MANAGING COAL: HOW TO ACHIEVE REASONABLE RISK WITH AN ESSENTIAL RESOURCE

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INTRODUCTION

Can the future of world energy production occur without coal?[1] Coal as an energy source laid the foundation for the modern industrial era. In the twentieth century, the ability to broadly and efficiently turn coal into electricity made possible the major technology developments that have defined modern society, and led to rising standards of living and longer life spans throughout the world.[2] The U.S. Academy of Engineering called this societal electrification the "greatest engineering achievement" of the past century,[3] a century that saw population growth of over four billion people, the rise of the metropolis, dramatic improvements in diet and health, and emergence of a vast system of electronic communication.

Today, electricity generation still relies heavily on coal-burning power plants, which provide forty-six percent of electricity production in the United States[4] and approximately forty percent of electricity worldwide.[5] America's coal reserves have also been estimated to contain more energy value than Saudi Arabia's oil. So, what does the future hold? One thing is for certain: demand for electricity is going to continue to rise. Net U.S. electricity demand is expected to increase by thirty-one percent between

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1. *See* James Fallows, *Dirty Coal, Clean Future*, THE ATLANTIC, http://www.theatlantic.com/magazine/archive/2010/12/dirty-coal-clean-future/8307/ ("There is no story of climate progress without a story for coal.").

2. Robert Mann, *Another Day Older and Deeper in Debt: How Tax Incentives Encourage Burning Coal and The Consequences for Global Warming,* 20 PAC. MCGEORGE GLOBAL BUS. & DEV. L.J. 111 (208). (stating that coal has "kept us warm, fired our factories, fed our trains and lit our world").

3. GEORGE CONSTABLE & BOB SOMERVILLE, A CENTURY OF INNOVATION: TWENTY ENGINEERING ACHIEVEMENTS THAT TRANSFORMED OUR LIVES (Joseph Henry Press 2003).

4. U.S. Energy Info. Admin., First-quarter 2011 Coal Share of Power Generation Lowest in Over 30 Years (July 27, 2011), *available at* http://205.254.135.7/todayinenergy/detail.cfm?id=2391.

5. U.S. ENERGY INFO. ADMIN., INTERNATIONAL ENERGY OUTLOOK 2011, at 11 (2011) *available at* http://205.254.135.24/forecasts/ieo/pdf/0484(2011).pdf [hereinafter INTERNATIONAL ENERGY OUTLOOK 2011].

2009 and 2035,[6] with similar increases around the world.[7] Thus, given current production and reserves, it seems clear that if the United States is and other countries are going to meet this rapidly increasing demand for electricity, coal is going to continue to be an essential resource.[8]

At the same time, coal has been increasingly facing environmental opposition stemming from allegations related to mining operations, coal's impacts on air and water quality, and climate change. These allegations are the driving force behind several high-profile lawsuits, including three reaching the Supreme Court of the United States,[9] a "cap and trade" proposal that received significant legislative consideration,[10] and new Environmental Protection Agency regulations of coal mining, water quality impacts, and emissions of conventional pollutants as well as carbon dioxide and other gases collectively referred to as "greenhouse gases" (GHGs).[11]

As U.S. policymakers continue to develop America's energy policy and seek to assure the American people that they will continue to have stable, affordable sources of electricity, one of the most important questions has become, what principles should guide the nation's decisions for managing risks and maximizing the benefits of coal?

The answer to this question cannot be derived in a vacuum. It must be informed by a comparable examination of other forms of energy that also will be important to electricity generation in the twenty-first century. These other energy sources include nuclear plants, natural gas, hydroelectric dams, wind, solar and biomass. As Julio Friedmann of Lawrence Livermore National Laboratory has explained, each one of these energy forms is "limited by cost, limited by scale, limited by physics and chemistry, [or] limited by thermodynamics."[12] The goal for U.S. energy policymakers,

6. U.S. ENERGY INFO. ADMIN., ANNUAL ENERGY OUTLOOK 2011 WITH PROJECTIONS TO 2035 73 (2011), *available at* http://www.eia.gov/forecasts/aeo/pdf/0383(2011).pdf [hereinafter ANNUAL ENERGY OUTLOOK 2011].

7. INTERNATIONAL ENERGY OUTLOOK 2011, *supra* note 5, at 85.

8. *See* Fallows, *supra* note 1 (arguing that "there is no plausible other way to meet what will be, absent an economic or social cataclysm, the world's unavoidable energy demands").

9. Massachusetts v. Envtl. Prot. Agency, 549 U.S. 497, 505 (2007); Am. Elec. Power Co. v. Connecticut, 131 S. Ct. 2527, 2529 (2011); Envtl. Defense v. Duke Energy Corp. 549 U.S. 561 (2007).

10. *See* American Clean Energy and Security Act of 2009, H.R. 2454, 111th Cong. (2009) (establishing in Titles III, VII, & VIII a cap and trade scheme for limiting carbon emissions from fossil fuel electric generators) (as passed by House, June 29, 2009).

11. *See, e.g.*, Prevention of Significant Deterioration and Title V Greenhouse Gas Tailoring Rule, 75 Fed. Reg. 31,514 (June 3, 2010); Endangerment and Cause or Contribution Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act, 74 Fed. Reg. 66,496 (Envtl. Prot. Agency, Dec. 15, 2009) (to be codified at 40 C.F.R. Chapter I).

12. *See* Fallows, *supra* note 1 (quoting Friedmann as saying, "Solar and wind power are going to be important, but it is really hard to get them beyond 10 percent of total power supply.").

therefore, is to weave together cogent strategies for managing the risks, benefits and capabilities of all of these energy sources.

This article seeks to assist policymakers with this task by facilitating an honest debate and focusing on sound scientific and traditional legal principles. Part I lays a foundation for the discussion by providing an historical perspective on coal use and production. Part II evaluates the potential and limitations of the other electricity generation resources. Part III begins by factually debunking five prominent myths in the public domain about coal production and conversion. It then sets forth five core principles for policies and regulations that can facilitate coal's continued use, along with the other energy sources, as a reliable, inexpensive, and environmentally sound source of global electricity.

I. COAL PRODUCTION AND USE IN THE UNITED STATES: INDUSTRIAL REVOLUTION, ELECTRIFICATION, AND MODERN INDUSTRY

A. Coal and the Industrial Revolution

The first recorded commercial shipment of coal in the United States occurred in 1758, when thirty-two tons were exported from the James River district in Virginia to New York.[13] At that time, and through the early 1800s, America lagged behind Europe in the development of factories.[14] American manufacturing was powered by water from small streams, which was not sufficient to develop an iron trade, leaving industry to use flimsier wooden machines.[15] Metal products and machinery were manufactured in small shops, not mass produced.[16] Sources of fuel for heating and cooking were primarily charcoal or wood.[17]

Coal was discovered in the United States in Pennsylvania, and by 1830, Pittsburgh was the only industrial center with sufficient bituminous coal ("soft coal") for household and industrial use.[18] Transporting coal across Pennsylvania's Appalachian mountains was prohibitively expensive. The

13. SAM H. SCHURR & BRUCE C. NETSCHERT, ENERGY IN THE AMERICAN ECONOMY, 1850-1975, 57 (JOHNS HOPKINS PRESS 1960).

14. Alfred D. Chandler, Jr., *Anthracite Coal and the Beginnings of the Industrial Revolution in the United States*, 46 Bus. History Rev. 141 (1972) (on file with authors).

15. *Id.* at 142, 147, 176. *See also* BARBARA FREESE, COAL: A HUMAN HISTORY 110 (Perseus Publishing ed. 2003) (noting that, in 1832, outside of Pittsburgh, which had access to coal, nearly all of the nation's large factories were powered by water).

16. Chandler, *supra* note 14, at 142.

17. *Id.* at 152–53.

18. *Id.* at 150.

small amount of anthracite coal ("hard coal") that American industry used came from Great Britain and Nova Scotia.[19] The ability to transport coal is what led to the revolution in steam power, iron making, and factory growth.[20] Three major coal canals were completed in the early 1830s,[21] after which annual output of the Pennsylvania fields[22] rose from 210,000 tons in 1830 to 1.2 million tons in 1837, to 3.3 million tons in 1847.[23] Nationwide coal production increased from 900,000 tons in 1830 to 8.4 million tons in 1850.[24] Completion of the Pennsylvania Railroad in 1853 further expanded coal availability throughout the United States.[25]

This affordable Pennsylvania anthracite coal provided sufficient heat, through steam power, to fuel manufacturing in the Northeast.[26] As a result, American consumption of high-grade iron tripled,[27] which led to increased production of high-quality stoves, furnaces, agricultural equipment, machine tools, glass, and paper.[28] Iron production also powered factories that made rails, wheels, locomotives, and engines.[29] In rural areas, steam engines replaced wood-burning engines to process sugar, rice, flour, cotton, and other crops.[30] Within twenty years, factories had more than 500 workers,[31] and by the turn of the century, coal satisfied three-quarters of America's demand for energy.[32] Coal became so integral to the shift to an industrialized society that the 1902 miners strike marked the first time a U.S. President, Theodore Roosevelt, intervened in a major labor dispute on the side of workers.[33]

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19. *See id.* at 151(explaining that anthracite coal has higher carbon content and greater energy yield per ton than bituminous coal. Anthracite coal gained use in domestic heating and cooking, as well as a source of heat for manufacturers, blacksmiths, bakers, and brewers. Bituminous coal was primarily used for railroad locomotives, steam engines, to make coke for steel.).

20. *Id.* at 150.

21. *See id.* at 155–56; *see also* Freese, *supra* note 15, at 118-21.

22. More than three-quarters of the nation's coal production was concentrated in Pennsylvania in 1850. *See* SCHURR & NETSCHERT, *supra* note 13, at 63. Slightly more than half of total coal production was anthracite, mined in northeastern Pennsylvania, while the remainder was bituminous coal, most of which was produced in western Pennsylvania. *Id*.

23. Chandler, *supra* note 14, at 158.

24. SCHURR & NETSCHERT, *supra* note 13, at 62.

25. Chandler, *supra* note 14, at 151. Even today, transportation accounts for as much as 70 percent of the cost of delivered coal. WORLD COAL INST., THE COAL RESOURCE 9 (2005) [hereinafter COAL RESOURCE], *available at* http://www.worldcoal.org/coal/uses-of-coal/.

26. *See* Chandler, *supra* note 14, at 165. In the 1840s alone, manufacturing rose from 17 percent to 30 percent of the national product. FREESE, *supra* note 15, at 126.

27. Chandler, *supra* note 14, at 159–65.

28. *Id.* at 168–69.

29. *Id.* at 168.

30. *Id.* at 166.

31. *Id.* at 177–78.

32. SCHURR & NETSCHERT, *supra* note 13, at 67–69.

33. FREESE, *supra* note 15, at 140-41.

B. Coal's Role in Lighting and Electrification

The first coal-fired electric generating station, Pearl Street Station, went into operation in New York City in 1882. Designed by Thomas Edison, it supplied electricity for households in lower Manhattan.[34] In 1917, American Gas & Electric (AG&E), now American Electric Power, established the first long-distance, high-voltage, transmission line.[35] AG&E built its Windsor, West Virginia steam plant at the mouth of a coal mine to eliminate transportation costs.[36] One year later, the Oneida Street Plant in Milwaukee used pulverized coal for the first time, paving the way for more efficient use of fuel.[37] Further developments in technology allowed coal-fired plants to produce more energy with less coal.[38] By 1920, coal provided 90 percent of the fuel used at these plants.[39] By 1955, coal use quadrupled in electricity-generating plants, where the amount of power generated increased from 24 billion to 434 billion kwh.[40]

This electrification led to significant rises in living standards and life expectancies. Electricity made homes safer because it reduced the number of open fires in homes. Modern refrigeration allowed Americans to have fresh meat and produce throughout the year and reduced numerous gastrointestinal threats by preventing meat from spoiling. Better ventilation in homes and workplaces lessened exposure to disease and other airborne threats. By 1930, nearly 90 percent of residents living in urban areas had electricity in their homes.[41] Electrification had a major effect on domestic

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34. *History of Pearl Street*, CONEDISON, http://www.coned.com/pearlstreet125/ (last visited June 1, 2012). Before the Pearl Street Station was constructed, gas light, which became common for lighting streets and homes in cities and large towns by the late 1860s, was powered by gas made from coal and piped beneath streets. FREESE, *supra* note 15, at 147. Following the Civil War, kerosene provided an alternative lighting source and was used largely in rural areas. Before the use of coal and oil for interior lighting, sperm whale oil provided the dominant source. As Freese, a critic of the potential environment impacts of coal acknowledges, coal and oil thus helped save the whales, just as coal had for centuries helped save the remaining forests." *Id*.

35. *Transmission "Firsts,"* AM. ELECTRIC POWER, http://www.aep.com/about/transmission/TransmissionFirsts.aspx (last visited June 1, 2012).

36. *Id.*

37. *Wells Street Power Station*, AM. SOC'Y OF MECH. ENG'RS MILWAUKEE, http://sections.asme.org/milwaukee/history/4-pulverizedcoal.html (last visited June 1, 2012).

38. *See* SCHURR & NETSCHERT, *supra* note 13, at 81 (noting it took seven pounds of coal to generate one kwh of electricity in 1900, twenty years later, three pounds of coal produced the same output, and by 1954, generating one kwh of electricity required only one pound of coal).

39. *Id.* at 80.

40. *See id.* at 80–81. Between 1920 and 1955, reliance on coal for electric power declined as a share of fuel used from 90 percent to 70 percent, yet, given the dramatic increase in demand for electricity, coal consumption by the plants significantly increased. *Id*.

41. U.S. DEP'T OF COMMERCE, BUREAU OF THE CENSUS, HISTORICAL STATISTICS OF THE UNITED STATES: COLONIAL TIMES TO 1970, PART 2 827 (1975), *at* http://www2.census.gov/prod2/statcomp/documents/CT1970p2-06.pdf (last visited June 1, 2012) (hereinafter HISTORICAL STATISTICS).

life. Households also benefited from new labor-saving appliances, such as washing machines, vacuum cleaners, and ironing machines.[42]

Americans living in rural areas largely gained electrification two decades later.[43] Electricity helped power farm machinery, facilitating an increase in owner-operated farms.[44] Rural America also shared the same quality of life benefits as city dwellers. They could attend educational meetings and entertainment at night, school children would have lights, heat, and ventilation, and stores could better serve customers.[45] In fact, rural electrification, which incorporated both coal-fired generation and hydroelectric power, led to perhaps the greatest advancement in living standards in the history of the United States.

C. Coal Production in the Post-World War II Era

Until 1950, coal served as America's primary energy source.[46] But, after World War II, the use of petroleum for automobiles and natural gas for other purposes rose and the use of coal for rail and water transportation, as well as heating, waned.[47] During the 1970s, a turning point occurred when several interests began tugging at America's energy policy. Environmental concerns generally rose in prominence, with enactment of the Clean Air Act in 1970, the Federal Water Pollution Control Amendments of 1972 (commonly known as the Clean Water Act), the Clean Air Act Amendments

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42. P.H. Adams, *Notes on Progress of the Use of Electricity in the Industrial and Domestic Field,* J. OF THE AM. INST. OF ELEC. ENGINEERS, 118-19 (1921).

43. *See* Robert T. Beall, *Rural Electrification*, *in* YEARBOOK OF AGRICULTURE, 1940 790, 793 (U.S. Dep't of Agriculture, 1940) (stating that in 1935, only one in ten farms had electricity). *See also id.* at 801 (establishing the Rural Electrification Administration and appropriating substantial funding to the project caused this percentage to rise to 25 percent); Exec. Order 7037 (May 11, 1935), *available at* http://www.presidency.ucsb.edu/ws/index.php?pid=15057 (establishing the Rural Electrification Administration); Rural Electrification Act of 1936, Pub. L. No. 74-605, 49 Stat. 1363 (1936) (empowering the REA to make loans for rural electrification and the furnishing of electric energy to persons in rural areas who were not receiving central station service, and appropriating $40 million annually for nine years for such purposes); HISTORICAL STATISTICS, *supra* note 41 (showing by the mid 1950s, rural electrification had caught up to urban electrification).

44. *See* Beall, *supra* note 43, at 806–09 (highlighting uses and benefits of rural electrification).

45. *See id.*

46. A. Dan Tarlock, *Western Coal in Context,* 53 U. COLO. L. REV. 315, 315 (1982).

47. *See id.* at 327 (finding "the history of federal energy policy and from 1945 to 1973 can be read as a series of successful battles waged by the oil and gas industry to keep coal use subordinated to use of oil and gas. With respect to coal, federal energy policies can be reduced to a simple rule: Whatever the government does, coal loses."); U.S. ENERGY INFO. ADMIN., COAL PRODUCTION IN THE UNITED STATES – AN HISTORIC OVERVIEW 1 (2006), *available at* http://www.eia.gov/cneaf/coal/page/coal_production_review.pdf [hereinafter COAL PRODUCTION].

of 1977, and other environmental statutes. Also, discussions began about the possible impact of carbon dioxide on the earth's climate.

