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ARTICLE

DIVERSIFYING AMERICA'S ENERGY FUTURE: THE FUTURE OF RENEWABLE WIND POWER

*Ronald H. Rosenberg**

I. Energy Policy in the United States

Americans expect abundant supplies of inexpensive energy to fuel their lifestyles. Recently, however, a number of global forces are combining efforts to force government officials and citizens to seriously reconsider the nation's energy future. These forces reflect three essential concerns about the nation's use of energy: economic, national security, and environmental. The economic impacts of changing energy prices are most readily observable. When crude oil prices jumped to more than sixty-seven dollars per barrel in August 2006, the price of regular gasoline spiked to a national average of 2.98 dollars per gallon,[1] affecting the lives and driving habits of most Americans. Beyond personal consumption, energy functions as an essential part of the American economy, powering the manufacturing, agricultural, and commercial sectors. Recent increased oil prices make American consumers, businesses, and policy makers aware of the effect of higher energy costs on the American economy and the overall quality of life.

Higher petroleum prices focus attention on the sustainability of American energy consumption patterns. Even before the oil price hikes during the summer of 2006, President George Bush summarized America's energy problems in the 2006 State of the Union address in striking terms: "Here we have a serious problem—

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1 *See* Energy Info. Admin., U.S. Dep't. of Energy, Monthly Energy Review December 2007, at 132 tbl. 9.4 (2008), *available at* http://tonto.eia.doe.gov/FTPROOT/multifuel/mer/00350712.pdf (average monthly gas prices); *id.* at 129 tbl. 9.1 (average monthly crude oil prices).

America is addicted to oil."[2] He reiterated this concern one year later in the 2007 State of the Union speech, challenging Americans to reduce gasoline consumption by twenty percent in ten years and calling for diversification of the nation's energy supply.[3] Emphasizing the nation's security risks from importing increasing amounts of oil from volatile and potentially hostile areas of the world, he stated that U.S. dependency on costly imported petroleum was its most serious energy policy problem.[4] Bush's comments, however, skirted another related global energy issue—the adverse environmental effects from combustion of carbon-based fuels.

Gradually, the problems stemming from the high levels of fossil fuel dependency in the United States have been recognized as ones that must be addressed. As the scientific consensus largely concludes that human activities contribute to global warming through the burning of coal, oil, and natural gas,[5] American policymakers must now decide how to respond. A broad range of policy and technical alternatives must be evaluated as the United States develops energy plans for the future.[6] While energy conservation might

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[2] Address Before a Joint Session of the Congress on the State of the Union, 42 WEEKLY COMP. PRES. DOCS. 145, 150 (Jan. 31, 2006) [hereinafter 2006 State of the Union Address].

[3] Address Before a Joint Session of the Congress on the State of the Union, 43 WEEKLY COMP. PRES. DOCS. 57, 59 (Jan. 23, 2007) [hereinafter 2007 State of the Union Address]. As Governor of Texas, Bush encouraged wind power for the state, resulting in 1999 legislation mandating that Texas electricity companies produce 2000 MW of electricity from renewable sources by 2009. Texas has since become America's wind power leader, and the Texas legislature raised the renewable energy bar to 5000 MW by 2015. Thomas L. Friedman, Editorial, *Whichever Way the Wind Blows*, N.Y. TIMES, Dec. 15, 2006, at A41.

[4] 2007 State of the Union Address, *supra* note 3, at 59. The fuel efficiency of American motor vehicles reveals an ever-increasing American demand for motor fuel. While the fuel rate for passenger cars has gradually improved to 22.5 miles per gallon in 2004, up from 21.1 miles per gallon in 1991, the annual average number of miles traveled per passenger car has steadily increased to 12,460 miles per year, up from 10,571 in 1991. ENERGY INFO. ADMIN., U.S. DEP'T OF ENERGY, MONTHLY ENERGY REVIEW FEBRUARY 2008, at 17 tbl. 1.8 (2008), *available at* http://tonto.eia.doe.gov/FTPROOT/multifuel/mer/00350802.pdf (providing data on vehicle mileage, fuel consumption and fuel rates). The fuel economy of vans, pickup trucks, and SUVs actually declined from levels in the mid-1990s. *Id.* The number of cars on the roads in the United States increased by approximately fifty-two million between 1990 and 2005. *See* U.S. CENSUS BUREAU, U.S. DEP'T OF COMMERCE, THE 2008 STATISTICAL ABSTRACT 680 tbl. 1064 (2008), *available at* http://www.census.gov/compendia/statab/2008edition.html [hereinafter 2008 STATISTICAL ABSTRACT] (showing motor vehicle registrations).

[5] INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, FOURTH ASSESSMENT REPORT, WORKING GROUP I REPORT: THE PHYSICAL SCIENCE BASIS 95 (2007), *available at* http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-chapter1.pdf.

