grants of money may be given to assist in the construction of clean-fuel or renewable energy source electric generating equipment, for construction of emissions reduction equipment, or for retirement of higher-emitting facilities.

Tax exemptions. Just as capital gains from municipal bonds are often tax exempt, capital gains from specified energy investments can be tax-exempt, helping to attract individual investors.

Government-provided below-market financing. Governmental agencies may act as lender, providing favorable credit terms for specified energy investments. Governmental agencies may also act as guarantor of certain investments, as some do for student loans.

Government acquisition. Governmental agencies may also act as buyer for energy produced from certain clean energy technologies. Such agencies may offer to buy energy produced under certain environmental or energy-efficiency conditions, thereby providing a guaranteed market for some clean energy production technologies.

87. *See, e.g.*, Chris Edwards et al., *Cool Code: Federal Tax Incentives to Mitigate Global Warming*, 51 NAT'L TAX J. 465 (1998) (stating that subsidies are inherently less efficient than taxes).

88. WILLIAM BAUMOL & WALLACE OATES, THE THEORY OF ENVIRONMENTAL POLICY 214-15 (3d ed. 1996).

89. It is more difficult to identify situations where a subsidy is appropriate than it is to identify situations where a tax is appropriate. A subsidy seeks to promote some activity that is viewed as being beneficial, while a tax seeks to curtail some activity that is viewed as being harmful. As some past experiences with hydroelectric power have shown, the latter is far easier to do, as there is often no way of knowing if a subsidy is targeting the most cost-effective means of achieving a policy goal. Taxing a harmful activity is more straightforward, as it requires a judgment that some activity, even if useful and productive to society, nevertheless imposes some cost to society. Extensive economic literature has discussed the possibility that an emission tax produces not only environmental benefits, but may also reduce the effects of other distortionary taxes, thereby producing a "double dividend." For a survey and discussion of the literature on double dividends, see generally Lawrence H. Goulder, *Effects of Carbon Taxes in an Economy with Prior Tax Distortions: An Intertemporal Equilibrium Analysis*, 29 J. ENVTL. ECON. & MGMT. 271 (1995) and Wallace E. Oates, *Green Taxes: Can We Protect the Environment and Improve the Tax System at the Same Time?*, 61 S. ECON. J. 914 (1995) (posing the idea that pollution taxes may exacerbate distortions, rather than relieve them, thereby producing no double dividend).

attempt to terminate it.[90] A third reason that subsidies are disfavored is that budgetary constraints necessarily limit the effectiveness of any subsidy program. Widespread achievement of a policy goal would probably require that many avail themselves of the subsidy; this would necessarily be costly.[91] Finally, some may object that giving a subsidy to electricity generation firms to induce them to retire coal-fired power plants constitutes a bribe to keep regulated parties from polluting.[92] What next? Shall we allow bank robbers to extort from us in exchange for a promise not to rob? Objections to subsidy programs on such grounds have proven difficult to quell.

The present energy situation may just be unique enough, however, to warrant the use of this ugly policy instrument. In the capital-intensive electricity generation industry, the issue of stranded costs (or what are argued to be stranded costs) must be confronted head-on. The industry has successfully resisted what might be considered first-best approaches to changing the incentives facing electric generation firms—cap-and-trade programs and emissions taxes.[93] There is a property rights

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90. Farm subsidies provide one compelling example of a costly subsidy program that has taken on a life of its own. Permits to graze cattle on federal lands at below-market prices are also a subsidy program that has given rise to a sense of entitlement on the part of recipients.

91. Some of these points are made by Edwards et al., *supra* note 87, at 465.

92. Professor Demsetz's article on liability rules in the context of Coasian bargaining is considered one of the most important articles in the field of law and economics, and is one of the first discussions on the effects of a change in the liability rule governing an externality situation. When a change in a liability rule gives rise to a wealth redistribution, there is a temptation to see a vindication of a right in the form of a payment as "extortion." It is erroneous from an economic standpoint to couch this behavior in such normative terms, since Coase's theorem holds that the parties will still reach an economically efficient bargain. Similarly, in this situation, a demand that society pay electric generation firms to retire their coal-fired plants may seem extortionary, but it is really an exercise of their right to continue to operate the plant. In theory, society will not pay the electricity generation industry any more than is worthwhile to retire the coal-fired plants. The fact that society may pay the industry more than is necessary does not mean that it is a bad exchange. Harold Demsetz, *When Does the Rule of Liability Matter?*, 1 J. LEGAL STUD. 13 (1972) (arguing that the imposition of liability is the key: if liability can be avoided by one party, that party has no incentive to cease the costly behavior).

93. The classical solution proposed by economists to the problem of air pollution is to levy a tax on pollution. For economists, pollution is a problem because there is a divergence between the price signals faced by the polluting firm and the actual costs of pollution to a larger society affected by it. The polluting firm does not face these costs, and thus imposes an "externality" upon society. An externality is an effect of a decision, on a party other than the decision-maker, that is not taken into account by the decision-maker. The solution is to internalize the externality and force the decision-maker, or polluter, to face the costs that are faced by society, and to levy a per-unit of pollutant tax upon the polluter. The amount of the tax is the difference between the price faced by the polluter and the actual cost to society, i.e., the extent of divergence between the private and social cost of pollution. This scheme was first proposed by the French economist Alfred Pigou, and is therefore commonly referred to as a Pigouvian tax. For a more detailed discussion of this theory, see Baumol & Oates, *supra* note 88, at 21-23. This Pigouvian emission tax is very closely related to a cap-and-trade program; both seek to place a specific cost on the emission of a specified unit of a pollutant, with theoretically the same effects.

controversy over the taxpaying and air-breathing public's right to demand that firms in the electricity generation industry give up their higher-polluting capital assets and invest in cleaner ones. The electricity generation industry argues that they are engaged in a lawful business complying with existing environmental regulations, and that new regulations would be unfair in singling them out.[94] On the other hand, while the industry has successfully fended off legislative challenges to their ability to operate coal-fired power plants, their legal ground is somewhat shakier in light of the EPA lawsuits challenging their grandfathered status: it could be that electricity generation firms with coal-fired power plants that have undergone major modifications are *not* engaged in a lawful business. Also, the EPA recently announced plans to regulate mercury emissions.[95] Forcing coal-fired power plants to control mercury emissions may represent a strong financial incentive to retire those plants, since controlling for mercury emissions is very costly. This may induce switching to natural gas as a fuel source, which does not result in mercury emissions.