At the same time, because of the 1973 Oil Embargo and the 1979 oil crisis, policymakers put a renewed emphasis on developing domestic energy sources. Concerns about energy independence and the importance of oil and gas for residential and industrial uses led Congress to enact legislation prohibiting power plants from relying on petroleum or natural gas as their primary source of power.[48] Four years later, Congress restricted construction of new power plants using oil or natural gas as a base load fuel, encouraging reliance on coal and nuclear energy.[49] As a result, national energy and economic policy led America to build a greater number of new coal plants and convert existing plants to coal-fired electricity generation. Thus, even as Congress and EPA began to act on environmental issues and Congress authorized initial studies into climate change allegations,[50] energy planners "turned back to coal as an intermediate term (fifty to 100 years) or long-term (more than 100 years) energy source."[51]

D. The Shift Westward

Coal production also began to shift geographically. Since the mid-1970s, production of coal in western states increased almost ten-fold, from 60 millions of short tons (MMst) to 549 MMst.[52] Domestic coal production doubled as this expansion occurred. The reason for this shift is that western states have abundant reserves of low sulfur coal, and switching to low sulfur coal became a principal strategy for utilities to comply with Clean Air Act requirements to reduce sulfur dioxide emissions. At the same time, coal mines became extremely efficient in producing, and railroads became extremely efficient in transporting, this coal. As a result, dedicated "unit trains" of as many as 135 cars, each carrying about 115 tons of coal, cycle back and forth between coal mines and distant generating stations 24 hours per day, 365 days per year.[53] By 2010, the United States produced 1,085.3

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48. Energy Supply and Environmental Coordination Act of 1974, Pub. L. No. 93-319, § 2, 88 Stat. 246 (1974) (codified at 15 U.S.C. § 792 (1994)).

49. Powerplant and Industrial Fuel Use Act of 1978, Pub. L. No. 95-620, 92 Stat. 3289 (1978) (codified at 42 U.S.C. § 8301 et seq. (2006)).

50. *See* National Climate Program Act of 1978, 15 U.S.C. §§ 2902, 2904 (establishing a "national climate program" to increase general knowledge of the global climate "through research, data collection, assessments, information dissemination, and international cooperation," in 1978).

51. Tarlock, *supra* note 46, 318.

52. COAL PRODUCTION, *supra* note 47, at 2.

53. *See* American Ass'n of Railroads, Railroads and Coal (2010), *at* http://www.aar.org/~/media/aar/backgroundpapers/railroadsandcoal.ashx (last visited June 1, 2012); *Coal Transportation*, The Energy Library, *at* http://theenergylibrary.com/node/12186 (last visited June 1, 2012).

MMst, 54 percent of which came from Western States, 31 percent came from Appalachia, and 14 percent came from interior states.[54] Wyoming and Montana joined West Virginia, Kentucky, and Pennsylvania, as the main coal-producing states.[55]

This westward shift also caused mining techniques to change. Early "eastern" coal production was characterized by labor intensive, expensive underground mining. The majority of modern "western" coal production comes from surface mining.[56] In western states, such as Wyoming, and in particular the massive coal fields of the Powder River Basin, coal is largely found in thick seams near the surface, enabling low cost and efficient mining.[57] This difference in mining techniques led to a significant decrease in total coal mining employment, which fell from its national peak of 175,642 in 1983 to 71,023 by 2003.[58] Daily underground employment had the most decline during this period – falling by two-thirds from 112,000 to approximately 40,000.[59] In West Virginia, the former leader in coal production, mining jobs peaked in 1940 at 130,457; today, mine employment stands at about 28,000.[60]

Because western coal was cheap and easy to mine, it became known at one time as "six-pack coal" – a ton of coal cost less than a six-pack of beer.

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54. *See* WILLIAM WATSON ET AL., U.S. ENERGY INFO. ADMIN., U.S. COAL SUPPLY AND DEMAND: 2010 YEAR IN REVIEW 5, tbl. 2 (2011), *available at* http://www.eia.gov/coal/review/ [hereinafter COAL SUPPLY AND DEMAND]. The states comprising "Appalachia," in the order of quantity of coal produced include West Virginia, Kentucky, Pennsylvania, Ohio, Virginia, Alabama, Maryland, and Tennessee. *Id*. The interior region, in the order of quantity of coal produced includes Texas, Kentucky, Indiana, Mississippi, Louisiana, Oklahoma and Missouri. *Id*. at 5. Over the last six years, western Kentucky has experienced the largest growth in coal, increasing its production each year. *Id.* The Western region in the order of coal produced includes Wyoming, Montana, North Dakota, Colorado, New Mexico, Utah, Arizona, and Alaska. *Id.*

55. COAL SUPPLY AND DEMAND, *supra* note 54, at 5–6. *See also* COAL PRODUCTION, *supra* note 47, at 2 (noting the largest U.S. coal mine is Wyoming's North Antelope Rochelle Complex).

56. *See* COAL PRODUCTION *supra* note 47, at 3,5. In 1950, underground mining accounted for 75% of coal production; by 1973, production from underground mining and surface mining was about equal, at which point, surface mining became the more predominant method. *Id*. By 2003, surface mining accounted for two-thirds of coal production, the majority from western states. *Id.* at 5.

57. COAL PRODUCTION, *supra* note 47, at 10.

58. *Id.* at 8, tbl. 2, and 11.

59. *Id*. at 11.

60. W. VA. COAL ASS'N, COAL FACTS 14 (FRIENDS OF COAL 2010). Miners earn average weekly wages of approximately $1,100, which is equivalent to an annual salary of $60,000 to $70,000. Kentucky Office of Energy Policy, Division of Fossil Fuels and Utility Services & Kentucky Coal Ass'n, Kentucky Coal Facts 12 (10th ed. 2008) (providing 2006 statistics). *See also* W. VA. COAL ASS'N, COAL FACTS 6 (2010) (reporting estimated annual average coal wage of $68,500); Glen Daniel, *Craving Coal Dust 'Like Nicotine': Why Miners Love the Work*, ABC NEWS, Apr. 7, 2010 *available at* http://abcnews.go.com/US/Mine/west-virginia-coal-miners-allure-dangerous-profession/story?id=10305839 (reporting that the average starting salary of a West Virginia miner is $60,000).

E. Coal Use Today

Today, coal is mostly used for electricity generation in power plants, which collectively purchase more than ninety percent of the coal consumed in this country.[61] The two other principal uses of coal in the United States are metallurgical use for steel production and industrial use in manufacturing plants, paper mills, and food processors.[62] In addition, coal is critical to cement, chemical and pharmaceutical industries.[63] It also is an ingredient in products such as carbon water filters, kidney dialysis machines, and carbon fiber, such as that used in lightweight bicycles and tennis rackets.[64] Coal also has seen a steady decline in its price.[65] In inflation-adjusted dollars, coal costs half of what it did in 1950[66] and is significantly cheaper than other fuel sources in terms of dollars per Btu.[67]

Over the last 15 years, America has seen somewhat of a new "coal rush," led by renewed concern over the country's reliance on foreign oil, continued economic growth, and volatility in natural gas prices.[68] Several new coal-fired power plants, with a combined capacity totaling 11.5 gigawatts, are scheduled to come on line by 2012.[69] As this article will discuss in greater detail, the development of these coal plants has resulted in significant advances in efficiency and air emissions control technology, leading to far lower environmental impacts, particularly on a per megawatt basis.[70] New coal projects have virtually ceased in the last couple of years,

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61. The United States has more than 1,400 coal-fired electricity generating units at more than 600 power plants across the country. U.S. Energy Info. Admin., *What is the Role of Coal in the United States?*, http://205.254.135.24/energy_in_brief/role_coal_us.cfm (last updated May 27, 2011); *see also* COAL SUPPLY AND DEMAND, *supra* note54, at 2 (reporting that in 2010, 975.6 MMst of coal production (93%) was consumed by electric power, while the remaining 72.7 MMst (7%) was consumed among coke plants, other industrial plants, and other residential or consumer uses).

62. COAL PRODUCTION, *supra* note 47, at 16–17.

63. COAL RESOURCE, *supra* note 25, at 25.

64. *Id.*

65. COAL PRODUCTION, *supra* note 47, at 15.

66. *Id.*

67. *See id.* (finding one million Btu of coal sold for $0.87 compared with $4.41 for natural gas and $4.75 for crude oil in 2003).

68. *See* Mark Clayton, *America's New Coal Rush*, CHRISTIAN SCI. MONITOR, Feb. 26, 2004, *available at* http://www.csmonitor.com/2004/0226/p01s04-sten.html (reporting plans for at least 94 new coal-fired electric power plants with the combined capacity to power 62 million American homes in 36 states). These new plants were not without opposition. *See, e.g.*, Steven Mufson, *Coal Rush Reverses, Power Firms Follow*, WASH. POST, Sept. 4, 2007, at 1 (discussing Senate Majority Leader Harry M. Reid's vow to "use every means at my disposal" to stop plans to build new coal-fired plants), *available at* http://www.washingtonpost.com/wp-dyn/content/article/2007/09/03/AR2007090301119.html.

69. ANNUAL ENERGY OULOOK 2011, *supra* note 6, at 63.

70. *Id.* at 87 (predicting that coal's share of CO_2 emissions are expected to remain stable through 2035 and not reach 2005 levels (reflecting pre-recession energy consumption) until 2027, even assuming no explicit regulatory limits on green house gases).

given the economic downturn, reducing growth in consumer electric demand, plummeting natural gas prices, and environmental opposition.

Coal supply continues to be abundant. It was recently estimated that, at present mining levels, currently known and recoverable domestic coal reserves will last for more than two hundred years.[71]

II. COMPARATIVE ASSESSMENT OF RISKS AND BENEFITS OF MODERN ENERGY SOURCES

Strategically assessing where this abundance of coal fits in the mix of national energy resources going forward requires a comparison of the strengths and limitations, including the potential environmental impacts, of the other sources of electricity generation. As indicated above, these sources include nuclear, natural gas, hydroelectric power, wind, solar, and biomass.[72] None of them are fungible. Each presents its own characteristics and challenges, making each suitable in specific situations. For example, some of these energy sources are "dispatchable," meaning that they can provide energy on demand. Others are available only under certain conditions and at certain times. Some forms of energy present special storage and transmission issues. Others impose higher capital and decommissioning costs. Finally, some energy sources have a higher energy density than others, affecting the amount of land, water, or other collateral resources required to produce usable forms of power.

In practical terms, coal, nuclear, and, to a limited but growing extent, natural gas, form the backbone of electricity generation. Coal and nuclear are "base-load fuels," meaning that coal and nuclear power plants operate around the clock to provide a steady, inexpensive output of energy that provides the "base" amount of electricity the public needs throughout the day. Power plants use natural gas and, to a far lesser extent, oil to supplement this "base" usage when consumer demand spikes during afternoon peak hours, as well as during "shoulder" hours of the day, which fall between the peak and minimum electricity usage hours. As this article discusses, natural gas may assume more of a base-load role in the future. Renewable sources of electricity, namely solar and wind, are intermittent and, therefore, only provide supplemental power to the electric grid.

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71. U.S. Energy Info. Admin., *United States Leads World in Coal Reserves* (Sept. 2, 2011), http://www.eia.gov/todayinenergy/detail.cfm?id=2930 (last visited June 1, 2012).

72. *See* Gregory Rigano, *The Solution to the United States' Energy Troubles is Blowing in the Wind*, 39 HOFSTRA L. REV. 201, 201 (2011) ("Wind energy provided by offshore wind turbines is an emission free, domestic source of energy that can supplement traditional fuel sources.").

A. Nuclear Power

Nuclear power is a principle source of base-load generation. The United States has 103 nuclear power plants generating twenty percent of American electricity production.[73] Nuclear plants have very high capital costs, but their operating costs and, in particular, fuel costs, are relatively low. For these and certain safety reasons, nuclear plants operate at or near capacity. Therefore, nuclear is the first form of energy to be dispatched to meet electricity generation demands. To the extent nuclear power provides excess capacity at time of low demand, this excess power can be stored by converting electricity into potential kinetic energy. From an environmental perspective, nuclear power plants can have a lower impact than other sources of electricity because they do not produce significant air emissions. Safety issues are infrequent, but have the potential for catastrophic consequences when they occur.[74]

The heyday for nuclear energy growth in the United States occurred between the 1950s and 1970s. This period ended with the 1979 Three Mile Island incident. New construction of nuclear power plants slowed and then stopped, with increasing concerns about the safety of nuclear energy, despite a track record, particularly in the United States, of safe operation. The melt-down in Chernobyl, Ukraine and the recent failure of cooling systems of nuclear reactors following the 2011 earthquake in Japan are the highest profile examples of risks associated with nuclear generation.

Since the Japan incident, many global policymakers have begun reassessing nuclear power. Germany, for example, announced that it intends to totally abandon nuclear power in the future.[75] Also, after the incident, a poll in the U.S. found that about half of Americans, up fourteen percent from 2009, oppose development of new nuclear power plants,[76] leading

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73. U.S. Energy Info. Admin., Electric Power Monthly, August 2011, at 15, *available at* http://205.254.135.24/cneaf/electricity/epm/epm.pdf. *See also* Arthur Rizer, *The National Security Threat of Energy Dependence: A Call for Nuclear Renaissance*, 2 HARV. NAT'L SEC. J. 193 (2011) (emphasizing the importance of nuclear energy to America's future).

74. *See, e.g.*, Phred Dvorak, Juro Osawa & Yuka Hayashi, *Japanese Declare Crisis at Level of Chernobyl*, WALL ST. J., Apr. 12, 2011, *available at* http://online.wsj.com/article/SB10001424052748703841904576256742249147126.html.

75. Judy Dempsey, *RWE Attacks Merkel on Nuclear Power Reversal*, N.Y. TIMES, Apr. 20, 2011, *available at* http://www.nytimes.com/2011/04/21/business/global/21rwe.html.

76. *See* Brian Montopoli, *Poll: Support for New Nuclear Plants Drops*, CBS NEWS (Mar. 22, 2011), http://www.cbsnews.com/8301-503544_162-20046020-503544.html (last visited June 1, 2012). *See also CNN Poll: Public Says Yes to Nuclear Energy but No to New Plants*, CNN (Mar. 22, 2011), http://politicalticker.blogs.cnn.com/2011/03/22/cnn-poll-public-says-yes-to-nuclear-energy-but-no-to-new-plants/?iref=allsearch (last visited June 1, 2012) (finding that 53 percent of the public opposes building more nuclear power plants in the U.S., up six points from the prior year).

some U.S. officials to call for a moratorium on new plants.[77] This scrutiny increased even more when, six months after the Japanese incident, a 5.8 magnitude earthquake in Virginia was centered twelve miles from the North Anna nuclear power plant .[78] The Virginia quake caused the plant to shake within its design limits, cut off its external source of electricity, and led it to temporarily shut down.[79] These protective systems functioned as planned and no damage or radionuclide releases were reported,[80] but the incident brought heightened attention to existing and proposed new facilities.

Another issue affecting the growth of nuclear power in the United States is managing spent fuel rod waste. Some countries, such as France, reprocess nuclear fuel and recycle the plutonium to create additional reactor fuel. The United States banned reprocessing in the 1970s because reprocessing is extraordinarily expensive and raises security concerns. By chemically separating uranium and plutonium and purifying them, reprocessing spent fuel rods creates material that can be used in nuclear weapons, thereby potentially contributing to nuclear proliferation and nuclear terrorism.[81] As a result, the U.S. is struggling to manage a continuing and significant stream of spent fuel rod waste.

Currently, nuclear power plants generate about 2,000 metric tons of spent fuel rod waste per year, and the Department of Energy (DOE) estimates that by 2055, there will be 153,000 tons of nuclear waste.[82] These spent fuel rods cannot generate enough heat to make electricity, but are still extremely radioactive and will remain so, for the foreseeable future.[83] Thus, the rods must be stored for the long-term in safe, protected areas. A final

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77. *See* Joseph Lieberman, *Stop New Nuclear Plants in US*, THE HILL, Aug. 30, 2011, *available at* http://thehill.com/homenews/sunday-talk-shows/149173-lieberman-stop-new-nuclear-plants-in-us (stating position of author, who is the Senate Homeland Security and Governmental Affairs Chair, that the U.S. should not build nuclear power plants until current safety measures are reevaluated).

78. Brian Vastag, *Inspectors Check Virginia Nuclear Plant for Earthquake Damage*, WASH. POST, Aug. 30, 2011, *available at* http://www.washingtonpost.com/national/health-science/inspectors-check-virginia-nuclear-plant-for-earthquake-damage/2011/08/30/gIQA8SU3rJ_story.html.

79. *See id.* (describing that the earthquake was within .4 magnitudes of facility's maximum).

80. *See id.*

81. *See* Editorial, *Adieu to Nuclear Recycling*, 460 NATURE 152 (2009) (reporting on President Obama's decision to cancel a review underway for determining whether and how to resume commercial nuclear reprocessing in the United States).

82. David Biello, *Spent Nuclear Fuel: A Trash Heap Deadly for 250,000 Years or a Renewable Energy Source?*, SCI. AM., Jan. 28, 2009, *available at* http://www.scientificamerican.com/article.cfm?id=nuclear-waste-lethal-trash-or-renewable-energy-source&print=true; GOVERNMENT ACCOUNTABILITY OFFICE, NUCLEAR WASTE MANAGEMENT: KEY ATTRIBUTES, CHALLENGES, AND COSTS FOR THE YUCCA MOUNTAIN REPOSITORY AND TWO POTENTIAL ALTERNATIVES (2009), *available at* http://www.gao.gov/new.items/d1048.pdf.