[6] Policy design will undoubtedly be influenced by the economic costs associated with each alternative. Recent analyses differ as to the economic costs of responding to global warming. *Compare* NICHOLAS STERN, STERN REVIEW ON THE ECONOMICS OF CLIMATE

hold promise in restraining the rate of growth in energy use,[7] all predictions of America's energy future anticipate higher levels of consumption, particularly consumption of electricity.[8] How can the nation satisfy its ever-increasing demand for electricity to power its homes, offices, manufacturing plants, and commercial venues? Where will the necessary emission reductions in air pollutants and greenhouse gases (GHGs) be obtained in the future, especially if more energy is consumed? How will U.S. businesses and citizens shift away from a near-total dependence on fossil-fuel energy sources in coming years?[9] These difficult energy questions pose a significant challenge for the nation.

Change in American energy patterns is already underway. While this shift presents numerous complex legal, economic, and environmental questions, the nation stands at the brink of a new era regarding the diversification of its energy supplies. The numerous disadvantages of costly and environmentally-damaging fossil fuels have led to the consideration of energy alternatives previously considered too costly or technically infeasible. In this new world of energy, the need to alter patterns of American energy use and supply has taken on an increased sense of urgency, as future penalties for carbon discharge may be implemented in the future.[10] As a result, innovative energy sources are no longer viewed as experimental or exotic, but rather significant features of the developing

CHANGE (2007) *with* William Nordhaus, *The Stern Review on the Economics of Climate Change* (Nat'l Bureau of Econ. Research, Working Paper No. W12741, 2006).

7 Three of the largest European light bulb makers advocate a switch to energy-saving light bulbs to cut global greenhouse gas (GHG) emissions by phasing out incandescent light bulbs by 2016. Associated Press, *Europe to Unplug from Common Light Bulbs*, MSNBC.COM, Mar. 7, 2007, http://www.msnbc.msn.com/id/17364944. The American Bar Association (ABA) also teamed up with the U.S. Environmental Protection Agency (EPA) to issue the ABA-EPA Law Office Eco-Challenge "to become better environmental and energy stewards, and thereby reduce their carbon footprint." *See* AM. BAR ASSOC., THE ABA-EPA LAW OFFICE CLIMATE CHALLENGE (2007).

8 *See* ENERGY INFO. ADMIN., U.S. DEP'T OF ENERGY, ANNUAL ENERGY OUTLOOK 2007, at 2 tbl. 1 (2007), *available at* http://www.eia.doe.gov/oiaf/archive/aeo07/pdf/aeotab_1.pdf [hereinafter ANNUAL ENERGY OUTLOOK 2007] (estimating ever growing consumption of energy).

9 In 2004, fossil fuels (petroleum, coal, and natural gas) comprised 86.2% of total U.S. energy consumption, with nuclear electric power contributing 8.2% and renewable energy sources contributing 6.4%. Energy Info. Admin., U.S. Dep't of Energy, U.S. Energy Consumption by Energy Source, http://www.eia.doe.gov/cneaf/solar.renewables/page/trends/table1.html (last visited Dec. 26, 2007).

10 New construction of coal-fired electrical generating plants has occurred in part to "beat" new carbon discharge restrictions. *See* Steven Mufson, *Midwest Has "Coal Rush," Seeing No Alternative-Energy Demand Causes Boom in Construction*, WASH. POST, Mar. 10, 2007, at A1 (predicting that forty new coal fired utility plants would start up in the next five years, creating the largest wave in coal fired plant construction since the 1970s).

energy future. As an example, renewable energy sources, including solar, wind, and hydro-power, are now being considered as substantial contributors to future American energy supplies.[11]

This Article focuses on wind power as a form of renewable energy and addresses the central question of how the United States will change its electrical energy portfolio to respond to evolving energy realities. What are the prospects and obstacles for large-scale development of the potentially inexhaustible, non-polluting source of electricity derived from wind power?[12] Historically, wind has been harnessed to serve basic human needs like grain-grinding and water-pumping,[13] but has only recently been tapped to supply electrical energy in sizable amounts that supplement conventional technologies. The last quarter century witnessed the tremendous growth of wind power capacity, beginning with extremely small amounts[14] and culminating most recently with a dramatic annual increase of approximately twenty-five percent.[15] This recent expansion has been buoyed by escalating fossil fuel costs, as well as an increasing concern about the environmental impacts of current energy use. The central inquiry of this Article is whether wind power can be an important contributor to the supply of domestic electricity.

Although in the past wind power played a relatively small role in electricity generation, with the support of government policies and

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11 The U.S. renewable energy industry collectively tallies its future energy capacity at 550 to 700 gigawatts (GW); at such a production rate, renewable energy would supply twenty-five percent of the United State's electrical energy requirements by 2025. Jim Callihan, *Forecast: U.S. Renewable Energy to Hit 700 GW*, RENEWABLE ENERGY ACCESS, Dec. 1, 2006, http://www.renewableenergyaccess.com/rea/news/story?id=46717.

12 President Bush announced an Advanced Energy Initiative in conjunction with his 2006 State of the Union address. This initiative emphasized the potential significance of wind power as a possible electricity source. NAT'L ECON. COUNCIL, WHITE HOUSE, ADVANCED ENERGY INITIATIVE 13 (2006) (noting that "[a]reas with good wind resources have the potential to supply up to 20% of the electricity consumption of the United States.").