In such a volatile legal and political climate, a negotiated package of subsidies and a cap-and-trade program offers a concrete, if imperfect, vehicle for solving a surprisingly difficult problem. Such a package represents in effect a settlement agreement between government and industry over industry's contested right to emit high levels of pollutants and greenhouse gases from coal-fired power plants. While this cedes legal ground to electricity generation firms with coal-fired plants, precious time has already been lost in the political stalemate that has gripped Capitol Hill for the past six years. Moreover, all economic indications are that an expensive but affordable financial push can induce a substantial retirement of coal-fired power plants.[96] With the production cost gap at less than a penny per kilowatt-hour, it is entirely possible that the cessation of operation of many coal-fired plants can be had for a less than princely sum.

Importantly, the general disadvantages of subsidies discussed above would not be as acute in this setting as they would be generally. First,

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The difference is only that of who pays for the emissions reductions—in the case of an emission tax, polluters pay and taxpayers benefit, and in the case of a cap-and-trade program, there is revenue neutrality. While there has been strong resistance to cap-and-trade programs, hostility towards taxes in the United States has for the time being ruled out virtually any kind of a Pigouvian tax, no matter what economists may say. *See* Frank S. Arnold, *Why There Are No Pollution Taxes*, 15(2) ENVTL. F. 14, 14 (Mar./Apr. 1998).

94. Najor I, *supra* note 35, at 1269.

95. EPA, REGULATORY FINDING ON THE EMISSIONS OF HAZARDOUS AIR POLLUTANTS FROM ELECTRIC UTILITY STEAM GENERATING UNITS, 65 Fed. Reg. 79,825, 79,830 (Dec. 20, 2000).

96. Biewald et al., *supra* note 29, at 2.

the task of identifying desirable and harmful activities has already been accomplished. As discussed above, the high levels of emissions of coal-fired power plants make it imperative that the retirement of these plants be effected as soon as possible. Second, because there is a finite number of coal-fired power plants, there is no danger that this subsidy will become entrenched and perpetuate itself indefinitely, as farm subsidies and cattle grazing subsidies have. Third, the limited number of coal-fired power plants renders this policy objective a one-shot deal, and the price tag therefore finite. Finally, the moral implications of a subsidy proposal may be troubling to some, but repeated failures to change the legal climate for electricity generation firms with coal-fired plants are revealing. The inability of reform-minded members of Congress to push through their proposals to remove the grandfathered status of coal-fired power plants indicates that moral judgments on the inappropriateness of coal as a fuel source are unlikely to be vindicated in Congress.[97]

It is also important to increase and better tailor subsidies for the development of renewable energy resources. The ten percent investment tax credit that is available to solar and geothermal developers provides up-front benefits and stimulates investment in riskier and more speculative technologies that require refinement through pilot projects.[98] This seems appropriate for the still-nascent solar photovoltaic industry, but not for the nearly competitive solar thermal and geothermal industries. These industries would benefit from a production tax credit, which are helpful for projects that are more reliable and proven and can be assured of smooth operation for a long time. Investment tax credits for well-developed technologies like windpower may even have the perverse effect of stimulating construction of poorly designed wind turbines that were built mostly as tax shelters and not designed to produce electricity for a sustained period.[99] Also, tax credits must be for a sufficiently long term to provide certainty for investors, but have a certain endpoint so as to avoid the creation of an entitlement.

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97. Najor I, *supra* note 35, at 1269.

98. Muller, *supra* note 59, at 41, 43.

99. This is cited by Muller as one reason for why the California investment tax credit for wind energy was terminated. In the wake of some unsuccessful wind energy enterprises, political opposition to the tax credits resulted in repeal of the credit. Muller, *supra* note 59, at 51-52; *see also* LOUISE GUEY-LEE, U.S. ENERGY INFO. ADMIN., U.S. DEP'T OF ENERGY, WIND ENERGY DEVELOPMENTS: INCENTIVES IN SELECTED COUNTRIES, *at* http://www.eia.doe.gov/cneaf/solar.renewables/rea_issues/windart.html (last visited Jan. 11, 2001).

B. Cap-and-Trade

The second aspect of the present proposal, a cap-and-trade program, has fewer varieties. Genuine cap-and-trade programs place an absolute limit on total emissions of a given pollutant in a jurisdiction, and allow emitting firms within that jurisdiction to trade emissions allowances amongst themselves, as well as with potential third-party traders.[100] Each allowance is a license to emit a fixed quantity of the pollutant, and may be exercised at any time.[101] In such a program, emitting more pollution than permitted by the allowances would be punishable by a fine that must be much larger than the price at which allowances are traded. This is to be distinguished from the vast majority of air pollution regulations, which are considered "command and control" regulations, and which are more prescriptive. Command and control regulations may require the installation of certain pollution control equipment, or that pollution control equipment be of a minimum quality. One typical command and control type of regulation is a rate standard, where a limit is imposed upon the *rate* at which pollutants are emitted, but not the total *amount* of pollutants emitted.[102] These types of regulations provide the emotional satisfaction of forcing polluters to do their best with what they have, but unlike a cap-and-trade program, they guarantee nothing with respect to the total amount of pollution that is permitted to enter the environment.