83. David L. Foberg, Case Note, *Nuclear Energy Institute, Inc. v. EPA, 373 F.3d 1251 (D.C. Cir. 2004) Will Science Trump Over Policy? The Future of Nuclear Waste Repository at Yucca Mountain, Nevada*, 24 TEMP. J. SCI. TECH. & ENVT'L L. 187, 191 (2005).

solution for the fuel rod storage issue has proven to be controversial and elusive. For years, the federal government sought to establish a permanent national repository of spent fuel rods at Yucca Mountain, Nevada, but that project has been suspended due to local and other political concerns.[84] The decision to terminate these long-term disposal plans led the utilities to seek a termination of the federally-imposed nuclear fuel surcharge of $0.001 per kilowatt hour (amounting to $750 million per year) intended to cover the cost of long-term spent fuel storage.[85]

The net result is that America's nuclear power plants are aging and producing at full capacity, and there has not been a consistent investment in constructing new facilities. The costs associated with decommissioning nuclear power plants, as demonstrated at Three Mile Island and Fukushima, as well as constructing new sources of nuclear energy are substantial. For that reason, the Nuclear Regulatory Commission, the states, and the public are struggling to decide whether to extend the lifetime of nuclear power plants beyond the forty-year period for which they were originally licensed.[86] Some utilities have begun to move forward with plans to build new units at existing plants. Even these new sources of nuclear energy require a long regulatory process and very high capital costs, thereby putting nuclear power expansion beyond the financial and managerial capabilities of all but the largest electric utilities. Indeed, development of new nuclear plants will likely require groups of companies to share costs.

Accordingly, the ability for nuclear-generated electricity to expand significantly, such that it can take on a greater share of American electricity generation, is being increasingly challenged.

B. Natural Gas

Natural gas produces a greater share of American electricity than nuclear power—approximately 24 percent[87]—but it has not yet become a consistent base-load fuel. Until a few years ago, natural gas was favored by

84. *See* Matthew L. Wald, *Court Won't Intervene in Fate of Nuclear Dump*, N.Y. TIMES, July 1, 2011, *available at* http://www.nytimes.com/2011/07/02/science/earth/02yucca.html (describing the long history of setbacks to the Yucca Mountain storage site).

85. Matthew L. Wald, *U.S. Sued Over Nuclear Waste Fees*, N.Y. TIMES, Apr. 5, 2011, *available at* http://www.nytimes.com/2010/04/06/business/energy-environment/06nuke.html.

86. *See* Jia Lynn Yang & Steven Mufson, *Japan Quake Puts Spotlight on Aging U.S. Nuclear Reactors, Cost of Building New Ones*, WASH. POST, Mar. 16, 2011, *available at* http://www.washingtonpost.com/business/economy/japan-quake-puts-spotlight-on-aging-us-nuclear-reactors-cost-of-building-new-ones/2011/03/16/ABFOiWh_story.html (reporting on challenges to proposed relicensing of older nuclear power plants).

87. U.S. ENERGY INFO. ADMIN., SHORT-TERM ENERGY OUTLOOK 8 (Dec. 6, 2011), *at* http://www.eia.gov/forecasts/steo/pdf/steo_full.pdf.

environmentalists because combusting natural gas produces fewer emissions per megawatt than coal. Natural gas prices, however, are prone to significant fluctuations, and over the past twenty years conventional production in the United States has declined.[88] For these reasons, efforts were under way to build facilities along the coasts to import liquefied natural gas (LNG) from Russia, Venezuela, and Middle Eastern countries.[89]

LNG facilities have run into heavy community opposition, and policymakers have expressed concern that a reliance on imported LNG would frustrate national energy independence goals. Much like petroleum, the main international sources of LNG are countries whose interests are not necessarily aligned with those of the United States.[90] The possibility of an "OPEC for natural gas," or natural gas cartel,[91] and concerns that the United States would be competing for LNG with emerging nations and Europe affected natural gas prices in the United States. Given these numerous supply and demand factors, natural gas prices in the 1990s and 2000s were on an upward course and highly volatile. After Hurricanes Katrina and Rita damaged a number of natural gas processing facilities on the Gulf Coast in 2005, natural gas prices spiked from $6/Mcf to more than $14/Mcf over the course of one year.[92] This volatility was of particular concern because natural gas has become the primary fuel used for residential and commercial heating in many areas of the country.[93]

The dynamics for natural gas, though, may be in the process of fundamentally changing given the recent development of "shale" gas.[94] Shale gas is developed by injecting water and chemicals under pressure into deep shale gas formations. The pressure fractures the shale and liberates the

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88. ANNUAL ENERGY OUTLOOK 2011, *supra* note 6, at 79.

89. *See* Federal Energy Regulatory Comm'n, North American LNG Import/Export Terminals: Proposed/Potential, Nov. 1, 2011, *available at* http://www.ferc.gov/industries/gas/indus-act/lng/LNG-proposed-potential.pdf.

90. *See* THE LNG INDUSTRY 5 (2010), *available at* http://www.giignl.org/fileadmin/user_upload/pdf/A_PUBLIC_INFORMATION/Publications/GNL_2010.pdf (finding that more than one-third of LNG exports came from the Middle East in 2010, and that the largest exporters of LNG that year were Qatar (25.5%), Indonesia (10.6%), and Malaysia (10.5%)).

91. Brian Wingfield, *An OPEC For Natural Gas?*, FORBES, Apr. 6, 2007, http://www.forbes.com/2007/04/06/gas-cartel-doha-biz-energy-cx_bw_0406business1.html.

92. U.S. Energy Info. Admin., *EIA Report on Hurricane Impacts on U.S. Energy* (Dec. 27, 2005), http://www.eia.gov/oog/special/eia1_katrina.html (last visited June 1, 2012). Mcf is a unit of measure used for natural gas that equals 1,000 cubic feet.

93. *See* U.S. ENERGY INFO. ADMIN., ANNUAL ENERGY REVIEW 2009, at 51 tbl. 2.4 (2010), *available at* http://www.eia.gov/totalenergy/data/annual/pdf/aer.pdf (providing household energy consumption by census region, selected years, 1978-2005).

94. *See, e.g.,* KENNETH B. MEDLOCK ET AL., SHALE GAS AND U.S. NATIONAL SECURITY 13 (Baker Inst. for Pub. Pol'y at Rice Univ., 2011), *available at* http://bakerinstitute.org/publications/EF-pub-DOEShaleGas-07192011.pdf (last visited June 1, 2012).

gas, which is then pumped to the surface. Advances in horizontal drilling and computer modeling of geological formations have made it economical to develop natural gas from deep underground shale gas formations. The development of shale gas has been referred to by shale gas advocates as a "paradigm shift" and "game changer" for energy policy[95] in providing a "bridge" to a clean energy future.

One of the largest known potential reservoirs of shale gas is in the Marcellus Field located near and along the Appalachian Mountain ranges in New York, Pennsylvania, Ohio, Maryland, and West Virginia. This shale gas is not only important because of the vast quantities that are potentially available, but also because it is located relatively close to major population centers. If the forecasts claiming that shale gas will provide an abundant, low cost source of energy are true—a claim that is subject to significant controversy[96]—then natural gas may become a base-load fuel. If this occurs, additional infrastructure to store and transport gas safely will be required, which can be costly, and, if history is a guide, contentious.

Some have voiced environmental concerns with hydraulic fracturing, particularly with respect to the use of chemicals and vast quantities of water in the fracturing process and the potential contamination of drinking water aquifers.[97] The Secretary of Energy Advisory Board (SEAB), in a ninety-day report on the environmental impact and improved safety of shale gas production, explained those concerns.[98] First, because that water is pumped deep into rock formations, it may not re-enter the water cycle and be available for later consumption. This is a significant concern where there is a scarcity of water resources.[99] Second, the committee expressed great concern for the potential of methane leakage from producing wells into surrounding drinking water.[100] As the New York City Department of

95. Joe Kamalick, *Shale Gas Can Meet US .Needs for 100 Years*, ICIS (July 30, 2008), http://www.icis.com/Articles/2008/07/30/9144315/shale-gas-can-meet-us-needs-for-100-years-study.html (quoting Aubrey McClendon, chief executive of Chesapeake Energy Corp).

96. *See* Ian Urbina, *Behind Veneer, Doubt on Future of Natural Gas,* N.Y TIMES, June 27, 2011, at A1 (reporting skepticism of Energy Information Administration officials regarding shale gas forecasts); Ian Urbina, INSIDERS *Sound an Alarm Amid a Natural Gas Rush*, N.Y. TIMES, June 26, 2011, at A1 (reporting on released e-mails in which "energy executives, industry lawyers, state geologists and market analysts voice skepticism about lofty forecasts").

97. *See, e.g.*, Angela Cupas, Note, *The Not-So-Safe Drinking Water Act: Why we Must Regulate Hydraulic Fracturing at the Federal Level*, 33 WM. MARY ENVTL. L. & POL'Y REV. 605, 610 (2009) (outlining basic hydraulic fracturing procedures).

98. NATURAL GAS SUBCOMM. OF THE SEC'Y OF ENERGY ADVISORY BD., THE SEAB SHALE GAS PRODUCTION SUBCOMMITTEE NINETY-DAY REPORT: AUG. 11, 2011, at 1, *available at* http://www.shalegas.energy.gov/resources/081111_90_day_report.pdf (last visited June 1, 2012).

99. *Id.* at 19.

100. *See id.* at 19-20.

Environmental Protection stated, "[b]ecause of the vast volumes of water utilized in hydraulic fracturing, 1 percent concentration of chemical additives to the fracking fluids results in 160 tons of 'chemistry' [per well]; some of it benign, some of it hazardous, and much of it unknown and undisclosed."[101] The EPA is examining these issues,[102] as understanding and managing the risks and benefits of hydraulic fracturing is still in its infancy. One recent EPA study raised controversy by concluding that groundwater in an aquifer around Pavillion, Wyoming contained "compounds likely associated with gas production practices, including hydraulic fracturing."[103]

Risks posed by natural gas, including shale gas, with respect to climate change allegations are also being studied. A new natural gas electric station produces about half the CO_2 of an equivalent coal plant, though this statistical gap narrows when comparing the two on a life-cycle basis. Robert Howarth, the David R. Atkinson Professor of Ecology and Environmental Biology at Cornell University, found that when one accounts for "leaking" natural gas in the production process, pipelines, or other modes of transportation, the life cycle carbon dioxide-equivalent emissions of gas may be greater than those of coal. As Howarth found, "The take-home message of our study is that if you do an integration of 20 years following the development of the gas, shale gas is worse than conventional gas and is, in fact, worse than coal and worse than oil."[104] Tom Wigley, senior research associate at the National Center for Atmospheric Research, reached a similar conclusion in his paper to be published in the journal *Climatic Change Letters*. He writes that "switching over coal-fired power plants to natural gas would have a negligible effect on the changing climate."[105] A study sponsored by the natural gas industry reached a

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101. HAZEN & SAWYER CONFERENCE, IMPACT ASSESSMENT OF NATURAL GAS PRODUCTION IN THE NEW YORK CITY WATER SUPPLY WATERSHED 9 (2010) , *available at* http://csis.org/files/attachments/100309_Prush_NYDEP.pdf (last visited June 1, 2012).

102. *See, e.g.,* Environmental Protection Agency, Draft Plan to Study the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources (2011), *available at* http://water.epa.gov/type/groundwater/uic/class2/hydraulicfracturing/upload/HFStudyPlanDraft_SAB_020711-08.pdf (last visited June 1, 2012).

103. "EPA Ties Fracking, Pollution," OnlineWSJ, Dec. 19, 2011.

104. ROBERT W. HOWARTH ET AL., METHANE AND THE GREENHOUSE-GAS FOOTPRINT OF NATURAL GAS FROM SHALE FORMATIONS (2011), *available at* http://www.sustainablefuture.cornell.edu/news/attachments/Howarth-EtAl-2011.pdf. *See also* Stacey Shackford, *Natural Gas From Fracking Could be 'Dirtier' Than Coal, Cornell Professors Find,* CHRONICLE ONLINE (Apr. 11, 2011), *available at* http://www.news.cornell.edu/stories/April11/GasDrillingDirtier.

105. Umair Irfan & ClimateWire, *Switching to Natural Gas Power May Not Slow Climate Change*, SCI. AM., Sept. 9, 2011, *at* http://www.scientificamerican.com/article.cfm?id=switching-to-natural-gas-power (last visited June 1, 2012) (discussing study to be in CLIMATIC CHANGE LETTERS).

different conclusion, saying that life cycle natural gas emissions have been overstated.[106]

The larger question of whether natural gas can become a stable, reliable source of base-load fuel has yet to be answered. Utilities and regulators have expressed concern that, without long-term fixed-price contracts to manage financial risk, the price volatility of natural gas is still a significant obstacle. Gas producers have been unwilling to provide such contractual terms, though, because the price volatility of natural gas is a product of weather, pipeline and storage facility reliability, and other factors beyond a natural gas company's control. It is also unclear how utilities would manage temporary spikes in prices. In the past, utilities passed on higher costs to ratepayers, but in the recent age of deregulation, reregulation, and increased rate scrutiny, there is less certainty as to how companies will manage such cost fluctuations. Natural gas will also have to overcome the experience some states, namely Florida, Texas, California, and those in the Northeast, have had with "high levels of dependence on natural gas for electricity," which "have increased the bulk power system's exposure to interruptions in fuel supply and delivery."[107]

Some have speculated that to price natural gas so that it can become a base-load fuel, in addition to finding ways to create additional supply—either through shale gas or imports—companies may have to vertically integrate or pursue other structural changes to the industry. Each of these options could raise regulatory and competition concerns.[108] The bottom line is that a shift in American energy policy to emphasize natural gas as a base-load fuel is potentially on the horizon, but it will first require answers to these and other environmental, economic, and energy questions.

C. Hydroelectric Power

Hydroelectric power provides a significant regional source of renewable energy in the United States, accounting for six to eight percent of electricity generation.[109] Here, energy is generated by converting kinetic energy of flowing or falling water into electricity, typically through the

106. IHS CERA, "Mismeasuring Methane: Estimating Greenhouse Gas Emissions from Upstream Natural Gas Development."

107. N. Am. Elec. Reliability Corp., *Key Issues: Natural Gas Dependency*, *at* http://www.nerc.com/page.php?cid=4%7C53%7C59 (last visited June 1, 2012).

108. *Xcell VP Leery of Natural Gas*, PLATT'S MEGAWATT DAILY, Aug. 4, 2011, at 1.

109. U.S. ENERGY INFO. ADMIN., SHORT-TERM ENERGY OUTLOOK, *supra* note 87, at tbl. 7D.

release of river water held in a dam reservoir through a turbine.[110] Benefits of this electricity generation method are that it does not result in the emission of wastewater, and, once a facility is online, it can generate electricity at comparatively low cost.[111] The great hydroelectric dams built in the 1920s and 1930s—Hoover Dam, Grand Coulee Dam, and the early TVA dams—were instrumental in fostering rural electrification and the development of the West.

The country's dam building days, however, are largely behind it. The chief limitation for hydroelectric power, which prevents it from substantially increasing its share of electricity generation, is the relative shortage of water resources available to build or expand hydroelectric capacity.[112] In the 1920s, hydroelectric plants supplied as much as forty percent of the nation's electric energy.[113] Few new facilities have been built over the past several decades given the lack of suitable new sites.[114] In part, the lack of new hydroelectric capacity reflects the comparatively high-capital costs of constructing a dam—an outlay that is prohibitive to all but the largest companies and the federal government[115] – and the fact that hydroelectric power has inherent reliability limitations because water availability varies "dramatically" from year to year.[116]

New dam building also has been opposed in the environmental community, as hydroelectric power production carries environmental risks. Most prominently, the large land and water flow requirements can displace human populations and adversely impact riparian habitats.[117] Hydroelectric turbines can harm fish populations, frustrate fish migrations, and reduce oxygen levels in downstream water, damaging plants and other

110. Other methods of hydroelectric power production such as tidal and wave power produce an effect similar to a conventional hydroelectric dam. *See* U.S. Energy Info. Admin., *Hydropower Explained: Energy From Moving Water*, http://www.eia.gov/energyexplained/index.cfm?page=hydropower_home (last visited June 1, 2012).

111. *See* Karlie Clemons, *Hydroelectric Dams: Transboundary Environmental Effects and International Law*, 36 FLA. ST. U. L. REV. 487, 490 (2009) (comparing the environmental benefits and harms of hydroelectric with other types of energy production).

112. *See* U.S. DEP'T OF THE INTERIOR BUREAU OF RECLAMATION POWER RES. OFFICE, MANAGING WATER IN THE WEST: HYDROELECTRIC POWER (2005), *available at* http://www.usbr.gov/power/edu/pamphlet.pdf (noting extensive development around areas suitable for hydroelectric power).

113. *See id.*

114. *See id. See also* ANNUAL ENERGY OULOOK 2011, *supra* note 6, at 74.

115. *See* U.S. Energy Info. Admin., *Where Hydropower is Generated* (last updated July 5, 2011), http://www.eia.gov/energyexplained/index.cfm?page=hydropower_where ("[A] small percentage of all dams in the [U.S.] produce electricity"). *See also* Roy L. Nersesian, Energy for the 21st Century: A Comprehensive Guide to Conventional and Alternative Sources 291 (2007) (detailing costs of dams).

116. U.S. Energy Info. Admin., *U.S. Hydropower Output Varies Dramatically From Year to Year*, (Aug. 15, 2011), http://www.eia.gov/todayinenergy/detail.cfm?id=2650.