13 *See* PETER ASMUS, REAPING THE WIND: HOW MECHANICAL WIZARDS, VISIONARIES, AND PROFITEERS HELPED SHAPE OUR ENERGY FUTURE 24-32 (2001).

14 California was first in the United States to operate wind power plants. In 1978, it initiated the Wind Energy Program, with the goal of securing 500 MW of wind power electricity installed and operating by the mid-1980s. By 1985, California installed 1000 MW of wind capacity. ENERGY INFO. ADMIN., U.S. DEP'T OF ENERGY, POLICIES TO PROMOTE NON-HYDRO RENEWABLE ENERGY IN THE U.S. AND SELECTED COUNTRIES 9-10 (2005).

15 ENERGY INFO ADMIN., U.S. DEP'T OF ENERGY, ELECTRIC POWER MONTHLY JANUARY 2008, at 1 (2008) [hereinafter ELECTRIC POWER MONTHLY], *available at* http://www.eia.doe.gov/cneaf/electricity/epm/epm.pdf (showing annual increase from October 2006 to October 2007 of over twenty-five percent).

popular attitudes it can produce significant amounts of electrical power in the next ten to fifteen years. Such a shift is already underway in parts of Europe.[16] If a similar change were to occur in the United States, important environmental and economic benefits would accrue to the nation and the world. Energy diversification towards wind power is underway in the United States, and the operative question is whether this pattern will accelerate to achieve the optimistic electricity generation goals set forth by government policymakers and wind power advocates. But is this transition towards wind power a uniformly positive step? All energy alternatives have associated benefits and drawbacks, and wind power is no exception. What are the disadvantages of wind power, and do they make this technology undesirable? The adverse effects of this form of renewable energy must be carefully assessed and understood. The most important judgment is one of comparative assessment: how do the effects of wind power compare with similar aspects of other forms of electricity production? This Article concludes that the United States must accelerate the diversification of American electricity. The environmental and social advantages of wind-generated electricity clearly outweigh the disadvantages, and public policy should encourage this form of renewable energy.

II. Introduction to Patterns of World Energy Production and Consumption

A. *Global Energy: Large and Growing Demand*

Global primary energy consumption steadily increased over the last decade, and in 2005 totaled 10,537 million tons of oil equivalents (mtoe), an increase of 2.7 percent from 2004 levels.[17] The strongest increase in consumption from 2004 was in the Asia Pacific region (5.8%), while North America recorded the weakest growth (0.3%).[18] Energy consumption in the United States fell slightly, while China accounted for more than half of global energy

16 *See* European Wind Energy Ass'n, 2006 Annual Report 4-6 (2007) (showing wind growing wind energy capacity in Europe and plans for additional expansion).

17 British Petroleum, Statistical Review of World Energy 40 (2006) *available at* www.bp.com (select the "Reports and Publications" hyperlink on the top of the page, choose "Downloads" from the pull-down menu under "Statistical Review of World Energy 2007," and then select "Review 2006" from the pull-down menu under "Statistical Review 2006") [hereinafter BP: Primary Energy Consumption]. One million tonnes of oil equivalents have a heat equivalency of approximately forty million British thermal units (Btus). *See* British Petroleum, Conversion factors, http://www.bp.com/extendedsection genericarticle.do?categoryId=9017944&contentId=7033505 (last visited Jan. 23, 2008).

18 BP: Primary Energy Consumption, *supra* note 16.

consumption growth,[19] consuming 1554 mtoe of energy, second only to the United States' total of 2336 mtoe.[20] The future appears to portend even more energy use. Current baseline projections of the International Energy Agency (IEA) indicate that worldwide demand will increase at the average rate of 1.6 percent annually, reaching a total of 16.3 billion tons of oil by 2030—a fifty-two percent increase from 2003.[21] Under this scenario, oil, natural gas, and coal will account for eighty-three percent of this increase and ultimately comprise eighty-one percent of global energy demand by 2030.[22] If this view is correct, serious increases in GHGs will inevitably result. This estimate also assumes that renewable energy (other than hydro-electric and biomass) will increase at the largest annual rate of any fuel source. This rapid increase, however, springs from a small initial share of global energy demand.

While the dominance of fossil fuels as the world's largest energy source appears certain, changes in governmental policy could alter the energy mix to some degree. Such a shift could reduce the severity of climate change if fossil fuel emissions are reduced by alternative energy technologies that do not produce GHG emissions. Increased energy efficiency could also reduce the rate of increase in total energy consumption. By advancing the goals of reduced GHG emissions[23] and enhanced energy security, world

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[19] *Id.* In 2005, the top ten world consumers of energy were (expressed in mtoe and in percentages of total consumption): United States (2336 mtoe: 22.2%), China (1554 mtoe: 14.7%), Russian Federation (679 mtoe: 6.4%), Japan (524 mtoe: 5%), India (387 mtoe: 3.7%) Germany (324 mtoe: 3.1%), Canada (317 mtoe: 3%), France (262 mtoe: 2.5%), United Kingdom (227 mtoe: 2.2%), and South Korea (224.6 mtoe: 2.1%). *Id.*

[20] *Id.* In the last forty years, China's energy consumption rose twelve-fold, from 182.4 to 1554 mtoe. By comparison, the United States increased its energy use roughly two-fold, from 1324 to 2336 mtoe. This reflects the significant change in industrial, residential, and commercial energy use that occurred over during the last forty years. *Id.*

[21] INT'L ENERGY AGENCY, WORLD ENERGY OUTLOOK 80 (2005), *available at* http://www.worldenergyoutlook.org/2005.asp [hereinafter 2005 WORLD ENERGY OUTLOOK]. These estimates spring from the IEA Reference Scenario, which takes into account governmental policies and actions already adopted, even if not currently in place. This "baseline vision" does not include possible, potential, or even likely future policy initiatives even though it is quite possible or desirable that new energy policies will be adopted in the next two decades. *Id.* at 59.