Economists have argued for the use of cap-and-trade programs for decades to little avail,[103] as genuine cap-and-trade programs have remained rare. Earlier experiments with trading mechanisms, such as the United States Environmental Protection Agency's "bubble" program,[104] have been modest, covering only a single emitting facility. The bubble policy allowed an emitting facility to combine its allowed emissions from all its smokestacks and treat it as a single source of emissions.[105] Thus, rather than having to meet smokestack-by-smokestack emissions limits, a facility could increase emissions at one smokestack if it decreased emissions at another. Such a program is not strictly a cap-and-

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100. Robert W. Hahn & Gordon L. Hester, *Marketable Permits: Lessons for Theory and Practice*, 16 ECOLOGY L.Q. 361, 369 (1989).

101. *Id.*

102. Swift I, *supra* note 6, at 18.

103. *See, e.g.*, Hahn & Hester, *supra* note 100 (discussing generally the marketability and economy of emissions trading programs); *see also* Daniel J. Dudek & John Palmisano, *Emissions Trading: Why Is This Thoroughbred Hobbled?*, 13 COLUM. J. ENVTL. L. 217 (1988) (outlining the successes of emissions trading).

104. EMISSIONS TRADING POLICY STATEMENT; GENERAL PRINCIPLES FOR CREATION, BANKING AND USE OF EMISSION REDUCTION CREDITS, 51 Fed. Reg. 43,814, 43,814 (Dec. 4, 1986); *see also* Hahn & Hester, *supra* note 100 (explaining the concept of the bubble program).

105. Hahn & Hester, *supra* note 100, at 372.

trade program because there is no overall cap, or limit on the volume or weight of pollutant emitted.

A closer imitation of a cap-and-trade program is the Regional Clean Air Incentives Market, or "RECLAIM" program, administered by the South Coast Air Quality Management District (SCAQMD), the district with the weighty responsibility of improving air quality in the Los Angeles basin.[106] The RECLAIM program is a credit trading program that provides for trading of NO_x and SO_2 emissions reduction credits among a wide variety of emitters.[107] The RECLAIM program is also not strictly a cap-and-trade program because the variety of emissions sources have different capacities to emit pollutants, so there is no explicit cap on emissions. Instead, there are mandated emissions reductions which vary for different sources and are measured against some baseline emissions level.[108] Emissions reductions will earn the emitter an emissions reduction credit, which has a value on the RECLAIM market. That value is determined by the willingness to pay by emitters that find it too costly to achieve a mandated emissions reduction.

The only nationwide experience with cap-and-trade programs is a program of SO_2 emissions trading under the Acid Rain Program of the 1990 Clean Air Act Amendments, under which electricity generation plants may trade allowances to emit a ton of SO_2 in conjunction with the production of electricity.[109] The two-phased SO_2 cap-and-trade program under the Acid Rain Program has been considered a reasonable success,[110] even if the emissions cap may have been set at too high a level.[111] By placing a direct and specific market value on SO_2 emissions

106. *See generally* South Coast Air Quality Management District Website, http://www.aqmd.gov (last visited Jan. 11, 2001). The rules governing the RECLAIM program are available at http://www.aqmd.gov/rules/html/tofc20.html (last visited Jan. 11, 2001).

107. *See id.*

108. *Id.*

109. Swift I, *supra* note 6, at 19.

110. *See id.*; Dallas Burtraw, *Cost Savings, Market Performance, and Economic Benefits of the U.S. Acid Rain Program*, DISCUSSION PAPER 98-28-REV, at 15 (revised Sept. 1998), *available at* http://www.rff.org/disc_papers/PDF_files/9828rev.pdf.; Carlson et al., *supra* note 16, at 90-92.

111. The emissions cap was set at 5.7 billion tons for "Phase I" of the Acid Rain Program, which occurred between 1995 and 2000, but only covered 110 of the dirtiest plants in the United States. By 2010, "Phase II" will require that all electricity generation plants in the United States meet an annual cap of 8.95 tons per year. Swift I, *supra* note 6, at 19. The fact that only seven out of 263 power plants regulated under Phase I have been retired is a clear disappointment to environmental policymakers. As noted by Chestnut, *supra* note 16, tbls. S-2 to S-3, the health benefits alone of the Acid Rain Program have been estimated in the range of $12 to $78 billion in the United States, and $290 million to $1.8 billion in affected areas of Canada. This does not include ecological and recreational benefits. And as noted above, compliance costs were estimated to be $832 million in 1995 and $1.04 billion in the long run (because of a more stringent cap). Carlson et al., *supra* note 16, at 66, 87. This has been a far cry from the $4 billion

reduction, SO_2 emissions trading introduced competition among the different industries, offering a way of reducing SO_2 emissions.[112] Competition has stimulated innovation in the emission control equipment industry, induced enterprising experimentation with different emissions control techniques, and achieved a general savings in abatement costs in the electricity generation industry.[113] Compliance costs have been much lower than expected, exceeding the most optimistic estimates of cost savings, as allowances seem to have flowed to those plants for which abatement would be most expensive.[114] Perhaps most importantly, nationwide SO_2 emissions have declined since the onset of the program.[115] The most important lesson learned from a comparison of rate standards and a cap-and-trade program is that reductions in emissions of a particular pollutant are achieved *only* when a direct and specific cost is placed on the emission of that pollutant.[116]

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compliance cost estimate made by the EPA in 1990, and the $2 billion estimate made by the United States General Accounting Office in 1994, and suggests that further SO_2 emissions reductions thus far would pass any cost-benefit test. Legislative attempts to lower the SO_2 emissions cap have been unsuccessful. S. 172, *supra* note 50, would have tightened the SO_2 emissions cap and introduced a cap-and-trade program for NO_x emissions. S. 1369, *supra* note 50, would have imposed a nationwide cap on emissions of NO_x, CO_2, and mercury, and would have reduced the SO_2 cap provided for by the 1990 Clean Air Amendments Acid Rain Program by 60%. Other proposals to tighten emissions regulations or to introduce or tighten caps have also been defeated or scuttled. In the meantime, studies indicate that Acid Rain is still a persistent problem in Northeastern states. C.T. DRISCOLL ET. AL., HUBBARD BROOK RESEARCH FOUND., ACID RAIN REVISITED: ADVANCES IN SCIENTIFIC UNDERSTANDING SINCE THE PASSAGE OF THE 1970 AND 1990 CLEAN AIR ACT AMENDMENTS 6 (2001) (Science Links Publication, Volume. 1, no. 1), *available at* http://www.hbrook.sr.unh.edu/hbfound/report.pdf.