117. *See* Karlie Clemons, *Hydroelectric Dams: Transboundary Environmental Effects and International Law*, 36 FLA. ST. U. L. REV. 487, 491-98 (2009) (describing harms from hydropower).

indigenousness species.[118] With regard to GHGs, it was believed that hydroelectric power does not generate carbon dioxide and methane, but recent studies suggest that these gases form in man-made dam reservoirs and are emitted into the atmosphere.[119] Such theories need closer study.[120]

Today, the focus of the nation's efforts regarding hydroelectric power is to decommission and remove existing, smaller dams.[121] The absolute number of dams has been declining, and only three percent of U.S. dams generate electricity.[122] With nearly sixty percent of hydroelectric capacity concentrated in just four states – Washington, Oregon, California, and New York[123] – the outlook for hydroelectric power production is relatively flat.

D. Wind

Wind is a clean, renewable energy source. It can provide a significant source of electricity, particularly in the "wind belt" region from the Dakotas to Texas. Since 2006, wind has quickly risen from four to eleven percent of total renewable energy generation.[124] Overall, it accounts for about two percent of power generation in the United States.[125]

As with all renewable energy sources, wind has limitations that prevent it from serving as a base-load source of electricity. First and foremost, wind is intermittent and cannot consistently meet demand. As a result, it is difficult to put wind power on the grid, even during peak times (early morning, late evening, and during hot and cold extremes) because wind is

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118. *See id.* at 493-97 (outlining the negative effects hydroelectric dams may have on river ecosystems); Janet M. Hager, *Tension Between Hydroelectric Energy's Benefits as a Renewable and its Detrimental Effects on Endangered Species*, 10 Sustainable Dev. L. & Pol'y 50 (2009).

119. *See* Clemons, *supra* note 111, at 492 (stating Brazil's National Research Institute "estimate that large damns may be responsible for worldwide annual emissions of 800 million tons of carbon dioxide whereas the United Kingdom's *total* greenhouse gas emissions in 2006 was around 660 million tons"); U.S. Energy Info. Admin., *Hydropower and the Environment, at* http://www.eia.gov/energyexplained/index.cfm?page=hydropower_environment (last visited June 1, 2012) ("Greenhouse gases, carbon dioxide and methane, may also form in reservoirs and be emitted to the atmosphere.").

120. *See Hydropower Explained: Energy From Moving Water*, *supra* note 110 ("The exact amount of greenhouse gases produced from hydropower plant reservoirs is uncertain.").

121. Two-hundred forty-one dams were demolished between 2006 and 2010, more than a forty percent increase over the prior five years. Those demolished were mostly smaller dams that powered everything from textile to paper production. *See* Juliet Eilperin, *Elwha Dam Removal Illustrates Growing Movement*, WASH. POST, Sept. 16, 2011.

122. *See* Hager, *supra* note 118, at 50

123. *See* ENERGY INFO. ADMIN., RENEWABLE ENERGY CONSUMPTION AND ELECTRICITY PRELIMINARY STATISTICS 2010, at 10 tbl. 5 (2011), *at* http://www.eia.gov/renewable/annual/preliminary/pdf/preliminary.pdf (last visited June 1, 2012) [hereinafter Renewable Energy and Electricity Statistics].

124. U.S. ENERGY INFO. ADMIN., RENEWABLE ENERGY CONSUMPTION AND ELECTRICITY PRELIMINARY STATISTICS 2010, 2 (2011), *available at* http://www.eia.gov/renewable/annual/preliminary/pdf/preliminary.pdf.

125. *Id.*

generally strongest overnight.[126] For instance, on hot summer days, when air conditioner use is highest, winds tend to be calm. Second, not all states have the capacity to generate significant wind energy. Texas currently accounts for more than one-quarter of the nation's energy generation from wind, and the Great Plains states have the highest concentration of wind turbines.[127] Yet, Texans can count on less than ten percent of that capacity to be available during periods of peak electricity usage.[128]

Wind energy has received considerable government support, including a renewable tax credit that funds about one-third of the cost of wind energy.[129] In addition, a number of states have "renewable portfolio" requirements, forcing utilities to purchase defined amounts of wind energy.[130] The ability of wind to survive without this government support is unproven. The federal government has not authorized permanent or long-term renewable tax credits, and each time the credits have expired before renewal, wind construction has plummeted.[131]

Wind energy also faces several other obstacles. From an environmental perspective, these challenges include bird kills and the endangered species and other land use issues that arise from the construction of large wind projects. Additionally, wind projects have to be backed up by fossil fuel generation that can ramp operations up and down quickly to match the

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126. U.S. Energy Info. Admin., *Increasing Wind Capacity Requires New Approaches to Electricity Planning and Operations* (Mar. 22, 2011), http://www.eia.gov/todayinenergy/detail.cfm?id=610.

127. *See* RENEWABLE ENERGY AND ELECTRICITY STATISTICS, *supra* note 123, at 11 (wind generation in Texas in 2010 was 26,132,202 thousand kilowatt-hours compared to the national total of 96,646,778 thousand kilowatt-hours). *See also Increasing Wind Capacity Requires New Approaches to Electricity Planning and Operations*, *supra* note 126 (highlighting problems with variability in wind energy production); Margaret Bryant, *Wind Energy in Texas: An Argument for Developing Offshore Wind Farms,* 4 ENV'T & ENERGY L. & POLICY J. 127, 128-29 (2009) (explaining Texas' inability to rely on wind power resulting from variability in wind power production).

128. *See* Declaration of Warren Lasher, Manager of Long-Term Planning and Policy of the Electricity Coordinating Council of Texas, in *Texas v. EPA*, No. 11-1338 (D.C. Cir.) (stating the ERCOT region of Texas, representing most of the state, has 9,452 MW of wind generation, but counts on only 822 MW of that generation, or 8.7%, as "firm" capacity).

129. *See* American Recovery and Reinvestment Tax Act of 2009, Pub. L. No. 111-5, 123 Stat 115, § 1603 (2009) (offering renewable energy project developers cash awards are equivalent to thirty percent of the project's total eligible cost basis). The government has awarded the bulk of this funding to wind projects. *See* U.S. Dep't of Treasury, Overview and Status Update of the §1603 Program, at 2 (Feb. 25, 2011), *at* http://www.treasury.gov/initiatives/recovery/Documents/2011-03-02-S1603%20Overview.pdf (last visited June 1, 2012) (reporting approximately eighty percent of such tax credits were awarded to wind projects).

130. *See* U.S. Dep't of Energy, States with Renewable Portfolio Standards (May 2009), *at* http://apps1.eere.energy.gov/states/maps/renewable_portfolio_states.cfm (last visited June 1, 2012).

131. *See, e.g.,* Jim Witkin, *Wind Industry Lobbies for Tax-Credit Extension*, N.Y. TIMES GREEN BLOG, Sept. 6, 2011, at http://green.blogs.nytimes.com/2011/09/06/wind-industry-lobbies-for-tax-credit-extension/ (last visited June 1, 2012).

intermittent nature of wind generation. These fossil fuel generators emit GHGs; thus, there is no such thing as a carbon-free wind project. Further, because wind farms in the "wind belt" are located far from major metropolitan areas, long-line transmission projects to bring the power to the customers are needed, which are costly and difficult to build. These transmission projects also can create intractable issues, including where to locate the projects, landowner opposition, and determining who should pay for these projects. Further, off-shore wind farms, which can be closer to people, require high capital costs for installation.[132] An installed offshore wind farm can cost as much as $4,600 per kilowatt, which is higher than electricity generated from almost any other source.[133]

In addition, wind development has been opposed by communities that do not want wind farms and associated transmission lines near their homes or marring the landscape.[134] For example, the best wind resources in the eastern United States are on the ridge lines of the Appalachian Mountains and in the Atlantic Ocean just off the coast. Coastal wind farms must be placed close enough to the shoreline so that the wind harnessed by the turbines can be transmitted back to the mainland via underwater cables. In Massachusetts, the wind farm planned for off the coast of Cape Cod, known as "Cape Wind," has drawn the ire of the local community because of concerns over aesthetics, noise, safety, navigation, property values, and environmental issues – disturbances to marine animal and migratory bird populations, changes to the seascape, and the impact on tourism.[135] In an effort to overcome these complaints, the developers, federal government and state governments are considering the feasibility of building affordable offshore wind farms beyond visual range.[136]

Optimistically, if wind farms are built and backed up with natural gas, there is a potential that wind energy can shoulder a greater share of the market. Such progress will largely depend on the price and availability of natural gas and continued government support. It remains unlikely, though, that wind will be able to compete as a base-load source of electricity.

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132. Michael P. Giordano, *Offshore Windfall: What Approval of the United States First Offshore Wind Project Means for the Offshore wind Energy Industry*, 44 U. RICH. L. REV. 1149, 1152-53 (2010).

133. *Id.* at 1152.

134. Rigano, *supra* note 72, at 213.

135. *See* Dominic Spinelli, *Historic Preservation & Offshore wind Energy: Lessons Learned from the Cape wind saga*, 46 Gonz. L. Rev. 741, 748 (2010-2011); NAT'L RENEWABLE ENERGY LAB., LARGE-SCALE OFFSHORE WIND POWER IN THE UNITED STATES: ASSESSMENT FOR OPPORTUNITIES AND BARRIERS 8 (2010), *available at* http://www.nrel.gov/wind/pdfs/40745.pdf.

136. The Department of Interior issued guidelines summarizing and streamlining requirements for agencies to site and contract offshore wind farms. Renewable Energy and Alternate Uses of Existing Facilities on the Outer Continental Shelf, 74 Fed. Reg. 19,638 (Apr. 29, 2009).

E. Solar

Solar energy, as a share of the nation's energy consumption, has steadily risen each of the past five years; it currently fulfills more than one percent of America's electricity needs.[137] Three states (California, Nevada, and Florida) provide the bulk of solar energy generation that is placed on the grid; other areas have shown far less potential.[138] This is because solar energy has some of the same basic limitations as wind with respect to satisfying a meaningful share of electricity demand. Just as wind energy can be created only when the wind blows, solar energy can be generated only when and where the sun shines.[139] Solar energy also has limited storage abilities, primarily through rechargeable batteries and molten salts. It also is not "dispatchable." These shortcomings are exacerbated in the winter when the temperatures are the coldest, the days are shortest, and the demand for electricity at night is highest.

Three other factors limiting solar energy from increasing its contribution to the grid are: the amount of acreage needed for the mass generation of electricity from solar plants, the amount of water resources needed to generate solar energy, and its cost. Solar projects require approximately five to ten acres of land per megawatt of capacity. Therefore, an area as large as 29,000 acres may be required for a single utility-scale solar plant. This makes locating large solar energy installations near population centers particularly difficult.[140] For example, the solar mirror field proposed for just outside the Mojave National Preserve will consume some 3,400 acres (5.3 square miles).[141] Land and wildlife conservation

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137. U.S. ENERGY INFO. ADMIN., RENEWABLE ENERGY CONSUMPTION AND ELECTRICITY PRELIMINARY STATISTICS 2010, 5 (2011), *available at* http://www.eia.gov/renewable/annual/preliminary/pdf/preliminary.pdf. *See also* Sarah Pizzo, *When Saving the Environment Hurts the Environment: Balancing Solar Energy Development with Land and Wildlife Conservation in a Warming Climate*, 22 COLO. J. INT'L ENVTL. L. & POL'Y 123, 131 (2011) (stating "solar energy accounts for a small percentage of U.S. energy demand").

138. California, Nevada, and Florida account for 88 percent of solar power generation, followed by Colorado, New Jersey, Ohio, Illinois, Arizona, North Carolina, and Pennsylvania. *See* RENEWABLE ENERGY AND ELECTRICITY STATISTICS, *supra* note 123, at 11 (finding California, Nevada, and Florida each provide more than five times as much solar energy generation as any other state). Solar power generation is negligible in most other states. *See id.*

139. U.S. Envt'l Protection Agency, *Energy and Global Climate Change in New England: Solar Energy*, http://www.epa.gov/region1/eco/energy/re_solar.html (last visited June 1, 2012).

140. Pizzo, *supra* note 137, at 135-36.

141. *Ivanpah Solar Electric Generating System*, CAL. ENERGY COMM'N, http://www.energy.ca.gov/sitingcases/ivanpah/index.html (last visited June 1, 2012).

groups have vocally opposed this project because of the impact it will have on endangered species and migration corridors.[142]

Thermal solar energy also strains water resources. It requires up to 1,000 gallons of water per megawatt hour of electricity produced, which exceeds the amount of water used at a nuclear or coal plant.[143] Water is primarily used to produce steam, which generates electricity. Maintaining these water temperatures when the sun does not shine can require the combustion of fossil fuels. Water is also needed for cooling and regular cleaning of the panels and reflectors.[144] In 2009, the National Park Service sent the Bureau of Land Management a memorandum informing the Bureau that "approving dozens of solar power plants in southern Nevada could dramatically impact water supply across the arid region."[145]

Finally, the cost of solar power is higher than conventional power sources, even with about one-third of solar power's cost subsidized through federal tax credits. Such government support of solar power may be undermined by recent events with Solyndra, a solar-panel company supported by more than $500 million in government loan guarantees that filed for bankruptcy protection.[146] Without those subsidies, the average price of solar electricity will reflect its true cost, which is roughly double that of coal-fired generation.[147]

Solar energy has established itself, though, as a means for governments, businesses, and individuals to supplement electricity received from power companies. It is well-suited to provide needed electricity for specific tasks, such as generating electricity for street lights, homes, and office buildings. However, as discussed above, the advantages of solar power diminish when used on a large scale or to produce power for the grid.

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142. *See* Ken Cole, *WWP Sues to Stop Fast Tracked Ivanpah Power Plant in California*, WILDLIFE NEWS, Jan. 17, 2011, *available at* http://www.thewildlifenews.com/2011/01/17/wwp-sues-to-stop-fast-tracked-ivanpah-power-plant-in-california/ (alleging planned solar plant would destroy habitat for endangered desert tortoise and other species).

143. Pizzo, *supra* note 137, at 138.

144. In addition, spills can contaminate nearby water sources *Id.*

145. Scott Streater, *Park Service Warns of Solar Projects' Impacts to Mojave Desert*, N.Y. TIMES, Apr. 23, 2009, *available at* http://www.nytimes.com/gwire/2009/04/23/23greenwire-park-service-warns-of-solar-projects-impacts-t-10660.html.

146. Solyndra was considered the "hallmark of the President's green jobs program" that was part of the stimulus package. *See* Joe Stephens & Carol D. Leonnig, *Solyndra Loan: White House Pressed on Review of Solar Company Now Under Investigation*, WASH. POST, Sept. 13, 2011, at A1. *See also* Matthew L. Wald & Charlie Savage, *Furor Over Loans to Failed Solar Firm*, N.Y. TIMES, Sept. 14, 2011. Indeed, the House of Representatives reacted by seeking reallocation of $1.5 billion allocated to the Department of Energy's green auto loan program to disaster relief funding. *See* Amy Harder, *Solyndra is Silent; Lawmakers Make Noise*, NAT'L J., Sept. 23, 2011.

147. *See* Pizzo, *supra* note 137, at 132 (comparing the difference in production cost of energy from solar sources to that of industrial sources).

F. Biomass

Biomass energy is derived largely from organic and agricultural waste, such as bark, wood, and sugar cane. It has a long history of use in pulp and paper industry boilers. In fact, it is commonly called "[t]he oldest and most prevalent source of renewable energy known to man."[148] Biomass is a dispatchable form of energy and produces about one percent of the American electricity supply. Additionally, it can be converted into other usable forms of energy, including methane gas, ethanol, and bio-diesel.

Since the early 1990s, the federal government has promoted biomass energy production through renewable energy credits,[149] as biomass is considered "carbon neutral." Some have questioned this assertion, however, because a tree's carbon dioxide is released in one "shot" during the production of biomass energy rather than as if the same tree were allowed to rot over decades. A larger issue for environmentalists is that in "closed loop" operations where plants are harvested to be burned, the plants tend to be wet, burn inefficiently, and emit more carbon dioxide per unit of energy than are associated with other sources, including coal.[150] This led certain environmental groups to argue that switching to biomass can increase GHG emissions[151] and challenge EPA's decision to treat biomass as carbon-neutral in issuing Clean Air Act preconstruction permits.[152]

If biomass is to contribute more to America's national energy supply, then "closed loop" facilities will need to rise in prominence. "Open loop" plants—those that take waste from whatever sources are available, including wood waste from construction and manufacturing industries—are limited by the amount of waste available for burning. In the United States, approximately 100 million tons of forest residue is generated each year. Even if half of all of this waste were burned, biomass's percentage of national energy production would only increase a few percentage points. In addition, there are concerns that burning these "open loop" items will emit

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148. *Earth Talk, Can Biomass Be Used to Generate Power*, N.H. PUB. RADIO (Mar. 18, 2009), http://www.nhpr.org/node/24076.

149. Deferral for CO_2 Emissions From Bioenergy and Other Biogenic Sources Under the Prevention of Significant Deterioration (PSD) and Title V Programs, 76 Fed. Reg. 43,490 (July 20, 2011).

150. *Biomass Energy in the South,* S. ENV. L. CENTER (AUG. 26, 2011), http://www.southernenvironment.org/cases/biomass_energy_in_the_south.