[22] *Id.* at 80. Under this appraisal, nuclear power will fall from supplying 6.4% to 4.7% of energy demand, while the share of renewable resources will increase from 13% to 14%. *Id.* at 80.

[23] Maintaining the status quo of heavy reliance on fossil fuel energy sources will result in a substantial increase in the emission of energy-related CO_2 over the period ending in 2030. Under the IEA Reference Scenario, emissions of CO_2 will increase from twenty-four gigatonnes to thirty-seven gigatonnes, an increase of fifty-two percent over 2003 levels. Electrical power generation is expected to contribute approximately half of this increase, while transportation-related energy use will add another quarter. *Id.* at 92.

governments might stimulate the demand for renewable energy technologies beyond their projected levels of growth. If progress is to be made in slowing down global warming, then governments, citizens, and power companies must aim to expand renewable energy.

The Energy Information Administration (EIA) estimates the rate of annual increase in electricity generation at a 2.4 percent worldwide for the period 2004 to 2030; this projection results in an estimated increase in global electrical generation from 16,424 kilowatt hours (kWh) in 2004 to 30,634 kWh in 2030.[24] How will this large increase in generating capacity be met? The fuels and generating technologies to be used in meeting this sizable capacity expansion will vary from country to country, depending upon available fuels, national security concerns, market competition, and governmental policies. Considering the ratios of fuels currently used to generate electricity,[25] it seems likely that a large percentage of the needed new capacity will be fossil fuel-powered. Approximately seventy percent of U.S. electricity currently comes from fossil fuels,[26] while in China an even greater share of electricity is fueled by coal, natural gas, and oil.[27] The dramatic increase in worldwide burning of fossil fuels will only increase emissions of GHGs and other air pollutants. This raises the question of how other non-polluting generating technologies, such as renewable energy, can be advanced to offset such damaging growth.

B. U.S. Energy Production and Consumption Patterns

To understand the scope of energy policy issues in the United States, it is necessary to comprehend the trends of U.S. energy production and consumption. As a measure of total energy consumption, the United States used 79.99 quadrillion Btus from fossil fuels,

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[24] ENERGY INFO. ADMIN., U.S. DEP'T OF ENERGY, INTERNATIONAL ENERGY OUTLOOK 65 (2007), *available at* http://www.eia.doe.gov/oiaf/ieo/pdf/electricity.pdf [hereinafter INT'L ENERGY OUTLOOK].

[25] *See* BRITISH PETROLEUM, STATISTICAL REVIEW OF WORLD ENERGY: PRIMARY ENERGY CONSUMPTION (2006) *available at* http://www.bp.com/statisticalreview (follow "Historical data" hyperlink and then "Primary Energy: Consumption by Fuel" hyperlink) [hereinafter BP: CONSUMPTION BY FUEL].

[26] U.S. Dep't of Energy, Energy Info. Admin., Net Generation by Energy Source by Type of Producer, 1995 through 2006, http://www.eia.doe.gov/cneaf/electricity/epa/epat1p1.html (last visited Dec. 26, 2007).

[27] China already provides over seventy percent of its electrical generation with coal. Natural gas and oil electrical production will only add to the fossil fuel component of China's electricity generation portfolio. *See* INT'L ENERGY OUTLOOK, *supra* note 23, at 68.

nuclear electric power, and renewable energy in 1978.[28] By 2005, this number grew to 99.89 quadrillion Btus—an increase of 24.9 percent over twenty-seven years.[29] By comparison, the population growth over this same time period was 34.6 percent—suggesting that per capita energy use decreased, perhaps through the introduction of energy conservation methods.[30] Between 1978 and 2005, renewable sources of energy have stayed remarkably static at slightly more than six percent of the energy mix, with wind power representing a small fragment of that total.[31]

In the future, U.S. energy consumption is expected to rise approximately one percent per year to reach a total of 131.16 quadrillion Btus by 2030, with domestic energy production growing one percent each year and any shortfall made up for by imported energy.[32] All renewable sources of energy (including hydroelectric, biomass, wind, geothermal, and solar) will increase by an annual rate of approximately 2.2 percent and will constitute over ten percent of overall domestic energy production by 2030.[33] This bullish prediction of American renewable energy growth is reinforced by the IEA's estimate of world-wide energy trends, which indicates that renewable energy will increase globally by 9.2 percent per year.[34]

In 2005, the United States led the world in total electricity production with 4062 billion kWh, followed by China with 2866 billion kWh.[35] Between 2004 and 2005, however, the rate of American electrical generation growth (two percent) is dwarfed by that of

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28 Energy Info. Admin., U.S. Dep't of Energy, Energy Overview: Selected Years, 1949-2006, http://www.eia.doe.gov/aer/pdf/pages/sec1_5.pdf (last visited Jan. 26, 2007).