112. *See* Dallas Burtraw, *Innovation Under the Tradable Sulfur Dioxide Emission Permits Program in the U.S. Electricity Sector* 17 DISCUSSION PAPER 00-38 (Sept. 2000), *available at* http://www.rff.org/disc_papers/PDF_files/0038.pdf.

113. For example, electricity generation firms discovered that one way of reducing SO_2 emissions was to purchase low-sulfur coal mined in the Powder River Basin in Wyoming, and have it freighted via a deregulated and surprisingly inexpensive rail industry. Swift I, *supra* note 6, at 23. Electricity generation firms also experimented with mixing low- and higher-sulfur coal to create an optimal mix of low emissions and lower-priced coal. *Id.* The very presence of these alternatives may have been partly responsible for stimulating firms in the scrubber industry to improve their product. *Id.* Also, electricity generation firms found ways to use a byproduct of scrubbers to make commercial-grade gypsum to defray the expenses of installing and operating the scrubbers. *Id.*

114. *Id.*

115. EPA, EMISSION SCORECARD 1999, fig. 1, *at* http://www.epa.gov/airmarkt/emissions/score99/index.html (last visited Jan. 11, 2001).

116. For an empirical study of the effects of a price signal on energy-related investments, see Adam B. Jaffe & Robert N. Stavins, *Dynamic Incentives of Environmental Regulations: The Effects of Alternative Policy Instruments on Technology Diffusion*, 29 J. ENVTL. ECON. & MGMT. S-43 (1995). This study found that energy conservation techniques in home-building were more readily adopted in jurisdictions where there was a greater energy consumption tax. Jaffe and Stavins also found, however, that even more important than the presence of an energy consumption tax was the availability of energy conservation subsidies.

Only then is there an incentive to innovate in achieving emissions reductions, and to do so in the most cost-effective way. Rate standards may provide some temporary incentive to innovate in reducing costs to meet a more stringent level, but they lose their influence once firms have achieved the mandated standard. Rate standards thereafter do more harm than good—firms will receive no credit or compensation for any further emissions reductions, and face a disincentive to innovate further, because of a reasonable fear that the new technology may become the next standard.

A phased cap-and-trade program is necessary to send a continuing price signal to electricity generation firms regarding the emissions of pollutants and greenhouse gases. Without prices, emissions of NO_x and other pollutants have remained high, and emissions of CO_2 have increased. Regulations calling for end-of-pipe controls may meet some rigid mandate, but do not provide any incentive for firms to exceed the standards, and do not provide any impetus for innovation in emissions control or of other means of producing energy.[117] A continuing price signal that reflects some rough proxy of the social costs of emitting is necessary to induce the turnover of our energy infrastructure from coal- to natural gas-fired, and ultimately, to renewable sources. In addition, a continuing price signal may present a significant incentive for energy conservation measures for both consumers and generators of electricity. While consumers must bear the ultimate responsibility for energy conservation, it certainly does not help that the electricity generating industry *wastes* more energy than Japan consumes.[118]

C. A Proposal Combining the Two Policy Instruments

A subsidy program and a cap-and-trade program packaged together can remedy flaws in the two individual programs standing alone. A subsidy program can help overcome opposition by the electricity generation industry to cap-and-trade programs for other emittants. Some firms in the electricity generating industry have resisted the implementation of cap-and-trade programs because they would render inadequate many ingenious SO_2 emissions compliance strategies adopted to comply with the Acid Rain Program. For example, the use of low-sulfur coal may lower SO_2 emissions, but not CO_2 or NO_x emissions, so placing a price on emissions of CO_2 and NO_x (as a cap-and-trade program would) could rob firms of the option of using low-sulfur coal as a compliance strategy. Also, firms that have installed end-of-pipe

117. Swift I, *supra* note 6, at 18.
118. Kaarsberg et al., *supra* note 37, at 9.

emissions control technology to reduce SO_2 emissions would face additional costs to reduce emissions of CO_2 or NO_x or both. Thus, a cap-and-trade program alone would face political obstacles, which a subsidy program can help overcome.

A cap-and-trade program can also address some problems in a stand-alone subsidy program. A subsidy program to induce the retirement of coal-fired power plants would provide a competitive advantage to these firms, to the detriment of those firms that have already converted their plants to natural gas-fired plants. The fairness issues raised by such a prospect are magnified in a deregulated energy environment. A cap-and-trade program can provide a mechanism for offsetting the advantage enjoyed by firms with coal-fired power plants that can take advantage of the subsidy by distributing the initial emissions allowances in such a way that benefits firms with no coal-fired power plants. This can be accomplished by allocating initial emissions allowances on the basis of *historical energy output*. This method of allocating allowances would inure to the advantage of low-emitting firms because they have produced electricity without high emissions by giving them emissions allowances that they *do not need*, and can therefore sell to other firms with high emissions that do need them. The initial allocation of emissions allowances thus represents a way of making low emissions into a valuable asset, the conferral of which to low-emitting electricity generation firms would at least partially offset the advantage that high-emitting firms obtain from the subsidy.

I thus propose the following cap-and-trade program and subsidy program:

- A cap-and-trade program on the emissions of CO_2, with one or more phased reductions in the cap,
- A twenty-year production tax credit on the production of electricity using wind, solar and geothermal resources for all facilities placed into service by 2012, and terminating in any case in 2020,
- A five-year partial investment tax credit for the construction of natural gas-fired plants *or* renewable energy plants that replace retired coal-fired capacity.