151. *See id.*

152. Center for Biological Diversity v. EPA, No. 11-1101 (D.C. Cir., filed April 7, 2011). *See also* Final Rule, Envt'l Protection Agency, *Deferral for CO_2 Emissions From Bioenergy and Other Biogenic Sources Under the Prevention of Significant Deterioration (PSD) and Title V Programs*, 76 Fed. Reg. 43,490 (July 20, 2011).

a variety of conventional pollutants, including particulate matter, carbon monoxide, nitrogen oxides, and volatile organic compounds.[153]

The current focus, therefore, is to build small biomass-fueled electric generating plants in the Southeast and Midwest that can be constructive pieces in America's energy puzzle.

G. Demand-Side Management

In addition to alternative sources of energy, the other aspect of America's energy policy that may improve the energy industry's environmental profile is to find ways to manage energy consumption more efficiently. This can be done through technology innovation or behavioral changes in consumer energy consumption. Such "demand-side management" (DSM) efforts have been part of national and state energy policy for decades and have recently received renewed emphasis.[154]

One widely-discussed energy efficiency effort involves the development of an efficient system of energy transmission through what is called the "Smart Grid."[155] Congress focused on this issue in enacting the Energy Independence and Security Act of 2007.[156] The Smart Grid system integrates "sophisticated sensing and monitoring technology" and "cutting-edge power engineering"[157] to maximize how efficiently electric energy is stored and transferred. It identifies and responds in "real time" to congestion problems, disturbances, and variations in energy consumption that ordinarily result in electricity loss.[158] The Smart Grid is intended to

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153. *Five Groups Sue EPA over Punt on Biogenic Greenhouse Gas Regulation*, PARTNERSHIP FOR POL'Y INTEGRITY (Aug. 16, 2011), http://www.pfpi.net/five-groups-sue-epa-over-punt-on-biogenic-greenhouse-gas-regulation (last visited June 1, 2012).

154. *See* Steven D. Czajkowski, Note, *Focusing on Demand Side Management in the Future of the Electric Grid*, 4 PITT. J. ENVTL PUB. HEALTH L. 115, 129 (2010) (noting demand-side management originated in the energy crisis of the 1970s and early 1980s). *See also* Steven Ferrey, Restructuring A Green Grid: Legal Challenges to Accommodate New Renewable Energy Infrastructure, 39 ENVTL. L. 977, 983 (2009) (stating President Obama's stimulus plan increased funding to DSM by 1,000%).

155. *See* Alison C. Graab, *The Smart Grid: A Smart Solution to a Complicated Problem*, 52 WM. & MARY L. REV. 2051, 2052-54 (2011) (Congress under the Energy Independence and Security Act of 2007 "delegated authority to federal agencies to implement the Smart Grid").

156. Energy Independence and Security Act of 2007, Pub. L. No. 110-140, §§ 1301–1309, 121 Stat. 1492, 1783–1794 (2007) (to be codified in scattered titles of the U.S.C.).

157. ENERGY FUTURE COALITION, CHALLENGE AND OPPORTUNITY: CHARTERING A NEW ENERGY FUTURE 24 (2003), *available at* http://www.energyfuturecoalition.org/files/webfmuploads/EFC_Report/EFCReport.pdf.

158. *See* STAN MARK KAPLAN, CONG. RESEARCH SERV., ELECTRIC POWER TRANSMISSION: BACKGROUND AND POLICY ISSUES 23 (2009), *available at* http://fpc.state.gov/documents/organization/122949.pdf ("[T]he smart grid can be viewed as a suite of technologies that give the grid the characteristics of a computer network in which information and control flows between and is shared by individual customers and utility control centers.").

replace the current electric energy transmission grid that has been in operation since the 1970s,[159] but the investment required will be massive and stimulus funds provided for Smart Grid in the American Recovery and Reinvestment Act were only a small down payment.

Smart Grid technology is also intended to promote energy-efficient choices on the customer's side of the meter.[160] "Smart meters" are more advanced than traditional meters installed at homes and used by utilities to measure consumer electricity use; they "track energy use daily, hourly, monthly and even instantaneously."[161] When demand is particularly high or electricity expensive, such as during peak times, smart meters allow utility companies to communicate with consumers, for example, via e-mail. Better-informed consumers can then reduce their electricity use and costs, and decrease overall consumption.[162] Consumers looking to conserve energy will also be able to monitor their electricity use online.[163] Although the utility industry believes strongly in the ability of a "smart gird" to make the transmission and distribution of electricity more efficient, opinion is more divided on whether "smart meters" will lead customers to significantly reduce electricity usage. In particular, unless utilities move to "time-of-day" pricing, where electricity is priced at higher rates during peak usage, customers may not have sufficient incentive to reduce electric consumption at the times when they want electricity the most. State utility regulators have shown reluctance to move to time-of-day pricing, and they have also been reluctant to approve funding of the large investments needed to make "smart grid" a reality on the utility side of the meter.

Traditional DSM efforts have produced significant results in some states. In California, DSM programs spanning four decades have helped stabilize the state's per capita electricity consumption.[164] Although other factors (such as high electric rates and mild climate) dominate the reasons for this trend, estimates suggest that policy measures and public awareness campaigns regarding energy use and efficiency account for a quarter of that

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159. *See* Massoud Amin & Phillip F. Schewe, *Preventing Blackouts*, Sci. Am., May 2007, at 61, *available at* http://central.tli.umn.edu/Amin/SciAm_0507_pp60-67.pdf, (arguing the energy grid, which has been in place since the 1970's must be made "smarter").

160. KAPLAN, *supra* note 158, at 23.

161. Graab, *supra* note 155, at 2056 (quoting Elizabeth Shogren, All Things Considered: Smart Meter Saves Big Bucks for Pa. Family (NPR radio broadcast Apr. 28, 2009)).

162. *See* KAPLAN, *supra* note 158, at 23 (noting utilities will seek to use indicators via the internet, email and computer software to inform customers demand and cost spikes).

163. *See id.*

164. Michael P. Vandenbergh et al., *Regulation in the Behavioral Era,* 95 MINN. L. REV. 715, 740 (2011).

result.[165] Similarly, a General Electric study estimated that increasing consumer awareness of electricity costs could result in a 10 to 20 percent reduction in demand due to deceased consumption.[166] Also, a recent U.S. Energy Information Administration (EIA) report stated that between 1989 and 2005 electric efficiency efforts saved 860 billion kilowatt-hours, or enough electric energy to power over 76 million homes for an entire year.[167]

III. GUIDANCE FOR MANAGING BENEFITS AND RISKS OF COAL

Determining how each energy source fits into America's national energy policy for electricity generation requires accurate and complete information, as well as honest assessments. At least with respect to coal, there has been significant misinformation put into the public domain by those seeking to curtail coal's use as a base-load fuel. This opposition is in large part based on outdated information or emotional rhetoric. This section of the article seeks to assist policymakers by factually debunking five prominent myths about the impacts of coal production and use. It then offers policymakers five principles for how coal's benefits can be maximized and its risks managed as part of this national energy policy.

A. Myths that Should be Dispelled When Regulating Coal

1. Myth #1: Coal Production Is Loosely Regulated

One rationale often cited for increased regulation of coal is that coal is loosely regulated.[168] This is a myth. Because of its long history, coal has become "one of the most heavily regulated industries in the United States."[169] Government regulation begins with mining operations, which are required to have permits under the Surface Mining Control and Reclamation Act (SMCRA) and parallel state laws.[170] SMRCA, which regulates all aspects of mining, operations, and reclamation, is administered

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165. *See id.*

166. Graab, *supra* note 155, at 2057.

167. *See* Edward H. Comer, *Transforming the Role of Energy Efficiency*, 23 NAT. RESOURCES & ENV'T 34 (2008).

168. *See, e.g.*, Jonathan Skinner, *Myths of Coal's Clean Future: The Story of Methylmercury*, 29 VA. ENVT'L L.J. 171, 195–96 (2011) ("From extraction to refinement to use, today's coal industry operates largely between the reach of major U.S. environmental acts and regulations.").

169. A. Brooke Rubenstein & David Winkowski, *A Mine is a Terrible Thing to Waste: Past, Present and Future Reclamation Efforts to Correct the Environmentally Damaging Effects of Coal Mines*, 13 VILL. ENVT'L L.J, 189 (2002).

170. Surface Mining Control and Reclimation Act, 30 U.S.C. §§ 1201–1328 (2006).

by the U.S. Department of the Interior's Office of Surface Mining (OSM). OSM sets detailed standards of performance for mining and reclamation projects, sets minimum standards for state programs, and requires operators to develop and adhere to specific mining plans. It funds state regulatory and reclamation efforts and assures consistency among state permitting and regulatory programs. The agency also requires bonding to ensure payment of reclamation costs, provides for a program of inspection and enforcement, and restricts mining on certain environmentally sensitive lands. In addition, mine operators must secure permits pursuant to the Clean Air Act, Clean Water Act and state law to control environmental impacts.

The shipment of coal, generally by rail, is regulated by three government agencies. The Surface Transportation Board regulates construction of new railroads, including spurs that connect mining facilities with the network of railroads around the country. The National Environmental Policy Act (NEPA) requires environmental impact statements for any significant railway construction. The Federal Railroad Administration regulates all movements of cargo on those railways. Both of these agencies are housed within the U.S. Department of Transportation. Air quality impacts from diesel locomotives are regulated by EPA.

Coal combustion is extensively regulated under the Clean Air Act (CAA). The National Ambient Air Quality Standards (NAAQS) program,[171] which prohibits accumulation in the air of the six most ubiquitous pollutants at levels that pose a threat to human health and welfare, limits emissions through facility-specific emission standards in state implementation plans. These and other public health and welfare-based regulations are implemented through programs requiring permits for new power plant construction, major renovation activity, and power plant operation.[172] EPA is also proceeding on a broad front to subject coal-fired power plants to more stringent NAAQS.[173] Within the last two years, EPA has promulgated new NAAQS for sulfur dioxide[174] and nitrogen dioxide,[175] new requirements for interstate transport of sulfur dioxide and nitrogen

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171. Clean Air Act, 42 U.S.C. §§ 7409–7411 (2006).

172. *Id.* at §§ 7502(c)(5), 7503, 7661–7661f.

173. EPA is on track to reconsider its ozone standards by 2013. John M. Broder, *E.P.A. Issues Tougher Rules for Power Plants,* N.Y. TIMES, July 8, 2011, at A12, *available at* http://www.nytimes.com/2011/07/08/science/earth/08epa.html.

174. Primary National Ambient Air Quality Standard for Sulfur Dioxide, 75 Fed. Reg. 35520 (June 22, 2010) (to be codified at 40 C.F.R. pts. 50, 53, & 58).

175. Federal Implementation Plans: Interstate Transport of Fine Particulate Matter and Ozone and Correction of SIP Approvals, 76 Fed. Reg. 48208 (Aug. 8, 2011) (to be codified at 40 C.F.R. pts. 51, 52, 72, 78 and 97).

oxides emissions,[176] and new pre-construction permit and operating permit standards for GHGs.[177] EPA is also contemplating tightening the ozone[178] and particulate matter NAAQS.[179]

EPA has also proposed new standards for power plant emissions of hazardous air pollutants,[180] intake structures for water used by power plants for cooling,[181] and the handling and disposal of coal combustion residuals.[182] It is promulgating new standards of performance for emissions of GHGs from new, modified, and potentially existing power plants.[183]

2. Myth #2: Coal mining is unsafe.

Coal mining has come a long way from its dangerous beginnings. Early miners faced a daily threat of being buried alive in a collapse, drowned in sudden floods, or burned in a fire.[184] Without modern ventilation, they were at risk of death from inhalation of coal dust ("black lung" disease) and from exposure to three gases: carbon dioxide, carbon monoxide, and methane.[185] The first could suffocate them without warning, the second could lead to a slow poisoning, and the third could lead to catastrophic explosions, which were so common in the 1700s that newspapers did not cover them.[186] The "canary in the coal mine" originated from the miners' use of the bird; when the canary fell off its perch, it was a warning sign of carbon monoxide.[187] In

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176. *Id.*

177. Envtl. Prot. Agency, Final Rule: Prevention of Significant Deterioration and Title V Greenhouse Gas Tailoring Rule 1-2, 6 (2010), *available at* http://www.epa.gov/nsr/documents/20100413fs.pdf.

178. *See* Proposed Rule, Environmental Protection Agency, National Ambient Air Quality Standards for Ozone, 75 Fed. Reg. 2938 (Jan. 19, 2010).

179. *See* Proposed Rule, Environmental Protection Agency, Hazardous and Solid Waste Management System; Identification and Listing of Special Wastes; Disposal of Coal Combustion Residuals From Electric Utilities, 75 Fed. Reg. 35,127 (June 21, 2010).

180. EPA National Emission Standards for Hazardous Air Pollutants From Coal- and Oil-Fired Electric Utility Steam Generating Units and Standards of Performance for Fossil-Fuel-Fired Electric Utility, Industrial-Commercial- Institutional, and Small Industrial-Commercial-Institutional Steam Generating Units; Proposed Rule, 76 Fed. Reg. 24976 (Proposed May 3, 2011) (to be codified at 40 C.F.R pt. 60, 63).

181. National Pollutant Discharge Elimination System – Cooling Water Intake Structures at Existing Facilities and Phase I Facilities, 76 Fed. Reg. 43230 (proposed July 20, 2011) (to be codified at 40 C.F.R. pt. 122).

182. Hazardous and Solid Waste Management System; Identification and Listing of Special Wastes; Disposal of Coal Combustion Residuals from Electric Utilities, 75 Fed. Reg. 35128 (Proposed June 21, 2010) (to be codified at 40 C.F.R. pt. 257).

183. Proposed Settlement Agreement, Clean Air Act Citizen Suit, 75 Fed. Reg. 82,392-01 (Dec. 30, 2010).

184. FREESE, *supra* note 15, at 47-53.

185. *Id*.

186. *Id*.

187. *Id*. at 49.

the early 1900s, American miners relied on the instincts of mine rats, who would scurry away when they sensed subtle shifts in mine workings.[188] Given this history, it is easy to understand the concern about mine safety.

Mining today is very different. Injuries have dropped dramatically in the United States from a peak of 3,242 work-related fatalities in 1907, when the nation had its single deadliest mine disaster,[189] to a low-point of eighteen work-related fatalities in 2009.[190] This decline is due to several reasons, most notably much greater safety measures, a cultural shift among workers and operators, and the substantial reduction in the number of miners, particularly those working underground. For instance, between 1931 and 1977, even as coal production increased substantially, annual fatal mining injuries fell from 1,456 to 100,[191] and the fatal injury-frequency rate per million man-hours declined by nearly 75 percent.[192] Coal miners were also less likely to suffer nonfatal injuries, as the number of such injuries declined from 77,193 to 11,724 during this period,[193] and the frequency rate of injuries fell by 43 percent.[194]

Enactment of the Federal Mine Safety and Health Act of 1977 (FMSHA),[195] which governs the Mine Safety and Health Administration's (MSHA) activities, and some recent laws,[196] have further increased mining safety. The number of fatal injuries, nonfatal injuries, and injury rates has continued to steadily decline.[197] The majority of coal mines in the United

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188. *Id*. at 139. An 1891 law, which set ventilation requirements and prohibited operators from employing children under twelve years of age, marked the first federal intervention in mine safety. *See* Mine Safety & Health Admin., History of Mine Safety and Health Legislation, http://www.msha.gov/mshainfo/mshainf2.htm (last visited June 1, 2012) (describing lack of safety legislation for miners).

189. *See* Assoc. Press, *Deadliest Recent U.S. Mine Accidents*, MSNBC.MSN.COM, (Apr. 6, 2010), http://www.msnbc.msn.com/id/36192868/ns/us_news-life/t/deadliest-recent-us-mine-accidents/ (noting that 362 miners were killed in an explosion near Monongah, West Virginia in 1907).

190. Mine Safety & Health Admin., *Coal Fatalities for 1900 Through 2010*, http://www.msha.gov/stats/centurystats/coalstats.asp (last visited June 1, 2012).

191. Mine Safety & Health Admin., *Historical Data 1931–1977, All Coal Mines in the United States*, tbl. 3 [hereinafter *Historical Data 1931–1977*], http://www.msha.gov/STATS/PART50/WQ/1931/wq31cl03.asp (last visited June 1, 2012).

192. *Historical Data 1931–1977*, *supra* note 191, at tbl. 5, *available at* http://www.msha.gov/STATS/PART50/WQ/1931/wq31cl05.asp.

193. *Historical Data 1931–1977*, *supra* note 191, at tbl. 4, *available at* http://www.msha.gov/STATS/PART50/WQ/1931/wq31cl04.asp.

194. *Historical Data 1931–1977*, *supra* note 191, at tbl. 6 *available at* http://www.msha.gov/STATS/PART50/WQ/1931/wq31cl06.asp.

195. Federal Mine Safety and Health Act of 1977, Pub. L. No. 91-173, § 2 (amended by Pub. L. 109-280 (Aug. 17, 2006).

196. Mine Improvement and New Emergency Response Act of 2006, Pub. L. 109-236, §§ 2(C), 5(a) (June 15, 2006).

197. *See Injury Experience and Worktime Data at All Coal Mines in the United States*, MINE SAFETY & HEALTH ADMIN., http://www.msha.gov/STATS/PART50/WQ/1978/wq78cl09.asp (last visited June 1, 2012).