29 *Id.*

30 *See* 2008 Statistical Abstract, *supra* note 4, at 7 tbl. 2.

31 Hydro-electric power and biomass sources represented the overwhelming majority of renewable energy, with geothermal, solar, and wind energy combined constituting only 9.3 percent in 2005. ENERGY INFO. ADMIN., U.S. DEP'T OF ENERGY, ANNUAL ENERGY REVIEW 2006, at 2 tbl. 1.2 (2007), *available at* http://tonto.eia.doe.gov/FTPROOT/multifuel/038406.pdf [hereinafter EIA: ENERGY CONSUMPTION BY PRIMARY ENERGY SOURCE] (table entitled "Energy Production by Primary Energy Source, Selected Years, 1949-2006").

32 ANNUAL ENERGY OUTLOOK 2007, *supra* note 8, at 2.

33 *See* ENERGY INFO. ADMIN., U.S. DEP'T OF ENERGY, ANNUAL ENERGY OUTLOOK 2008, at 1, tbl. A-1 (2008), *available at* http://www.eia.doe.gov/oiaf/aeo/pdf/appa.pdf.

34 INT' L ENERGY AGENCY, WORLD ENERGY OUTLOOK 2006, at 493 (2006).

35 U.S. CENT. INTELLIGENCE AGENCY, THE WORLD FACT BOOK (2007), *available at* https://www.cia.gov/library/publications/the-world-factbook/rankorder/2038rank.html. National electricity statistics have a small amount of variation. British Petroleum's Statistical Review of World Energy listed generation in the United States at 4239 billion kWh in 2005. BRITISH PETROLEUM, HISTORICAL DATA WORKBOOK (2007) *available at* http://www.bp.com/productlanding.do?categoryId=6848&contentId=7033471 (download the

China (12.6 percent—the highest in the world).[36] The overwhelming source for this generation increase in the United States is fossil fuels, with at least seventy percent of the electricity currently produced through the combustion of coal, natural gas, and oil.[37] The new power plant construction in the United States over the past few years emphasizes natural gas as a central fuel source, but coal plants are also on the drawing boards.[38] With this picture of strong future electricity demand, U.S. policy makers and citizens must consider the implications of the technologies available to meet the increased demand over the next twenty-five years.

III. Forcing Change in Patterns of American Energy Supply and Use

A. *Making Technological Choices for Electricity Generation*

Most American consumers and industrial and commercial users purchase their electricity from an electric utility company. Investor-owned utility corporations provide about seventy-five percent of electric utility generating capability, generation, sales, and revenue in the United States, and they are responsible to their shareholders, consumers, and government utility regulators.[39] Since energy generation is an extremely capital-intensive activity, a shift to a new technology can only follow a careful cost-benefit analysis of modifying technical approaches to electricity generation. Investment in new generating capacity represents a major long-term capital commitment that cannot be easily replaced if it fails to provide expected generating results. As a result, utilities often make incremental improvements to existing generating technologies and major changes to generating equipment only when significant benefits are projected. The supply of electricity also requires reliabil-

"Workbook" excel file in the middle of the page)[hereinafter BP: Electricity Generation].

36 BP: Electricity Generation, *supra* note 34.

37 In 2006, American electrical power was generated by coal (48.9%), petroleum (1.6%), nuclear (19.4%), and natural gas (20%). Renewable sources of electricity, including hydroelectric, comprised 10.1%. Electric Power Monthly, *supra* note 14, at 18.

38 U.S. Gov't Accountability Office, GAO-05-414T, Meeting Energy Demand in the 21st Century: Many Challenges and Key Questions 12 (2005).

39 Energy Info. Admin., U.S. Dep't of Energy, Electric Power Industry Overview, http://www.eia.doe.gov/cneaf/electricity/page/prim2/toc2.html (last visited February 8, 2008). Independent power producers produce and sell electricity on the wholesale market at non-regulated rates and must use renewable energy as a primary source for generation of electricity. *Id.*

ity, so new technology must have predictable characteristics that can be integrated into the overall stream of supply.

The choice of appropriate technology for energy production is driven by multiple factors. First, the technology must be feasible and reliable in large scale, real-world settings. Theoretically appealing yet untried energy production concepts are not suitable for actual application. The utility company or the Independent Power Producer (IPP) must be assured of the performance characteristics and reliability before major investments can be made. Second, the cost of construction and operation of the technology is usually of primary importance and is the subject of careful modeling and calculation. A number of costly energy technologies are not yet widely adapted because of their high relative expenses per units of energy delivered.[40] Consequently, the energy produced must be economically competitive with substitutes, and within the economic limits of most energy consumers. Third, environmental and other regulatory implications are also important. If a particular energy technology imposes excessive environmental harms, it will be subordinated to other less damaging technologies, all other things being equal. Fourth, raw material supply concerns are significant aspects of technology choices. If the use of a particular fuel or other necessary production component is difficult to obtain, has global political consequences, or wildly erratic prices, that energy technology will be considered less desirable for future installation. Furthermore, the total cost of procuring electricity—to workers, the environment, and communities—must be considered in light of the total fuel cycle. The siting acceptability of the new energy technology will be an important element of the calculus. Electricity producers approach new energy generation technologies with all of these considerations in mind.