The CO_2 cap should be low enough so that an emissions allowance is a scarce commodity, commanding a sufficiently high price, to provide those electricity generation firms without coal-fired plants with a substantial benefit to offset the investment tax credit available to competitors. The cap should also be low enough to provide a continuous emissions reductions incentive, at first to induce some fuel-switching from coal to natural gas, and then for a change-over to renewable energy technologies. Finally, the cap must be low enough so that no new coal-fired plants will be constructed.[119] Phased reductions in the cap are appropriate, as future technological improvements may make CO_2 emissions easier to abate. Subsequent cap reductions would also provide a continuing disincentive for the construction of new coal-fired plants, and a continuing incentive for the development of renewable energy technologies and for energy conservation measures. The cap must not only serve as a limit on permissible CO_2 emissions, but must also send appropriate price signals.

The twenty-year production tax credit is necessary to offer renewable energy technologies sufficient certainty to make substantial investments. By offering a longer-term tax credit, it may be possible to minimize the credit necessary to induce investment, effectively spreading out taxpayer outlay over a longer period of time. The goal of the production tax credit, however, should be to bridge the relatively narrow production cost gap between some of the renewable energy technologies and fossil-fuel technologies.

The investment tax credit should be sufficient to partially bridge the one-cent-difference in production cost between a new natural gas-fired plant and an old coal-fired plant. Completely covering the cost gap would be inappropriate, since that would be tantamount to a complete capitulation to electricity generation firms with coal-fired power plants. As discussed above, this subsidy should be viewed as a settlement agreement concerning the right to continue to operate coal-fired power plants. As the legal climate for electricity generation firms with coal-fired plants is unclear, this subsidy should not be so generous as to render costless their transition from coal to natural gas or renewable energy. To avoid the misuse of this investment tax credit, it should not apply to any coal-fired plant placed into operation in the past several years. Also, to minimize cost, the investment tax credit should be offered in an auction where firms submit bids to retire coal-fired plants for stated subsidy amounts, with the subsidies being awarded to the lowest bids. This would preferentially attract firms that were facing the highest compliance costs for their old coal-fired plants, and could make the most of their new capacity. With respect to extending this credit to renewable energy technologies, one might raise the issue of how similar investment tax credits in California gave rise to misuse of the credits for tax shelter

119. The Energy Information Administration estimates that of the 393 GW of new capacity that will be required to meet demand over the next twenty years, 5% will be coal-fired. AEO2001, *supra* note 21, at 73. The construction of *any* new coal-fired capacity should be discouraged.

purposes.[120] However, the requirement that new capacity replace coal-fired capacity should ensure that the new capacity is actually used for power generation.

Also, one could be troubled by the fact that renewable energy technologies would effectively receive a double subsidy—for a firm retiring a coal-fired plant and replacing lost capacity with renewable capacity, it would be eligible for both the investment tax credit and the production tax credit. However, this appropriately reflects the additional environmental advantages that renewable energy technologies have over natural gas-fired plants: renewables emit no carbon dioxide at all and thus achieve a 100% reduction in carbon dioxide emissions, as compared with a 67% reduction by natural gas and do not cause any of the environmental disruption caused by extracting natural gas reserves.[121]

Possibly even more important than direct subsidies is the removal of nonfinancial barriers to greater utilization of renewable energy technologies. Electricity generation firms have sometimes charged high hookup fees to nonutility power producers for access to the electric grid to market electricity.[122] Federal agencies must follow the Danish example of ensuring grid connectivity to wind turbines to create a more level playing field for renewable energy technologies.[123] Also, the existing 10% investment tax credit that applies to solar and geothermal energy should be limited to solar photovoltaic projects, in light of the above-proposed investment tax credit that would cover solar thermal and geothermal energy sources.[124]

Another important step is to repeal provisions that prohibit electricity generating firms from receiving subsidies connected to the generation of electricity from renewable energy sources. For example, "public utility property" is excluded currently from eligibility for the existing 10% investment tax credit for solar and geothermal.[125] This would also make obsolete the PURPA requirement that electric utilities buy electricity produced from renewable energy sources.[126] Also, the utility exclusions for the existing investment tax credit should be removed, so that electricity generating firms can participate in solar photovoltaic development. Precluding electricity generating firms from participating in the development of renewable energy makes no sense.

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120. Muller, *supra* note 59, at 43, 51.
121. Swift II, *supra* note 12.
122. Moore & Ihle, *supra* note 24, at 3.
123. *Id.* at 8.
124. 26 U.S.C. § 48(2) (1994).
125. *Id.* § 48(2)(B)(3) (1994).
126. 16 U.S.C. § 824a-3 (1994) (requiring that electric utilities purchase electric energy from such "qualifying small power production facilities").

Harnessing the resources and experience of these firms, and gaining their support for renewable energy subsidies may be very important to making progress on renewable energy development.

There is one potential implementation problem that confronts this policy package. As with any subsidy, it will be working against economic forces. By encouraging the retirement of coal-fired plants, a subsidy program will exert downward pressure on coal prices, which would encourage the use of more coal. The phased reductions in the CO_2 emissions cap should thus be established so as to ensure a continuing disincentive for the construction of coal-fired plants. Thus, as the costs of coal fall, a decreasing availability of CO_2 permits should continue to increase the costs of operating a coal-fired plant. Natural gas prices are likely to increase in a transition to an electricity generation industry that is much more dependent upon natural gas than is currently the case.[127] However, how much of an increase will take place is not clear. A recent study projected that even a retirement of 50% of the current coal-fired capacity by the year 2010, would only increase electricity prices by 0.6¢/kWh, or roughly ten percent.[128] This study assumed that long-term natural gas prices would remain at $4 per million Btu (mmBtu).[129] While natural gas prices have been well above this level in 2000, increases in drilling activity and in pipeline capacity are expected to bring long-term natural gas prices down to the neighborhood of $4/mmBtu.[130] The Energy Information Administration believes that even under a projected tripling of demand for natural gas for electricity generation purposes by 2020, domestic supplies along with Canadian imports will be sufficient to meet this increase in demand.[131] Also, electricity generation presently accounts for only 32% of natural gas

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127. AEO2001, *supra* note 21, at 4.