States operate each year without any lost work time due to injury.[198] Such improvements in the safety record of coal mining demonstrate that this activity can be and is performed in a safe manner.

Certainly, coal mining today is not without risk. In 2010, following a record low number of mining fatalities, a West Virginia coal mine explosion killed 29 miners,[199] contributing to a total of 48 fatalities that year.[200] The recent dramatic rescue of 33 Chilean miners after 69 days underground,[201] and other reports of mining tragedies abroad,[202] may reinforce the image of mining as a highly dangerous profession. They are to be taken seriously, and the importance of miner safety cannot be understated.

By and large, however, the horror stories associated with coal mining are relics of a by-gone era. The United States, along with the United Kingdom and Australia, lead the world in reducing miner fatality rates.[203] There were 21 coal mining-related fatalities in 2011, a level just above the 2009 historic low.[204] As one commentator noted, even in years when the number of coal mining fatalities is uncharacteristically high, "the rate at which coal miners died on the job was a little more than the fatality rate for garbage collectors and a little less than the fatality rate for iron workers."[205]

3. Myth #3: Coal mining will continue to leave "scars" on the earth's surface when the mines are abandoned.

Complaints about abandoned coal mines scarring the earth's surface or causing permanent hazards is an anachronism. Since 1978, all companies that operate coal mines have been required to reclaim land that they have

198. WOMENS MINING COALITION, MINE SAFETY: AN INDUSTRY PRIORITY 2 (2009), *available at* http://www.wmc-usa.org/IssuesStatements/Mine%20Safety.pdf; Colo. Mining Ass'n, *Colorado Mines Dedicated to Mine Safety*, http://www.coloradomining.org/Content/Body_Pdf/coal_safety_fact_sheet.pdf (last visited June 1, 2012).

199. *See* Ian Urbina, *No Survivors Found After West Virginia Mine Disaster*, N.Y. TIMES, Apr. 9, 2010, *available at* http://www.nytimes.com/2010/04/10/us/10westvirginia.html (finding the Upper Big Branch mine disaster to be the worst in four decades).

200. Mine Safety & Health Admin., *Coal Daily Fatality Report—Year End 2010*, http://www.msha.gov/stats/charts/coal2010yearend.asp (last visited June 1, 2012).

201. *See* Chris Kraul, *Chile Rejoices as All 33 Miners are Rescued*, L.A. TIMES, Oct. 14, 2010, *available at* http://www.nytimes.com/2010/04/10/us/10westvirginia.html.

202. Mark McDonald, *Gas Explosion Kills 35 Miners and Traps 44, China Says,* N.Y. TIMES, Sept. 8, 2009, *available at* http://www.nytimes.com/2009/09/09/world/asia/09china.html.

203. *See* Sara Mischner & Paula Rothfeld, *It's About Time: A Proposal to Establish a Specialized International Agency for Coal Miner Safety and Health*, 26 HOFSTRA LAB. & EMP. L.J. 583, 586 (2009) (linking lower death rates and strict enforcement of legislation).

204. *See* Mine Safety & Health Admin., *at* http://www.msha.gov/ (last visited June 1, 2012) (reporting fatalities recorded as of December 7, 2011).

205. C. Gregory Ruffennach, *Free Markets, Individual Liberties and Safe Coal Mines: A Post-Sago Perspective*, 111 W. VA. L. REV. 75, 77 (2008).

mined, and to maintain adequate financial security to assure that resources are available for those reclamation projects.[206] In addition, mining companies must pay into an abandoned mine fund to pay for reclaiming mines abandoned by other operators.[207] This reclamation system is working. U.S. coal operations have reclaimed more than 2.3 million acres of mined land over the past 25 years.[208] They also have paid more than $7 billion to reclaim mines that were abandoned prior to laws requiring reclamation.[209] "Approximately 5 million acres of land have been mined in the U.S. to produce coal; most of the land not under active mining has been or is being reclaimed to the standards set by law."[210]

These reclaimed mines are being returned to productive uses: recreation areas, economic development parks, farms, golf courses, housing developments, wildlife areas and wetlands. One reclamation technique involves saving the plant growth and topsoil when new surface mines are developed, and then transporting them for use in reclaiming other mines. With underground mines, reclamation projects involve stabilizing tailings ponds during the mining process and reclaiming the area when the mining is completed. Further, any surface subsidence must be included in mining plans, and surface and groundwater must be protected.

Reclamation is also an integral aspect to "mountaintop mining," a controversial mining technique used in Appalachia where the steep terrain and narrow valleys make mining there otherwise not economically viable. For mountains with low sulfur coal lying in horizontal layers relatively near the surface, the dirt and rock above the coal are removed to expose the coal seams and placed into the adjacent valley. These "valley fills" are carefully engineered and constructed to safely and permanently convert the dirt and rocks into plateaus where communities and access roads can be built. They create valuable level land above the flood plain for schools, government facilities, housing and recreational areas.

Valley fills are closely regulated by the Corps of Engineers (COE) and the EPA based on provisions of SMCRA and Section 404 of the Clean Water Act. The COE and EPA must issue a permit prior to the commencement of any valley fill activity. Valley fills must also meet a series of federal and state regulatory requirements designed to protect water resources. In order to receive a permit, a fill design must consider site-

206. *See* 30 U.S.C. §§ 1258, 1259.

207. *See* 30 U.S.C. §§ 1231 et seq.

208. National Mining Ass'n, *Fast Facts About Coal*, *at* http://www.nma.org/statistics/fast_facts.asp (last visited June 1, 2012).

209. *Id*.

210. *Id*.

specific soil characteristics, geology, physical and chemical properties of the material going into the fill, locations of springs or seeps, among other things. The structure must be free draining, and the fill design must provide a permanent factor of safety that ensures stability. In 1998, the U.S. Department of Energy estimated that 28.5 billion tons of high-quality coal is available to be mined because of these techniques.

Unquestionably, mountaintop mining entails choices. There is local public and political support for such mining, and the jobs and economic development that follow remain strong. Mountaintop mining in Appalachia currently represents approximately 10% of all coal mined in the United States and roughly 40% of the coal mined in West Virginia and Kentucky.[211]

4. Myth #4: There is no such thing as "Clean Coal"

Modern coal production should change people's perception of coal. The "Coal Rush" of the last decade in the United States yielded significant developments in "clean coal" technology during all stages of coal production: pre-combustion, combustion, post-combustion and conversion.

As an initial matter, coal production is significantly more efficient than in the past due to improvements in the precision of the equipment. For instance, where underground miners once used picks and shovels to gather coal, longwall mining now makes use of an electrically-powered tracked vehicle called a continuous miner that isolates, cuts, and collects huge panels of coal.[212] The continuous miner is calibrated to shave the coal in the seam while leaving the rock in the floor and ceiling behind, thus reducing the amount of energy used in the production process and the amount of waste produced. Longwall mining, which requires only three workers to operate the machinery, currently accounts for one-third of all underground coal production.[213] Longwall mining may result in the subsidence or sinking down of the land above the mine due to the removal of panels,[214] but provides significant environmental and safety improvements over traditional mining. These and other improved coal mining techniques have also increased the amount of organic carbon that is mined, which minimizes the amount of inorganic ash released into the environment.

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211. *Id.*

212. *See* Carl Hoffman, *High-Tech Mining Makes Coal King of Fossil Fuels, But is it Clean?*, POPULAR MECHANICS, *available at* http://www.popularmechanics.com/science/environment/4219178 (last visited June 1, 2012) (stating coal panels are up to 1,250 feet wide and 10,560 feet long).

213. *Id.*

214. *See id.*

The burning of coal at power plants has also become much cleaner. New power plants emit 90 percent less pollutants, such as SO_2, NO_x, particulates and mercury, than the plants they replace.[215] So, while coal use has tripled since the 1970s, regulated emissions from coal-based electricity has decreased by nearly 40 percent.[216] This reduction in pollutants is attributable to advances in clean coal technology. One of the most important developments has been the new "supercritical" combustion technology, which uses superheated steam to produce electricity and has much higher efficiency than the conventional pulverized coal technology that had been widely used for decades.[217] This increase in the amount of electricity produced from each unit of coal also means that emissions per unit of output have decreased. Research is under way for development of "ultra-supercritical" units that operate at even higher efficiency levels.[218]

In addition, improvements in boiler design have significantly reduced emissions per unit of electrical output. The development of fluidized bed combustion, where in a circulating fluidized bed boiler coal is combusted while suspended by jets of air in a bed of limestone, allows the emission control process to occur simultaneously with combustion.[219] This process has reduced SO_2 and NO_x during the coal-burning process.[220] A further advance, known as a "pressurized" fluidized bed boiler, increases the efficiency of burning coal by generating a high pressure stream of combustion gases that spins a gas turbine, generating electricity during the burning process itself.[221] Boiler manufactures have worked with air pollution control equipment manufactures to integrate these designs. The result is far more compatible and highly performing equipment. For example, low NO_x burners coupled with selective catalytic reduction (SCRs) technology have substantially reduced NO_x emissions. By combusting coal in stages, low NO_x burners can reduce the amount of NO_x released into the air by more than half.[222] Three-quarters of large coal-fired boilers now employ this technology.[223] SCRs, which are more expensive

215. National Mining Ass'n, Clean Coal Technology, *at* http://www.nma.org/pdf/fact_sheets/cct.pdf (last visited June 1, 2012) (citing findings of the National Energy Technology Laboratory).

216. *Id*.

217. *See* World Coal Ass'n, Improving Efficiencies, *at* http://www.worldcoal.org/coal-the-environment/coal-use-the-environment/improving-efficiencies/ (last visited June 1, 2012).

218. *See id.*

219. *See* U.S. Dep't of Energy, Cleaning Up Coal: A "Bed" for Burning Coal?, *at* http://www.fe.doe.gov/education/energylessons/coal/coal_cct4.html (last visited June 1, 2012).

220. *See id.*

221. *See id.*

222. *See* U.S. Dep't of Energy, Cleaning Up Coal: Knocking the NOx Out of Coal, *at* http://www.fe.doe.gov/education/energylessons/coal/coal_cct3.html (last visited June 1, 2012).

223. *Id*.

than the low NO_x burners, can remove 90 percent of NO_x pollutants by breaking apart the NO_x into nonpolluting gases.[224]

Finally, modern power plants built after 1978 have devices known as "scrubbers" to remove the sulfur, particulate matter, and other impurities from coal's combustion gases before they are released through the smokestack.[225] Scrubbers typically rely on limestone, which is crushed and processed into a white powder to absorb sulfur gases. The effectiveness and reliability of scrubbers have also significantly increased over time.[226]

Looking ahead, one of the most promising technologies is called Integrated Gasification Combined Cycle (IGCC). IGCC turns coal into gas, removes impurities from the coal gas before combustion, and turns the pollutants into reusable byproducts.[227] This process reduces emissions of sulfur dioxide, particulates, and mercury. IGCC also has the potential to increase coal's efficiency rate by 50 percent.[228] Two IGCC electricity generation plants are already in operation in the United States.[229]

Another developing technology for managing carbon dioxide is called carbon capture and storage (or sequestration). During this process, carbon dioxide is captured and stored in deep geological formations and other places that prevent it from entering the atmosphere. Capturing and compressing the carbon dioxide for this purpose is currently expensive and inefficient because the process consumes a significant amount of energy itself – estimated to be on the order of 20 to 30 percent of the electricity generated. The focus of current research and development efforts is on methods that will not impose such high energy costs. The carbon sequestration part is better understood; the oil and gas industry has used CO_2 injection for years to enhance production from existing wells.

Reflecting these technology developments, Tenaska committed to capture 85 percent of the carbon generated from its proposed Trailblazer Generating Project, near Sweetwater, Texas, which would also use 90 percent less water for cooling than a traditional plant.[230] Carbon dioxide

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224. *Id.*

225. The technical name for these "scrubbers" is "flue gas desulfurization units."

226. *See* U.S. Dep't of Energy, Cleaning Up Coal: The Clean Coal Technology Program, *at* http://www.fe.doe.gov/education/energylessons/coal/coal_cct2.html (last visited June 1, 2012).

227. For a description of how IGCC works, *see* Tyghe Trimble, *Clean Coal: How to Make Rock Into Biofuel*, POPULAR MECHANICS, *available at* http://www.popularmechanics.com/science/energy/coal-oil-gas/4218251 (last visited June 1, 2012).

228. National Mining Ass'n, *supra* note 215.

229. *Id*.

230. *See* Randy Lee Loftis, *Agreement to Trap CO_2 Wins Green Support for Coal Plant*, DALLAS MORNING NEWS, Apr. 20, 2010, at 2010 WLNR 8150036. If Trailblazer attains 85% carbon capture, it will emit 70% less CO_2 than the cleanest natural gas plants, according to Arch Coal which is

captured there will be used for enhanced oil recovery in the Permian Basin of Texas.[231] Environmentalists have acknowledged that the Trailblazer plant, if successful, could be a "game-changer"[232] and some groups dropped opposition to the plant's permit.[233] Texas regulators approved air quality permits for the $3.5 billion project in late 2010.[234]

Since the mid-1980s, the federal government has invested $3 billion in developing and testing clean coal technologies.[235] Even in an era of partisanship, the importance of developing clean-coal technology finds support on both sides of the aisle. President Barack Obama declared in his 2010 State of the Union address that his energy policy includes continued investment in clean coal technology.[236] He subsequently issued a presidential memorandum instructing federal officials to work toward "[r]apid commercial development and deployment of clean coal technologies, particularly carbon capture and storage (CCS)," which "will help position the United States as a leader in the global clean energy race."[237] In February 2009, the American Recovery and Reinvestment Act (known as the stimulus package) designated $3.4 billion for research, development, and demonstration of CCS technologies.[238] This funding was

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an owner of the project. *See* Arch Coal to Buy 35% Stake in Tenaska's Trailblazer Energy Center, St. Louis Bus. Daily, Mar. 11, 2010, at 2010 WLNR 5077413.

231. *See generally* Kate Galbraith, *Carbon Dioxide, the Bane of Environmentalists, Is in Demand in the Oil Industry*, N.Y. TIMES, Jan. 7, 2011, at A17, *available at* 2011 WLNR 381283; Jack Z. Smith, *West Texas Power Projects Could Hold the Key to Carbon Emissions*, FORT WORTH STAR-TELEGRAM, June 27, 2009, at D1, *available at* 2009 WLRN 12279602.

232. Smith, *supra* note 231 (quoting Tom "Smitty" Smith, Texas Director for Public Citizen).

233. *See* Randy Lee Loftis, *Agreement to Trap CO_2 Wins Green Support for Coal Plant*, DALLAS MORNING NEWS, Apr. 20, 2010, at 2010 WLNR 8150036. An official of the Environmental Defense Fund, which has generally opposed construction of new coal-fired power plants, has referred to the proposed Tenaska plant as a potential "role model" for the United States. *See* Jack Z. Smith, *Proposal for West Texas Coal Plant Gets Environmental Group's Praise*, FORT WORTH STAR-TELEGRAM, Apr. 20, 2010, *available at* 2010 WLNR 8102338 (quoting Jim Marston, Director of the EDF's national energy program and the Texas regional office)..

234. *See* Jack Z. Smith, *$3.5 Billion Power Plant in West Texas Wins Key Permits*, FORT WORTH STAR-TELEGRAM, Dec. 15, 2010, *available at* 2010 WLNR 24735401;

235. *See* U.S. Dep't of Energy, *Cleaning Up Coal*, *at* http://www.fe.doe.gov/education/energylessons/coal/index.html (last visited June 1, 2012).

236. Remarks by the President in State of the Union Address, Jan. 27, 2010, *at* http://www.whitehouse.gov/the-press-office/remarks-president-state-union-address. President Obama's predecessor, George W. Bush, also supported development of clean coal technology. *See, e.g.,* Robin Acton, *Bush Urges Clean Coal Technology for Electricity*, PITTSBURGH TRIBUNE-REVIEW, Aug. 1, 2008, *at* http://www.pittsburghlive.com/x/pittsburghtrib/news/s_580555.html.

237. Presidential Memorandum – A Comprehensive Federal Strategy on Carbon Capture and Storage, Feb. 3, 2010, *available at* http://www.whitehouse.gov/the-press-office/presidential-memorandum-a-comprehensive-federal-strategy-carbon-capture-and-storage.

238. *See* Executive Office of the President, Council of Economic Advisers, The Economic Impact of the American Recovery And Reinvestment Act of 2009, Second Quarterly Report 34, Jan. 13, 2010, *available at* http://www.recovery.gov/About/Documents/100113-economic-impact-arra-second-quarterly-report.pdf.

allocated to three major projects: $1.52 billion for a competitive bidding for industrial CCS projects;[239] $800 million for the Clean Coal Power Initiative (CCPI), a program initiated during the Bush Administration;[240] and $1 billion to help revive FutureGen, a public-private partnership with the goal of developing a zero-emission coal plant.[241]

As these and other new technologies develop, this progress will continue. With respect to carbon dioxide, U.S. emissions have remained relatively stable for a decade,[242] declining significantly between 2007 and 2009 (in part due to the recession). As the next section discusses, given the significant increases in coal use in the developing world, future technological breakthroughs for coal combustion and emissions are not only critically needed – the developing world is where they may take place.