B. Increasing the Emphasis on Renewable Energy Technologies

Renewable sources of energy are abundant and, when combined, have the potential to change the American energy mix in important ways. Although there is no authoritative definition of what constitutes a renewable energy source, the U.S. Department of Energy (DOE) includes hydroelectric power, geothermal, solar/photovoltaic, wind, wood waste, and biomass.[41] Over the last

[40] Energy Info. Admin., U.S. Dep't of Energy, Energy Technologies on the Horizon, http://www.eia.doe.gov/oiaf/aeo/otheranalysis/aeo_2006analysispapers/eth.html (last visited Jan. 26, 2008).

[41] EIA: ENERGY CONSUMPTION BY PRIMARY ENERGY SOURCE, *supra* note 30.

twenty-five years, renewable energy production has fluctuated between six and seven quadrillion Btus per year.[42] As a percentage of total energy production, the renewable component has varied within a tight range, between eight and ten percent of total American energy production.[43]

In 2007, renewable energy sources contributed eleven percent of the total electric power generation in the United States.[44] The rise in renewable electricity generation is attributable to significant increases in hydroelectric and wind power generation.[45] While eleven percent of electricity generation is a relatively small component of overall supply, this figure does provide evidence that a shift in generation can occur in the world's largest electrical market. This shift has important consequences for the environment because continued high fossil fuel prices would support the development and installation of larger amounts of electric power substitutes, such as renewable energy. Should this occur, renewable energy might emerge as a larger part of the energy mix.

IV. The Potential of Wind Power to Bolster Renewable Electricity Supplies

A. *Renewable Energy Worldwide*

The world acquired about nineteen percent of its electricity from renewable sources in 2003, and nations across the globe are diversifying the electrical generation mix by emphasizing new energy technologies.[46] Different countries lead the world with respect to different types of renewable sources. For example, Japan leads in photovoltaic power generation, Germany leads with generation from wind turbines, and the United States and Brazil lead in ethanol production.[47] Geothermal sources account for approximately twenty-five percent of the total electricity generated in El Salva-

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42 *Id.* The highest absolute amount of renewable energy production occurred in 1997, when the total topped 7.18 quadrillion Btus. *Id.*

43 *See id.* (showing U.S. renewable and total energy consumed).

44 Electric Power Monthly, *supra* note 14, at 5.

45 *Id.*

46 *See* Energy Info. Admin., U.S. Dep't of Energy, World Net Energy Generation by Type: 2004, http://www.eia.doe.gov/pub/international/iealf/table63.xls (last visited Jan. 26, 2008).

47 *See id.*; *see also* Energy Info. Admin., U.S. Dep't of Energy, World Net Geothermal, Solar, Wind, & Wood & Waste Electric Power Generation, Most Recent Annual Estimates: 1980-2006, http://www.eia.doe.gov/emeu/international/RecentOtherElectricGenerationBtu.xls (last visited Jan. 26, 2008).

dor, and twenty percent of all electricity in the Philippines, Kenya, and Iceland.[48]

Under a DOE program, one million solar energy systems will be installed on rooftops across the United States by 2010, and the installation of these systems could eliminate carbon dioxide emissions equal to those produced by 850,000 automobiles.[49] European nations lead the way with wind power: Germany and Spain have the highest total installed wind power capacity in the world, and Denmark ranks fifth.[50] Thus, in nations around the world, renewable energy is major contributor to the total energy mix. While each nation has its own reasons for setting its energy profile, it is clear that renewable forms of energy are not rare phenomena; they serve important purposes in diversifying the mixture and achieving a wide range of societal objectives.

B. *Wind Power as a Larger Component of the American Renewable Energy Mix*

Nature's wind movement has been utilized for centuries throughout the world, with records indicating the early use of the wind as an energy source in China and Persia for grinding grain and pumping water.[51] Over the last 2000 years, the power of the wind has assisted humans with land drainage, industrial activities, mining, textile production, and agriculture.[52] American inventor Charles Brush created the first automatic operating wind-powered electricity turbine to generate electricity for his home in 1888.[53] The technology thus has a long track record of utility for solving significant societal needs. Current research suggests that other innovative applications for wind power exist, including hydrogen production, the cleaning and moving of water in combination with

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48 British Petroleum Global, Geothermal energy, http://www.bp.com/sectiongenericarticle.do?categoryId=9017926&contentId=7033480 (last visited Jan. 23, 2008).

49 Natural Res. Def. Council, Solar Power, http://www.nrdc.org/air/energy/renewables/solar.asp (last visited Dec. 26, 2007).