128. Swift II, *supra* note 12, at 8.

129. *Id.* at 11. While "proven" U.S. reserves can only supply domestic needs for eight years, "technically recoverable reserves" in the United States are orders of magnitude larger and could readily supply, for a finite period of time, an electric generation industry dependent upon natural gas. "Proven reserves" are those natural gas reserves that currently exist and are economical to remove. Proven U.S. reserves are currently 167 trillion cubic feet (Tcf), not quite eight times the current annual consumption of 23 Tcf. "Technically recoverable reserves" are estimates of known sources of natural gas that are recoverable if cost is no object. This is currently estimated to be 1281 Tcf. AEO2001, *supra* note 21, at 31. Additional exploration and technological advances in exploration and recovery may also dramatically increase these estimates, as has been the case in the past. *See* BYRON SWIFT & JAY AUSTIN, ENVTL. L. INST., HOW ABUNDANT? ASSESSING THE ESTIMATES OF NATURAL GAS SUPPLY 22, *at* http://www.eli.org/pdf/rrgas99.pdf (1999) (stating that official estimates can be expected to grow as more geologic information is gathered).

130. *Mazur Testimony*, *supra* note 20, at 5.

131. *Id.* at 7.

consumption,[132] so a tripling of this sector's use of natural gas translates into less than a doubling of natural gas consumption. Should natural gas reserves again dwindle and cause upward pressure on prices, additional exploration and capacity can be expected to follow.[133] Therefore, California's painful experiment with energy deregulation is not necessarily a harbinger of things to come.[134] Indeed, Texas is moving ahead with its own energy deregulation plan, even as it observes the situation in California.[135]

Even if natural gas supplies can be expected to meet demand, however, developing renewable energy sources would be prudent. A long-term energy policy must include incentives to develop renewable energy. Even if the Kyoto Protocol is never implemented, the realities of global climate change will necessitate some multilateral agreement to drastically reduce emissions of greenhouse gases within the next two decades. Unless it insists on becoming an environmental pariah, the U.S. electricity generation industry must come to terms with the reality that it must produce electricity with a fraction of the emissions that it once produced. Renewable energy will be a necessity in the long term. If the United States does not invest in renewable energy technologies now, not only will it have failed to do its part in the global community, U.S. industries will continue to lose ground to competitors in countries with greater foresight, and the United States will again find itself dependent upon other countries for its energy needs.

Thinking seriously about the costs of this proposal is not for the faint of heart. The electricity generation industry is big business, and changing the direction of this industry will be like changing the course of a huge, cumbersome ship. While the appendix contains only a sample analysis, it does suggest in a very rough order—of magnitude calculation that the potential taxpayer costs of this policy are very high. Yet, the present course of the electricity generation industry is a certain path to

132. ELECTRIC POWER ANNUAL 1999 I, *supra* note 22, at 31, tbl. A2; AER1999, *supra* note 33, at 177, tbl. 6.5. Total natural gas use by electricity generation consists of use by utility producers and nonutility producers.

133. AEO2001, *supra* note 21, at 44.

134. A number of factors have contributed to the energy shortages in California that have nearly forced utilities to initiate planned blackouts. First, no new construction of electric generation capacity has occurred in several years. Second, pipelines carrying natural gas into the State have been strained, especially after a 1999 pipeline explosion in El Paso, Texas, that interrupted a critical supply of natural gas. U.S. ENERGY INFO. ADMIN., U.S. DEP'T OF ENERGY, A LOOK AT WESTERN NATURAL GAS INFRASTRUCTURE DURING THE RECENT EL PASO PIPELINE DISRUPTION 1, *at* http://www.eia.doe.gov/oil_gas/natural_gas/special/natural_gas_update/natgas_update.html (last visited Jan. 11, 2001). A six-to-eighteen-month lag in pipeline construction has slowed the response to the high gas prices in the form of new construction.

135. *See id.*

environmental disaster and energy insecurity as CO_2 emissions continue to grow.[136] The increasingly dire predictions regarding global warming are cause for serious alarm[137]—we ignore at our peril the capacity for severe weather events to disrupt the economic foundations of civilization. Moreover, U.S. dependency upon finite amounts of depletable energy sources is a policy of ignorant bliss, especially when the long-term nature of capital investments in this industry may outlast any economically recoverable reserves. The construction of timber mill capacity well in excess of the foreseeable supply of timber in the Pacific Northwest is one example of the human aversion to planning for the future, an aspect of human nature that economic theory does not yet adequately model. A dramatic change of course in energy production is absolutely necessary to the continued prosperity of the United States.

IV. CONCLUSION

Can we finally reverse course and reduce emissions from the electricity generation industry? Even the incomplete lessons of the SO_2 cap-and-trade program suggest that engaging certain members of the regulated industries can yield surprising successes. From a societal viewpoint, a cap-and-trade program offers at least four distinct advantages: (1) it produces a market incentive to reduce emissions, (2) it stimulates innovation and competition in methods of emissions reduction, (3) it allows emissions reductions to occur in the most cost-effective way, and (4) it provides a mechanism for offsetting the competitive advantage to high-emitting firms that take advantage of the subsidy by also creating a valuable asset in the hands of low-emitting firms. Even though economists have been touting these benefits for decades, passage of the 1990 Clean Air Act Amendments, which provided for SO_2 emissions trading under the Acid Rain Program was difficult and required a unique set of circumstances—the steadfast commitment of a Republican president, the bipartisan support of key lawmakers and extensive horse-trading.[138] Prospects for the kind of bipartisanship necessary for a comprehensive pollution control program appear quite slim in this divided Congress. A subsidy program thus plays the perfect complementary role: it can be used to overcome opposition

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136. *Greenhouse Gas Report*, *supra* note 10, tbl. 4.

137. *Draft Third Assessment*, *supra* note 3, at 2340.