5. Myth #5: Given the end of the recent American "Coal Rush," new coal plant technology that can reduce emissions is not advancing

The American "Coal Rush" of the last decade has slowed, but clean coal progress has not. In an influential article in the *Atlantic*, James Fallows noted that China is opening a new coal plant every week, making China the focal point for new coal technologies.[243] The Chinese are working closely with U.S. companies to develop and demonstrate newer, cleaner technologies for coal production and conversion. As a result, China and other nations, including India and potentially Germany with its recent renouncement of nuclear power, will likely lead the way into a new generation of coal as an even lower-emitting form of electricity generation.

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239. *See* U.S. Dep't of Energy, Press Release, Large-Scale Industrial CCS Projects Selected for Continued Testing, June 10, 2010, at http://www.fe.doe.gov/news/techlines/2010/10017-DOE_Selects_Industrial_CCS_Project.html (announcing selection of three projects located in Texas, Illinois, and Louisiana for federal funding to test large-scale CCS from industrial sources).

240. *See* U.S. Dep't of Energy, Clean Coal Technology & The Clean Coal Power Initiative, *at* http://www.fossil.energy.gov/programs/powersystems/cleancoal/ (last visited June 1, 2012) (announcing that DOE is selecting a third round of clean coal projects for funding, focusing on development carbon sequestration technologies).

241. *See generally Work Forges Ahead for FutureGen*, BELLEVILLE NEWS DEMOCRAT, Dec. 8, 2011, at 2011 WLNR 25365294; Julie Wernau, *FutureGen Coal Plant Put Further in Doubt*, CHIC. TRIB., Nov. 29, 2011, at 1.

242. *See* Energy Info. Inst., U.S. Energy-Related Carbon Dioxide Emissions, 2010 (Aug. 18, 2011), *at* http://www.eia.gov/environment/emissions/carbon/. Since 1990, carbon dioxide emissions in the United States have grown much more slowly than GDP. *Id*.

243. James Fallows, *Dirty Coal, Clean Future*, THE ATLANTIC (Dec. 2010), *available at* http://www.theatlantic.com/magazine/archive/2010/12/dirty-coal-clean-future/8307/ (last visited June 1, 2012).

In Japan, Denmark, Germany, and other countries, the newly constructed plants are using "ultra-supercritical" combustion technology.[244] Like their immediate predecessors, these units operate at very high pressures and steam temperatures, which results in conversion of energy stored in coal into electricity at a higher efficiency than conventional combustion technologies. Ultra-supercritical designs currently have a net efficiency in the mid-forty percent range, with a goal of achieving efficiencies of up to around fifty percent.[245] The net thermal efficiency of ultra-supercritical technology is approximately five percent higher than that of supercritical units, and about ten percent higher than traditional pulverized coal-fired boilers, which offer thirty-five percent efficiency.[246] In Yuhuan, China, four 1,000 MW coal-fired ultra-supercritical pressure boilers began operations in 2007.[247] Yuhuan Units 1 and 2 are claimed to be the cleanest, most efficient and advanced ultra-supercritical units in the world. They incorporate a high-efficiency combustion design that reduces emissions per unit of power output, and high-efficiency pollution control technologies. The units reportedly have a forty-five percent combustion efficiency and generate about 22 billion kwh of electricity a year.[248]

Ultra-supercritical technology also enhances operational performance, which decreases coal consumption per kwh of electricity and reduces CO_2 emissions. Thus, there is vast potential for emission reductions over the lifetime of an ultra-supercritical coal unit. A major vendor of coal-fired combustion technology, for example, claims that a "1% gain in efficiency for a 700 MW plant reduces 30-year lifetime emissions by 2,000 tons of NO_x, 500 tons particulates and 2.5 million tons CO_2."[249]

Other countries are also investing resources in innovative processes to address environmental impacts of coal mining and combustion. In addition to carbon capture and storage technology, which is discussed above, they are retrofitting existing pulverized coal-fired boilers with improved designs for turbines, burners, and other combustion equipment. Enhanced means of

244. World Coal Ass'n, *Improving Efficiencies*, http://www.worldcoal.org/coal-the-environment/coal-use-the-environment/improving-efficiencies/ (last visited June 1, 2012).

245. *See id. See also* Nima Heydarian, *1000-MW Ultra-Supercritical Units Contract Awarded to Emerson*, AUTOMATION NEWS, Oct. 1, 2010, *available at* http://www.automationnews.org/power-plant-china-emerson/1181.

246. UNFCCC, METHODOLOGICAL TOOL: "TOOL TO CALCULATE THE EMISSION FACTOR FOR AN ELECTRICITY SYSTEM" 27 (version 02.2.1 2011), *available at* http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v2.2.1.pdf.

247. *Yuhuan 1,000 MW Ultra-Supercritical Pressure Boilers*, POWER TECHNOLOGY.COM, http://www.power-technology.com/projects/yuhuancoal/ (last visited June 1, 2012).

248. *Id.*

249. *Id.*

coal beneficiation, which refers to various methods for cleaning coal to remove sulfur, ash, and other undesirable constituents before it is combusted, are also being explored. This allows coal to be burned more efficiently while reducing CO_2 emissions during transportation and handling. Finally, underground coal gasification, a new mining technique that also reduces the environmental impact of the coal, is receiving careful attention. Coal gasification can be used when coal would be otherwise unrecoverable. It involves injecting steam and oxygen into a coal seam through surface wells.[250] The seam is ignited and partially burned, which produces fuel-grade gases. The cavities created can then become CO_2 storage locations for the carbon capture and sequestration procedures discussed above. These and other similar efforts developed abroad can be imported to the United States if they prove to be successful and worthwhile.

B. Principles for Regulating Coal in the Context of a National Energy Policy

1. Principle #1: Congress is the proper government body to determine whether and how GHG emissions should be regulated.

As America formulates its national energy policy for electricity generation in the twenty-first century, a key controversy has arisen over which policymakers can make which decisions. This has played out most prominently over whether to limit GHG emissions, and, if so, to what levels. For this issue, the answers must come from Congress.[251]

Fossil fuels, the target of GHG emission caps, represent 85% of energy use in the United States. Because the economy, not just electricity generation, runs on fossil fuel energy, setting caps on emissions for fossil fuels will affect cost and availability of energy for most families and businesses. Thus, these decisions cannot be determined without making fundamental decisions about U.S. economic and social policy. Only Congress can make those decisions. Moreover, as this article has demonstrated, there are many moving parts that go into deciding the proper balance of energy use in America. Concerns over GHG emissions with respect to fossil fuels are only one aspect of the entire energy puzzle.

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250. *Id.*

251. *See* James L. Arnone et al., *Global Climate Change Litigation*, *in* ENVIRONMENTAL LITIGATION: LAW AND STRATEGY 11-12 (Cary R. Perlman ed., 2009) (noting *Massachusetts v. EPA* supports the conclusion that Congress and the Executive are the branches of government responsible for the regulation of greenhouse gases); Victor E. Schwartz, Phil Goldberg & Corey Schaecher, *Why Trial Courts Have Been Quick to Cool "Global Warming" Suits*, 77 TENN. L. REV. 803 (2010).

Since 2003, certain public and private groups have sought to circumvent Congress by asking courts to establish GHG emission limits for fossil fuels, including coal. These lawsuits, largely born out of frustration with Congress and presidential administrations, have come in the form of tort actions against utilities, coal producers, and oil and gas companies. In these tort actions, the plaintiffs allege that the industry's GHG emissions are the cause of the "public nuisance" of global climate change. Therefore, these companies should be responsible for any undesired environmental condition the plaintiffs say are caused by climate change.[252] To date, four such lawsuits have been filed with each case being dismissed or key aspects of the case rejected.[253] Most notably, the Supreme Court of the United States in *AEP v. Connecticut*[254] held that federal common law tort actions, which include public nuisance claims, were displaced by Congress's delegation of authority to the EPA to decide whether or how to set GHG emission limits under the CAA.[255]

In reaching its decision, the Court made clear that regulating GHG emissions in the United States is a federal issue and that courts do not have the institutional competence to issue rulings that would, in effect, limit those emissions.[256] The unanimous Court[257] stated plainly that "judges lack the scientific, economic, and technological resources an agency can utilize in coping with issues of this order."[258] Judges "may not commission scientific studies or convene groups of experts for advice, or issue rules under notice-and-comment procedures inviting input by any interested person, or seek the counsel of regulators" in reaching their decisions.[259] Rather, judges are "confined by a record comprising the evidence the

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252. *See* Victor E. Schwartz, Phil Goldberg & Christopher E. Appel, *Does the Judiciary Have the Tools for Regulating Greenhouse Gas Emission?*, 46 VAL. U. L. REV. (forthcoming 2012).

253. *See* Connecticut v. Am. Electric Power Co., 406 F. Supp.2d 265, 274 (S.D.N.Y. 2005), *vacated*, 582 F.3d 309 (2nd Cir. 2009), *rev'd*, 131 S. Ct. 2527 (2011). *See also* California v. Gen. Motors Corp., No. C06-05755 MJJ, 2007 WL 2726871 (N.D. Cal. Sept. 17, 2007) (rejecting Plaintiff's federal common law nuisance claim for global warming because it raised non-justiciable political questions); Kivalina v. ExxonMobil Corp., 663 F. Supp.2d 863 (N.D. Cal. 2009); Comer v. Murphy Oil USA, Inc., 1:05-CV-436-LG-RHW, 2007 WL 6942285 (S.D. Miss. Aug. 30, 2007), rev'd, 585 F.3d 855 (2009), appeal dismissed, 607 F.3d 1049 (5th Cir. 2010).

254. *Am. Elec. Power Co. v. Conn.*, 564 U.S. --, 131 S. Ct. 2527 (2011).

255. *See id*. at 2538. (Prior to the *AEP* decision, the Court in *Massachusetts v. EPA*, 549 U.S. 497, 531 (2007) rejected EPA's denial of a rulemaking petition to regulate emissions of four gases commonly characterized as GHGs under section 202 of the Clean Air Act).

256. *See id.* at 2539–40 (concluding the complex nature of GHG emissions requires agency expertise and broad policy, compared to judges confined to the record before the court).

257. The Court rendered an 8-0 decision. Justice Sotomayor did not participate in the decision because she was a member of the panel that heard the case in the Second Circuit.

258. *Id.* at 2539–40.

259. *Id.* at 2540.

parties present."[260] These considerations led the Court to conclude, "[i]t is altogether fitting that Congress designated an expert agency, here, EPA, as best suited to serve as primary regulator of greenhouse gas emissions . . . The expert agency is surely better equipped to do the job than individual district judges issuing ad hoc, case-by-case injunctions."[261]

Federal trial courts dismissed the other emissions-related tort cases, also reasoning that the judiciary is not an appropriate forum to set GHG emission standards. As one court noted, claims asking the judiciary to set GHG emission limits were not cases or controversies, but embodiments of the ongoing "debate" over global climate change policy; "[t]hese policy decisions are best left to the executive and legislative branches of the government, who are not only in the best position to make those decisions but are constitutionally empowered to do so."[262] Another trial court explained that no judicially discoverable and manageable standards existed to decide such cases in a manner that would permit courts to "render[] a decision that is principled, rational, and based upon reasoned distinctions."[263] Rather, these cases call on courts to establish emission caps "by judicial fiat,"[264] which is unconstitutional.

Further, while GHGs may be "air pollutant[s]" under the CAA, it is generally recognized that the CAA represents an inefficient vehicle under which national climate change policy should be decided. The CAA was designed to address local and regional sources of air pollution, not concerns about the impact of GHG emissions on global climate change, with GHGs emitted by innumerable sources worldwide and mixing uniformly in the global atmosphere. As a result, EPA has had to stretch the statute beyond its breaking point to try to accommodate GHG regulation.

For example, the CAA's preconstruction permit program requires that permits be obtained for new and "modified" facilities that potentially emit 100 or 250 tons per year (depending on the type of facility) of an air pollutant.[265] These thresholds were established in the statute because only large industrial facilities emit traditional pollutants above these thresholds and hence only these large facilities are required to obtain permits. By contrast, EPA estimates that more than 6 million facilities emit more than 100 tons per year of carbon dioxide, mostly because they use natural gas or

260. *Id.*
261. *Id.* at 2539.
262. *Comer*, 585 F.3d at 860 n.2.
263. *Kivalina*, 663 F. Supp.2d at 875 (citing Alperin v. Vatican Bank, 410 F.3d 532, 552 (9th Cir. 2005)).
264. Connecticut v. Am. Elec. Power Co., 406 F. Supp.2d 265, 274 (S.D.N.Y. 2005).
265. 42 U.S.C. §§ 7475, 7479(1).

oil for heating.[266] To prevent the permitting program from becoming so overwhelmed with permit applications as to cause gridlock, EPA issued regulations that increased the statutory thresholds to 100,000 tons, with subsequent phases to come that may never bring the threshold to within hailing distance of what the statute requires.[267] The statutory validity of EPA's action in this regard has been appealed.[268] EPA also faces a petition to establish NAAQS for GHGs.[269] If the petition is granted, then potentially the entire country would be in violation of the CAA subject to severe sanctions. Also, because it would be impossible to lower CO_2 emissions sufficiently, no state could "cure" this violation to avoid the penalties.

Rather than rely on EPA to shoe-horn GHGs into the CAA's regulatory regime, Congress should address GHG policy separately and anew. Cap-and-trade legislation, however, has proven to lack sufficient political support to pass. There also can be no real "solution" to GHG emissions that does not involve emerging economies.[270] Whereas the United States and developed nations' GHG emissions are relatively stable, it is in the developing nations where emissions are rapidly increasing. Other, and more global, means of addressing this issue will have to be found.

2. Principle #2: Policymakers should focus on facilitating the upgrade or replacement of old, inefficient coal plants with new, low-emitting ones.

As discussed earlier, significant advances have been made in coal-fired combustion technology and more are around the corner. Widespread commercial application of these technologies, here and abroad, will increase the efficiency of electricity generation and make coal better from an environmental standpoint. The key is to identify and reduce the regulatory hurdles preventing modernization of the coal fleet.

First, the starting point for increasing the efficiency of coal generation is a comprehensive overhaul of the permitting process for industrial facilities in the United States. The CAA pre-construction permitting process is extraordinarily complicated, creating undue delay, uncertainty and burdensome costs. As a result, it creates an impediment to the utilities' self-

266. 75 Fed. Reg. 31,514, 31,536 (Jun. 3, 2006).
267. *Id.* at 31,516.
268. Coalition for Responsible Regulation v. EPA, No. 10-1073 (D.C. Cir.).
269. Center for Biological Diversity et al., Petition to Establish National Pollution Limits for Greenhouse Gases Pursuant to the Clean Air Act (Dec. 2, 2009).
270. *See* Assoc. Press, *Climate Conference President Says Agreement Reached on Course for Future Global Warming Talks*, WASH. POST, Dec. 11, 2011 (reporting on agreement of 194-party conference to negotiate a new accord for binding emissions targets that includes the developing world).

interest of investing in efficiency projects and is the primary reason utilities have been unable to modernize or replace older coal plants, some of which are more than a half a century old. Even when issued, environmental groups strongly oppose the permits, generally filing lawsuits to delay them or make the process so costly that utilities abandon their plans. Groups such as the Sierra Club, as part of their anti-coal campaign, have challenged dozens of coal plant permit applications across the United States.[271]

The experience of the Sandy Creek Energy Associates' attempt to build a plant in Texas shows how tortured and uncertain the permitting process has become.[272] When Sandy Creek applied for its permit, it included an assessment of its compliance with the Clean Air Act's "Maximum Achievement Control Technology" (MACT) emission standard.[273] While the application was pending, the EPA issued a rule removing coal and oil-fired electric utilities from the MACT program, and instead issuing a stringent control technology-based standard under the NSPS program.[274] As a result, when the Texas Commission on Environmental Quality (TCEQ) approved Sandy Creek's application fourteen months later, it did not include a MACT standard, but rather an NSPS standard.[275] A month after Sandy Creek broke ground, however, the D.C. Circuit invalidated the EPA's decision to regulate under NSPS instead of MACT,[276] thereby giving environmental groups a hook to challenge the Sandy Creek permit.[277] The district court dismissed the case on summary judgment, but, nearly three years after construction was underway, the U.S. Court of Appeals for the Fifth Circuit reversed, finding the TCEQ permit invalid.[278] The case is now before the U.S. Supreme Court.[279]

Regulatory obstacles to meeting the expanding demand for energy are not limited to coal. A recent study catalogued over three hundred energy projects delayed or cancelled due to regulatory barriers and legal

271. *See, e.g.*, Assoc. Press, *Coal Power Goes on Trial Nationwide*, CBS NEWS, Feb. 11, 2009, *at* http://www.cbsnews.com/stories/2008/01/14/tech/main3713143.shtml (last visited June 1, 2012) (reporting legal challenges to at least four dozen coal plants in 29 states and noting that environment groups cite 59 canceled, delayed, or blocked plants as a result of their efforts).

272. *See* Sierra Club, Inc. v. Sandy Creek Energy Associates, L.P., 627 F.3d 134 (5th Cir. 2010).

273. *See* 42 U.S.C. § 7412(g)(2)(B).

274. 627 F.3d at 137.

275. *Id*.

276. *See* New Jersey v. EPA, 517 F.3d 574, 583 (D.C. Cir. 2008).

277. *See* 627 F.3d at 138.

278. *Id*. at 145.