50 Press Release, Global Wind Energy Council, Global Wind Energy Markets Continue to Boom (Feb. 2, 2006), *available at* http://www.gwec.net/uploads/media/07-02_PR_Global_Statistics_2006.pdf. While Europe leads the way, Asia is expanding its capacity as well, with China rapidly increasing its capacity by seventy percent in 2006 following the passage of the Chinese Renewable Energy Law. *Id.*

51 ASMUS, *supra* note 12, at 24-32.

52 *See* ROBERT GASCH & JOCHEN TWELE, WIND POWER PLANTS: FUNDAMENTALS, DESIGN, CONSTRUCTION AND OPERATION 17, 20-21 (2002); ERICH HAU, WIND TURBINES: FUNDAMENTALS, TECHNOLOGIES, APPLICATION, ECONOMICS 1 (2d ed. 2006).

53 Danish Wind Indus. Ass'n, A Wind Energy Pioneer: Charles F. Brush, http://www.windpower.org/en/pictures/brush.htm (last visited Jan. 23, 2008).

hydroelectric power plants, the powering of municipal drinking water, waste water operations, desalinization, and irrigation.[54]

In the twentieth century, the widespread availability of inexpensive, utility-generated electricity failed to place pressure on wind power as an alternative electrical source. For much of the century, there was scant interest in wind-produced electricity, save for as a means of charging batteries in remote, inaccessible locations.[55] Federal policies enacted in the early twentieth century that encouraged rural electrification by subsidizing rural electrical cooperatives and installation of electric transmission lines largely eradicated the more than eight million mechanical windmills that were installed throughout the west and mid-western parts of the United States. Under these policies, utility electrical lines were extended and ultimately connected to fossil fuel-powered generating plants.[56]

Even with this history of declining use, wind power is currently staging a come-back on multiple levels. The following subsections of this Article will explain how wind power is produced and describe some of the major wind power sources in the United States.

1. *What is Wind Power and how is it Produced?*

Wind power is a converted form of solar energy.[57] When solar radiation reaches the Earth, it heats different areas at uneven rates. The atmosphere warms evenly and warm air rises, causing a reduction in the atmospheric pressure at the Earth's surface. Cooler air is drawn in to fill in the low pressure area, and wind results. Moving air contains kinetic energy, which can be directly or indirectly converted into mechanical force or electricity.[58]

The generation of electricity requires a structure to convert the wind's force into a rotating motion.[59] Most modern wind power devices employ turbines, using the horizontal axis configuration that resembles the propeller of a boat or an airplane. Most wind turbines generally have the following components: a rotor or

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54 U.S. DEP'T OF ENERGY, WIND POWER TODAY AND TOMORROW 23 (2004).

55 Wind & Hydropower Techs. Program, U.S. Dep't of Energy, History of Wind Energy, http://www1.eere.energy.gov/windandhydro/wind_history.html (last visited Jan. 26, 2008).

56 *Id.*

57 Energy Info. Admin., U.S. Dep't of Energy, History of Wind, http://www.eia.doe.gov/kids/energyfacts/sources/renewable/wind.html#history (last visited Jan. 26, 2008).

58 *Id.*

59 Am. Wind Energy Ass'n, Wind Web Tutorial, http://www.awea.org/faq/wwt_basics.html (last visited Jan. 26, 2008) [hereinafter AWEA Tutorial].

blades (usually three per tower), which convert the wind's energy into a rotating shaft energy; a nacelle or enclosure, usually containing a drive train, gearbox, and generator; a tower, which supports the rotor and the drive train; and electronic equipment, such as controls, ground support equipment, and grid interconnection equipment.[60] The modern turbine has the capability to adjust its position to turn into the wind for optimal production.[61]

Wind turbine towers are usually composed of tubular steel, while the rotors or blades are made of fiberglass-reinforced polyester or wood epoxy. The most common turbine form uses three blades to rotate and generate electricity.[62] For small farm or home applications, relatively small-sized wind turbines with diameters of eight meters or less are placed on towers of forty meters or less in height.[63] There are a surprisingly large range of these small-scale users of wind power.[64] However, significantly larger machines are needed to generate utility-quantity electricity capable of interconnection with the nation's electrical grid system. Wind turbine units are measured in terms of their physical size as well as their generating capacity. Wind turbines for land-based wind farms come in various sizes, ranging from a few kilowatts to over 100 megawatts of electricity in capacity.[65]

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60 *Id.*

61 *Id.*

62 *See* JAMES L. TANGLER, THE EVOLUTION OF ROTOR AND BLADE DESIGN 2-3 (2000).

63 Small companies attract venture capital to produce home-sized wind power systems. For example, Southwest Windpower sells a thirty-three foot turbine with six-foot blades that can produce electricity at wind speeds as low as nine miles per hour and provide up to eight percent of the average household's electricity. *See* Jennifer Alsever, *Wind that Powers Your Home*, BUS. 2.0 MAG., Feb. 19, 2007, http://money.cnn.com/2007/02/16/magazines/business2/windpower_homes.biz2/index.htm.

64 For example, the school district in Spirit Lake, Iowa installed a 250 kW wind turbine in 1993. The turbine provided 350,000 kWh of electricity per year, which was more than necessary for the elementary school. The excess electricity was sold to the local utility system, netting the school $25,000 in its first five years of operation. Local Gov'ts for Sustainability, Case Study: Spirit Lake, Iowa, http://www.greenpowergovs.org/wind/Spirit%20Lake%20case%20study.html (last visited Dec. 26, 2007).