138. For example, the 3.5 million extra SO_2 emissions allowances for firms that installed or recently installed SO_2 emissions control equipment (or "scrubbers") is clearly a concession granted to coal mining interests and to owners of coal-fired power plants. Clean Air Act § 404(a)(2), 42 U.S.C. § 7651c(a)(2) (1994). Extra allowances were also allotted to utilities in Indiana, Illinois and Ohio. Clean Air Act § 404(a)(3), 42 U.S.C. § 7651c(a)(3).

from electricity generation firms that have resisted cap-and-trade programs because they feared that their stock of coal-fired power plants were a losing hand in a cap-and-trade program. These two policy instruments need each other.

If we can cobble together the right set of instruments, and face up to the costs of our heretofore collective energy profligacy, the electricity generation industry can be righted. We simply cannot afford not to, as precious time is being lost on innovation and infrastructure development for natural gas combustion and renewable energy resource exploitation. What is desperately needed now is federal support to speed up the evolution of the current electricity generation industry. The current administration's reversal of a campaign promise to limit carbon dioxide omissions from power plants is thus doubly regrettable, and its abandonment of renewable energy technologies and energy conservation mystifying, given its purported concern with energy shortages. The current administration's energy policy is unlikely to result in any energy cost savings in the short term and certain to result in dramatically greater costs in the long term. In short, the current administration's policy provides the exact opposite of what is needed to ensure a secure energy future and to gain a fighting chance to arrest global climate change.

V. APPENDIX: SAMPLE ANALYSIS OF COSTS OF INVESTMENT TAX CREDIT AND PRODUCTION TAX CREDIT

Under the assumptions of the sample analysis, subsidization of the retirement of 60% of the stock of coal-fired power plants in the United States would cost $56 billion over the five-year life of the credit.[139] *It is important to note that this is a very rough order-of-magnitude calculation*. It is beyond the scope of this Article to make a more careful economic estimate. This is a considerable sum of money, but is still less than, for example, the $62 billion in projects that the United States Army Corps of Engineers currently has budgeted for wreaking their environmental havoc.[140] The annual cost of the production tax credit will grow from $1.7 billion up to $34.7 billion.[141] The total cost of the twenty-one-year program would be $395 billion.[142] This is a costly program, but one should not expect the costs of energy security and environmental integrity to be cheap.

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139. *See infra* app. B, at 459.

140. Michael Grunwald, *An Agency of Unchecked Clout; Water Projects Roll Past Economic, Environmental Concerns*, WASH. POST, Sept. 10, 2000, at A1.

141. *See infra* app. C, tbl. 3, at 461.

142. *Id.*

A. Emissions Reductions

This is a very rough order-of-magnitude sample analysis of the emissions reductions and costs of the proposed program, and revolves around the goal of reducing CO_2 emissions. This analysis incorporates certain forecasts and assumptions made by the Energy Information Administration. The following assumptions are made:

- That energy demand will grow by 1.8% per year through 2020.[143]
- That by 2012, electricity from coal-fired generation will linearly decline to 40% of current levels, and that it will be the result of the retirement of 60% of the current stock of coal-fired power plants, with no new coal-fired power plants being built. That is, it is assumed that retirement of 60% of the power plants will result in a directly proportionate 60% reduction in electricity produced.[144]
- That by 2012, 16% of the electricity currently produced by nuclear energy will be lost to retirement of nuclear power plants, and that this electricity will be replaced by natural gas-fired power plants.[145]
- That renewable energy sources will increase linearly so that it accounts for 25% of all energy produced in the United States by 2012, and that it thereafter increases linearly so that it accounts for 33% of all energy produced by 2020.
- That electricity produced by natural gas-fired plants will roughly triple by 2012.[146]
- That there will be no change in production of electricity from petroleum-fired power plants.[147]
- That CO_2 emissions rates of coal-fired or natural gas-fired power plants will not change throughout this period.

143. This is the assumption made by the Energy Information Administration in its 2000 forecast. AEO2000, *supra* note 29, at 4.

144. While the investment tax credit lasts only five years, it is assumed that the cap-and-trade program will continue to induce retirements of coal-fired plants through 2012.

145. The Energy Information Administration (EIA) assumes in its forecasts that 27% of current nuclear capacity will be retired by 2020. A 16% retirement by 2012 reflects the pace of retirement that would achieve the EIA's projected retirements by 2020. Again, it is assumed that a retirement of 16% of the plants will result in a drop of 16% of the currently produced electricity. *See* AEO2000, *supra* note 29, at 45.

146. The EIA projects a tripling of natural gas-fired production by 2020. AEO2001, *supra* note 21, at 4.

147. In 1999, 115.6 billion kWh of petroleum-fired electricity were generated. AER1999, *supra* note 33, at 213, tbl. 8.2.

Under the above assumptions, Table 2 below shows the annual electricity generation from each fuel source and the emissions reductions accomplished through the year 2012. Because no figures are yet available for 2000, 1999 figures are used as a baseline for the year 2000, and serve as a starting point for calculated emissions trends. The emissions reduction of 0.81 billion tons of CO_2 accomplished by 2012 is 74% of the emissions reductions that would be necessary for the United States to meet its obligations under the Kyoto Protocol to combat global warming. The levels of CO_2 emissions are not necessarily equivalent, or even closely related to the CO_2 emissions cap that would be implemented under this proposal. Just as electricity generation firms have overcomplied under the SO_2 cap-and-trade program, firms can be expected to overcomply with a CO_2 cap-and-trade program. The reason is that firms will typically allow for a margin of error in emissions, and keep a reserve of extra allowances on hand to deal with unforeseen circumstances.