279. Sandy Creek Energy Associates, L.P. v. Sierra Club, Inc. and Public Citizen, Inc., No. 10-1333.

challenges.[280] In addition to 111 stymied coal projects, these included 22 nuclear and 38 gas and platform projects, as well as 140 renewable energy projects.[281] A recent case in point is the Avenal project in California. This is not a coal plant, but a modern, efficient *natural gas* plant. One would have expected this project to sail through the permitting process. Quite the contrary, despite the requirement in the Clean Air Act that EPA issue permits within one year after a completed permit application is filed, this project took more than three times that amount and was only issued after the developer obtained a court order requiring the agency to act. Even after the court order, EPA's headquarters office had to take the extraordinary step of revoking the authority of the EPA regional office over the project because personnel in the regional office continued to cause delays.[282]

Within a revamped permitting process, improving the efficiency of the existing fleet of coal-fired boilers should be considered "low hanging fruit"; it is the easiest way to gain quick emission reductions for both conventional air pollutants and GHGs. Some efficiency improvements at existing coal-fired boilers might be viewed by some as plant "modifications," though, which can trigger new source permitting. Therefore, to encourage electric utilities to undertake the capital expenditures to retrofit efficiency-improving technologies at existing coal-based generating units, EPA should clarify its regulations and change its enforcement policies to make clear that projects that improve plant efficiency without expanding fuel burning capability are not modifications subject to pre-construction permitting.

Policymakers should also focus on removing barriers to the development of new coal technologies and the construction of new plants in the United States. Even under current technology, estimates suggest that a gradual turnover of the fleet of existing coal-fired plants for new plants would reduce CO_2 emissions by as much as twenty-five to thirty-three percent.[283] In addition to the impediment caused by permitting burdens and delays are lawsuits that NGOs file under the CAA, Clean Water Act, and

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280. *See* STEVE POCIASK & JOSEPH P. FUHR JR., PROGRESS DENIED: A STUDY ON THE POTENTIAL ECONOMIC IMPACT OF PERMITTING CHALLENGES FACING PROPOSED ENERGY PROJECTS 2 (U.S. Chamber of Commerce 2011), *available at* http://www.uschamber.com/sites/default/files/reports/PNP_EconomicStudyweb.pdf (last visited June 1, 2012).

281. *Id*. at 4. The delayed renewable energy projects included 89 wind, 29 ethanol/biomass, 10 solar, 7 hydropower, 4 wave, and 1 geothermal project. *Id*.

282. *See* In re: Avenal Power Center, LLC, PSD Appeal Nos. 11-02, 11 -03,11-04 & 11-05, Order Denying Review (EPA Envt'l Appeals Bd., Aug. 18, 2011).

283. *See* Janos M. Beer, Massachusetts Institute of Technology, Higher Efficiency Power Generation Reduces Emissions, National Coal Council Issues Paper 2009, *available at* http://web.mit.edu/mitei/docs/reports/beer-emissions.pdf.

Endangered Species Act. Therefore, Congress, the agencies, and the courts should focus on two efforts with respect to encouraging the construction of modern, high-efficiency plants: (1) address in a coordinated inter-agency fashion the amount of time it takes to permit new industrial facilities, and (2) find ways to continue the important environmental protections included in the above statutes while reducing the opportunities for litigation designed to delay and to drive up the costs of new plant construction.

Second, regulators must assess the cumulative impact of environmental regulations that are currently being pursued for coal-fueled electric generation. The issue here is not whether coal plant emissions should decline in the future; as described above, electric sector emissions have been on a downward slope for decades, and that progress will assuredly continue in the future. The issue is EPA's "too much, too quickly" regulatory approach for existing plants that will force numerous coal plants into retirement without an adequate opportunity for utilities to bring substitute modern generation online. The result could be increased electricity costs and impaired reliability of the electric grid, with associated disincentives for development and use of new, clean coal technologies.

Third, policymakers should consider economic incentives to quicken the commercial application of carbon capture and sequestration (CCS), which is an important step toward controlling carbon emissions from new and existing coal-fired power plants. Research is needed to find ways to reduce the energy required to capture carbon, to support early commercial demonstrations including underground injection and storage of the captured CO_2, to identify and estimate available geological storage capacity,[284] and to enhance the understanding of the effects CO_2 storage can have on geological formations.[285] Incentives are needed to facilitate the availability of insurance products that provide certainty to investors gauging custody and liability issues associated with the operation and long-term storage of CO_2 at sequestration sites.[286] Further, EPA and the states need to provide a consistent and understandable regulatory framework for CO_2 injection and storage. CCS must be regulated in a manner that is protective of human

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284. *See* U.S. Dep't of Energy, Nat'l Energy Technology Laboratory, 2010 Carbon Sequestration Atlas of the United States and Canada, 3d ed. (Nov. 2008), *available at* http://www.netl.doe.gov/technologies/carbon_seq/refshelf/atlasIII/index.html (documenting potentially widespread geography suitable for CO_2 storage).

285. *See* U.S. Dep't of Energy, Carbon Storage Research, *at* http://www.fossil.energy.gov/programs/sequestration/geologic/ (last visited June 1, 2012).

286. *See* CO_2 CAPTURE PROJECT, UPDATE ON SELECTED REGULATORY ISSUES FOR CO_2 CAPTURE AND GEOLOGICAL STORAGE 78 (2010), *available at* http://www.co2captureproject.org/reports/regulatory_report.pdf.

health and the environment, while permitting projects to be financed, developed, and operated without unnecessary legal impediments. Also, programs along the lines of the CCPI should be expanded to integrate and demonstrate the range of coal-based technologies in a commercial setting.

These incentives, in addition to environmental benefits, will spur economic development and be "repaid" in job growth.[287] Such "green jobs" have been touted as a justification for substantial federal support for alternative technologies that are much more expensive, have less widespread application than coal-fired generation, and would produce far fewer jobs. Given that coal generates nearly fifty percent of America's electricity, these and other strategies will have a much greater impact on reducing emissions while creating jobs than by doubling or tripling the use of wind, solar or other sources of renewable energy.

3. Principle #3: Policymakers should ensure that electricity for average American consumers remains available and affordable.

All potential regulations with respect to coal and other sources of electricity should be first viewed through the lens of their impact on consumer affordability. For two centuries, affordable electricity has been a significant factor in increasing standards of living. People of average means have been able to use the electricity they need to sustain a basic quality of life and have more disposable income to spend on food, health care and other goods and services that improve the quality of their lives.

This progress will be stunted or, potentially, reversed should regulations artificially inflate the cost of electricity.[288] Advocates for the poor and elderly, some of whom joined under the group Affordable Power Alliance, demonstrated that, if this were to happen, individuals with lower incomes will be disproportionately affected and their health and welfare will be

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287. *See* NAT'L COAL COUNCIL, LOW-CARBON COAL: MEETING U.S. ENERGY, EMPLOYMENT AND CARBON DIOXIDE EMISSIONS GOALS WITH 21ST CENTURY TECHNOLOGIES 2 (2009), *available at* http://ccdtstorage.blob.core.windows.net/assets/posts/2009%20NCC%20Report(1).pdf (citing 2009 research conduct for the AFL-CIO indicating that operation and maintenance of these facilities will provide over 800,000 permanent jobs).

288. M. Harvey Brenner, *Commentary: Economic Growth Is the Basis of Mortality Rate Decline In the 20th Century –Experience of The United States 1901-2000*, 34 INT'L J. OF EPIDEMIOLOGY 1214-1221 (2005), *available at* http://ije.oxfordjournals.org/content/34/6/1214.full.pdf (last visited Sept. 27, 2011). Upward trend in real per capita income is the most important single factor explaining decreased U.S. mortality rates since the 1960s. Daniel E. Klein and Ralph L. Keeney, *Mortality Reductions from Use of Low-Cost Coal-Fueled Power: An Analytical Framework* (Dec. 2002), *available at* http://www.coalcandothat.com/images/content/MortalityRed.pdf (last visited Sept. 27, 2011) (finding that low-cost coal-fueled electricity prevented at least 14,000 to 25,000 premature deaths each year).

strained.[289] In March 2010, the Alliance found that emission regulations discussed at the time could cause gasoline and residential electricity prices to increase by fifty percent and industry electricity and natural gas prices to go up by seventy-five percent by 2030.[290] "Lower-income families [would be] forced to allocate larger shares of the family budget for energy expenditures, and minority families [would be] significantly more likely to be found among the lower-income brackets."[291]

Others have studied the vulnerability of average Americans to increased energy costs.[292] They have found the following:

- For the half of American households whose average pre-tax annual income is less than $50,000, the amount they are spending on energy costs has risen dramatically. In 2001, these families spent an average of 12% of their after-tax income on residential and transportation energy. By 2005, those costs rose to 16% of their average after-tax income, and in 2011, these households are projected to spend 20% of their after-tax income on energy.
- The 23% of U.S. households earning between $10,000 and $30,000 will allocate 23% of their 2011 after-tax income to energy – over twice the national average.
- Household gasoline costs have more than doubled, from an average of $1,680 in 2001 to a projected $3,601 in 2011. Electricity, because it is fueled by domestic, stable sources, has seen lower annual price increases: the average household electric bill has increased from $938 in 2001 to a projected $1,368 in 2011.
- Households of senior citizens on fixed incomes, Hispanics and blacks are particularly vulnerable to energy prices. In 2009, the average Social Security income of 31.5 million senior households was $15,443. Also, 62% of Hispanic households and 67% of black households had average

289. *See* Affordable Power Alliance, *About Us*, *at* http://www.affordablepoweralliance.org/Aboutus.aspx (last visited Sept. 27, 2011).

290. *See* AFFORDABLE POWER ALLIANCE, POTENTIAL IMPACT OF EPA ENDANGERMENT FINDING ON LOW INCOME GROUPS AND MINORITIES, at 92 (Mar. 2010), *available at* http://www.Affordablepoweralliance.org/LinkClick.aspx?fileticket=yXQwPRYFUF8%3D&tabid=40 (last visited June 1, 2012).

291. *Id.*

292. *See* EUGENE M. TRISKO, ENERGY COST IMPACTS ON AMERICAN FAMILIES, 2001-2011 (American Coalition for Clean Coal Energy, 2011), *available at* http://www.americaspower.org/sites/default/files/Energy_Cost_Burdens_on_American_Families_2011.pdf (last visited Sept. 27, 2011).

annual incomes below $50,000, compared with 46% of white and 39% of Asian households.

- Poverty rates also have increased due to the recession, with 10.5% of all families and 14.3% of the overall population in 2009 living below the poverty level. Government's assistance programs, namely the Low Income Home Energy Assistance Program, can assist some families, but 2011 funding levels are estimated to represent only 2% of total U.S. residential energy costs in 2011.

The National Economic Research Associates (NERA) recently prepared a report analyzing the impact of regulations currently being considered by the EPA on these and other sectors of the American community.[293] These regulations include two major air emission policies–the Cross-State Air Pollution Rule and regulation of mercury and other hazardous emissions–as well as policies to regulate coal combustion residuals under the Resource Conservation and Recovery Act and to regulate cooling water intake under the Clean Water Act. The Report found that "[o]ver the period from 2012 to 2020, about 183,000 jobs per year are predicted to be lost on net due to the effect of the four regulations . . . U.S. disposable personal income would be reduced by $34 billion each year on average . . . [and] the average annual loss in disposable personal income per household is $270."[294] Just two of these rules will increase average U.S. retail electricity prices in 2016 by about 12%, with regional increases as much as 24%, and natural gas prices, as set at Louisiana's Henry Hub facility, by about 17%.

Part of the job loss figures result from the fact that this country has historically enjoyed a cost advantage in manufacturing as compared to Europe and, more recently Japan, due to lower electricity prices. While this advantage has eroded somewhat in recent years due to increased competition from China, this advantage led to U.S. job growth during the 1980s and 1990s, particularly in the automobile industry, as many Japanese car manufacturers opened U.S. plants. The high-tech industries are similarly reliant on affordable power.

As is the theme throughout this article, affordable electricity need not require that we sacrifice environmental goals. As discussed above, financial

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293. *See* NERA ECONOMIC CONSULTING, POTENTIAL IMPACTS OF EPA AIR, COAL COMBUSTION RESIDUALS, AND COOLING WATER REGULATIONS (American Coalition for Clean Coal Energy 2011), *available at* http://www.globalwarming.org/wp-content/uploads/2011/09/NERA_Four_Rule_Report_Sept_21.pdf.

294. *Id.* at E-5.

incentives and smart regulation can create an appropriate environment for innovation and commercial application of clean generation technologies. Sufficient time must be provided for any cost-effective transition to new technologies and new energy sources.

4. Principle #4: Policymakers should emphasize domestic sources of electricity to avoid undue influence by foreign governments over the availability and pricing of U.S. electricity.

American policymakers should not divert from the decades-long effort to rely largely on home-grown sources of American electricity. Coal, nuclear, natural gas, and all of the renewable energy sources have traditionally been mined, produced, or generated in the United States. This stands in stark contrast to America's dependence on foreign sources of petroleum-based energy, which has created decades of instability for consumers and driven significant foreign policy decisions, including being a factor in major diplomatic and military actions in the Middle East. In the 1970s, the United States made a conscious decision not to subject its base-load electricity demands to these same whims and forces.

As indicated, coal is not the only domestic source of base-load fuel, but it is the most abundant. Some estimate that the United States has more energy value in U.S. coal than Saudi Arabia has in its oil.[295] As discussed above, while the United States is not planning to build enough new nuclear power plants to meaningfully impact America's electricity needs, natural gas may become a secondary stable, abundant source for electricity. New fracturing technology and increased infrastructure for transportation and storage may result in a strong, steady supply of shale gas. Market forces will determine how much base-load capacity can be generated by natural gas and whether it can reduce the use of coal. For now, though, regulators should not act prematurely and artificially reduce the use of coal based on expectations of huge shale gas deposits and necessary infrastructure development. If Congress and regulators force utilities to invest in gas plants at the expense of coal plants and their forecasts as to shale gas availability prove wrong, America would become dependent on imports of LNG. This would undermine the nation's energy independence and likely bring back and potentially worsen the price and supply issues that residents and businesses have experienced. This is the reason natural gas has not served as a base-load fuel in the past.

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295. *See* Clayton, *supra* note 68.

Without shale gas, and given declines in conventional production, the spread between the nation's need for natural gas and the available North American supply by 2020 already would be more than 4 TCF—–which is more than the total production of both the Gulf of Mexico and Oklahoma. Thus, additional natural gas would have to be imported to close this gap.[296] As indicated above, countries that have large natural gas deposits to export are not traditional U.S. allies. For example, Venezuela leader Hugo Chavez reportedly is seeking to create "something similar to OPEC with gas."[297]

5. Principle #5: Policymakers should focus their efforts on maximizing the utility and minimize risks of coal, not eliminating its use.

As policymakers shape America's energy policy so that consumers and businesses can affordably and efficiently meet their current and future electricity needs, there is no doubt that coal will remain a significant part of that energy picture for the foreseeable future.

Consider the findings of the U.S. Energy Information Administration (EIA), which has estimated the relative contributions that each energy source will make by 2035. Generation from nuclear power, for example, will likely increase by 9 percent, but its share of total power generation will fall from 20 to 17 percent.[298] If domestic shale gas reserves prove to be an additional, significant energy resource for this country, those reserves will supplement, not displace coal-fired generation. Use of renewable energy sources are expected to increase 72 percent, raising their share from 11 to 14 percent.[299] Hydroelectric capacity will grow a half of a percent annually through 2035, and that growth is likely to come as existing facilities become more efficient by replacing older equipment with new technologies.[300] The bottom line is that even if these numbers are reached, coal's share of electricity generation will fall only from 45 to 43 percent.[301] Further, if demand side management is aggressively pursued, a reduction in energy consumption of 5 to 10 percent on top of these shifts would still leave the country reliant on coal as its principal source of base-load

296. *See* ANNUAL ENERGY OUTLOOK 2011, *supra* note 6 at 2 (providing statistics on shale gas production and domestic consumption).

297. Kiraz Janicke, *Venezuela's Chavez Promotes Organisation of Gas Exporting Countries During Tour,* VENEZUELA ANALYSIS (Sept. 9, 2009), http://venezuelanalysis.com/news/4784.

298. ANNUAL ENERGY OUTLOOK, *supra* note 6, at 73.

299. *Id.*

300. *See id.* at 115, 146.

301. *Id.* at 3.

generation. Outside the United States, demand for electricity is rapidly increasing with fewer offsets, which will cause the use of coal to expand.

As a result, policymakers must remain focused on maximizing coal's benefits and managing its risks. Any effort to eliminate coal or significantly reduce its viability will be a fool's errand; it will waste significant time and resources, create the wrong incentives, and impose significant costs. As discussed above, policies that discourage investment in research, development and commercialization of clean coal technologies will directly and adversely impact economic growth and job creation. Conversely, incentives created for the development and demonstration of clean-burning technology will not only help emissions within the United States, they will help assure that coal is used around the world more efficiently as well, which will have a significant additional impact on reducing global emissions. After all, because air pollution does not respect national boundaries, America has a national interest in ensuring that coal burned around the world is burned in as clean a manner as possible.

CONCLUSION

As with all energy sources, coal comes with risks. It also has significant benefits; particularly in the United States where it is an abundant, inexpensive domestic source of energy for meeting America's increasing needs for electricity. U.S. policymakers, in setting future energy policy, should embrace coal as part of the future. They should then strategically set forth a broad vision for managing the risks of each energy source that generates electricity so that all of their many benefits can be maximized.