TABLE 2: PROJECTED ENERGY PRODUCTION AND CO_2 EMISSIONS

Year	Total Energy Demand[a]	Coal-fired Energy[a]	Coal-fired Plant Emissions[b]	Natural Gas-fired Energy[a]	Natural Gas-fired Plant Emissions[b]	Renewable Energy[a]	Nuclear Energy[a]	Emissions Reduction[b]
2000	3678	1891	1.98	546	0.19	83	728	0.00
2001	3744	1796	1.88	636	0.22	171	718	0.07
2002	3812	1702	1.78	725	0.25	259	708	0.13
2003	3880	1607	1.68	815	0.28	347	699	0.20
2004	3950	1513	1.58	904	0.32	435	689	0.27
2005	4021	1418	1.49	994	0.35	523	679	0.34
2006	4094	1324	1.39	1083	0.38	611	669	0.41
2007	4167	1229	1.29	1173	0.41	699	659	0.47
2008	4242	1135	1.19	1262	0.44	787	649	0.54
2009	4319	1040	1.09	1352	0.47	875	640	0.61
2010	4396	946	0.99	1441	0.50	963	630	0.68
2011	4475	851	0.89	1531	0.53	1051	620	0.74
2012	4556	756	0.79	1620	0.57	1139	610	0.81

a. In billions kWh.
b. In billions of tons.

B. *Cost of Investment Tax Credit to Induce Retirement of Coal-Fired Power Plants*

One way of determining the amount of subsidy required to induce a retirement of a coal-fired power plant is to calculate the cost advantage enjoyed by that power plant over new natural gas-fired power plants, on a per-kilowatt-hour basis. For example, if it is assumed that:

- the production cost of electricity for a coal-fired plant is 2¢/kWh,
- the production cost of a natural gas-fired plant is 3¢/kWh,
- the useful remaining life of a coal-fired plant is fifteen years,[148]
- for every megawatt of electric capacity, a coal-fired power plant produces 6000 megawatt-hours of electricity each year,[149]
- then the opportunity cost of operating a natural gas-fired power plant as opposed to continuing operation of the existing plants is:

(3¢-2¢/kWh) x (6,000 MWh/MW) x (15 years) = $900,000/MW

For a typical 300 MW plant, the cost of converting to natural gas would be $270 million. As discussed above, however, subsidizing the transition so that it is costless would be inappropriate. An appropriate figure would reflect the fact that the subsidy is a compromise and would be substantially less. This rough calculation excludes other costs that may be incurred by an electricity generation firm that switches from coal to natural gas, such as the cost of siting a new natural gas-fired plant or re-firing a coal-fired plant to utilize natural gas, and the cost of retraining personnel or hiring new personnel to operate a new type of power plant.

As a very rough order-of-magnitude calculation, if the investment tax credit average cost of a subsidy were hypothetically to be $300,000 per megawatt, and if the subsidy payment were successful in inducing the retirement of 60% of the 312 GW stock of coal-fired plants in the United States, the total taxpayer cost of the investment tax credit would be $56 billion over the five-year life of the tax credit.

C. *Cost of Production Tax Credit to Encourage Development of Renewable Energy Sources*

Of the nonhydro renewable energy sources, solar photovoltaic is the only one that is not close to being competitive with coal or natural gas. It is difficult to predict what level of investment would be necessary to spur the innovation required to bring the production cost down to a competitive level, so this appendix will not attempt to perform even a rough order-of-magnitude estimate.

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148. Given the remarkable longevity of some coal-fired power plants, it is not unreasonable to assume that even some of the oldest power plants in operation can be patched up enough to continue operation for another fifteen years. This assumes, however, that the EPA will not generally be successful in their lawsuit against the electricity generation firms to remove their grandfather status, nor will Congress or any of the states pass any legislation to do the same.

149. This is a very rough estimate. In 1999, 312,544 MW of coal-fired capacity generated 1891 billion kWh of electricity, so the average MW of generating capacity in the United States produced 6021 MWh of electricity. AER1999, *supra* note 33, at 213.

A sample analysis can be done for wind, geothermal and solar thermal energy sources, which account for approximately 83 billion kWh of electricity. Again, using 1999 figures as a proxy baseline for the year 2000, and assuming that a production tax credit of 2¢/kWh (an increase of 0.5¢ over the current production tax credit of 1.5¢/kWh) will induce a steady growth in these four renewable energy industries, such that they will account for 25% of all electricity produced by 2012,[150] the annual cost of the production tax credit will be as shown in Table 3.

TABLE 3. HYPOTHESIZED GROWTH IN NONHYDRO RENEWABLE ENERGY AND ASSOCIATED SUBSIDY COSTS (IN 2001 DOLLARS)

Year	Total Energy Demand (bill kWh)	% of Total Energy met by Renewable Energy	Renewable Energy (bill kWh)	Cost of Production Tax Credit (billions 1999 $)
2000	3678	2.26	83	1.7
2001	3744	4.57	171	3.4
2002	3811	6.80	259	5.2
2003	3880	8.94	347	6.9
2004	3950	11.01	435	8.7
2005	4021	13.01	523	10.5
2006	4093	14.93	611	12.2
2007	4167	16.78	699	14.0
2008	4242	18.55	787	15.7
2009	4318	20.26	875	17.5
2010	4396	21.91	963	19.3
2011	4475	23.49	1051	21.0
2012	4556	25.00	1139	22.8
2013	4638	26.16	1213	24.3
2014	4721	27.28	1288	25.8
2015	4806	28.34	1362	27.2
2016	4893	29.36	1436	28.7
2017	4981	30.33	1511	30.2
2018	5070	31.27	1585	31.7
2019	5162	32.15	1660	33.2
2020	5255	33.00	1734	34.7

Total cost over twenty-one years: $395 billion

150. The Department of Energy estimates that renewable energy technologies will roughly double by 2020. AEO2001, *supra* note 21, at 79. This analysis assumes that this program will accelerate at this rate of growth.

The total cost of the proposal, under this very rough sample calculation, is $451 billion over the twenty-one-year life of the program. The heaviest costs of the program will be absorbed in the later years of the program, where the production tax credit for renewable energies will be greatest. Again, this sample analysis is not intended to represent a careful estimate of the costs of such a proposal.