65 *See* enXco, Understanding Wind, http://forasenergy.com/understanding_wind_faqs.php (last visited Jan. 23, 2008).

2. *Where are the Major Wind Power Sources in the United States?*

According to the DOE, thirty-seven states boast wind resources that would support utility-scale wind power projects.[66] One estimate suggests that wind power could supply approximately twenty percent of the United State's total electricity need.[67] The DOE estimates that the Midwest, including the Great Plains, has more than enough wind energy to fulfill the entire nation's electricity needs.[68] The DOE also estimates that good wind areas, which cover six percent of the nation's land area, are widely distributed across the nation and have the potential to supply more than two-and-a-half times the current electricity consumption of the United States.[69]

The generation of electricity from wind depends upon wind speed, since large-scale commercial wind farms require consistent high-velocity winds. The land area of the United States is mapped and classified by the DOE.[70] Small wind systems, also known as distributed wind systems, are more flexibly sited; it is estimated that as much as sixty percent of the United States is suitable for

[66] U.S. GOV'T. ACCOUNTABILITY OFFICE, GAO-04-756, RENEWABLE ENERGY: WIND POWER'S CONTRIBUTION TO ELECTRIC POWER GENERATION AND IMPACT ON FARMS AND RURAL COMMUNITIES 17 (2004) [hereinafter GAO WIND REPORT].

[67] D.L. ELLIOTT ET AL., PACIFIC NW. LAB., AN ASSESSMENT OF THE AVAILABILITY OF THE WINDY LAND AREA AND WIND ENERGY POTENTIAL IN THE CONTIGUOUS UNITED STATES iii (1991). After factoring in environmental and land use exclusions for wind class 3 or higher areas, this assessment also concluded that North Dakota, Texas, Kansas, South Dakota, and Montana each held the potential of over 1000 billion kWh of electricity. *Id.*

[68] GAO WIND REPORT, *supra* note 65, at 17.

[69] U.S. Dep't of Energy, Wind Energy Resource Potential, http://www1.eere.energy.gov/windandhydro/wind_potential.html (last visited Dec. 26, 2007). The land base of the continental United States is classified into seven wind potential categories. Estimates of the wind resources are expressed in wind power classes ranging from class 1 to class 7, with each class representing a range of mean wind power density or equivalent mean speed at specified heights above the ground. Areas designated class 4 or greater are suitable with advanced wind turbine technology under development today; class 3 areas may be suitable for future technology; class 2 areas are marginal; and class 1 areas are unsuitable for wind energy development. Areas potentially suitable for wind energy applications (wind power class 3 and above) include "much of the Great Plains from northwestern Texas and eastern New Mexico northward to Montana, North Dakota, and western Minnesota; the Atlantic coast from North Carolina to Maine; the Pacific coast from Point Conception, California to Washington; the Texas Gulf coast; the Great Lakes; portions of Alaska, Hawaii, Puerto Rico, the Virgin Islands, and the Pacific Islands; exposed ridge crests and mountain summits throughout the Appalachians and the western United States; and specific wind corridors throughout the mountainous western states." *Id.*

[70] *Id.*

small turbine use.[71] Tribal land encompasses ninety-six million acres, much of which possesses excellent wind resources, as do federally-owned lands under the control of the Bureau of Land Management (BLM).[72] Large potential wind power regions also exist in off-shore locations. The National Renewable Energy Laboratory estimates that off-shore wind resources between five and fifty nautical miles away from the Atlantic and Pacific coasts could provide 1000 gigawatts (GW) of wind energy for the United States, an amount equal to the current installed U.S. electrical capacity.[73] Higher offshore construction costs may be offset by higher and more consistent wind speeds, which can produce more electricity at significantly lower costs.[74] Only a small amount of this potential is tapped, although there are at least 600 MW of new offshore wind projects, some of which are extremely controversial, currently in the permitting stage in the United States.[75]

3. *What is the Rate of Growth of Installed Wind Power Generating Capacity?*

Wind power is increasingly considered part of the mix of renewable energy sources. The first 1000 MW of wind power generating capacity was in place in the United States by 1985, yet it took until 1999 for the total capacity to reach 2000 MW.[76] Growth has sped up considerably, with 5000 MW installed by 2003, 11,600 MW in place by 2006, and 16,800 MW installed by the end of 2007.[77] This

71 PAUL GIPE, WIND ENERGY BASICS: A GUIDE TO SMALL AND MICRO WIND SYSTEMS (1999).

72 U.S. DEP'T OF INTERIOR, BUREAU OF LAND MGMT., FES 05-11, FINAL PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT ON WIND ENERGY DEVELOPMENT ON BLM-ADMINISTERED LANDS IN THE WESTERN UNITED STATES 2-5 (2005) [hereinafter BLM WIND DEVELOPMENT IMPACT STATEMENT]. The BLM estimates that approximately 160,000 acres of land under its control in eleven western states would be "economically developable" as wind power sites between 2005 and 2025. This land was located mainly in California, Nevada, and Utah. *Id.*

73 Walt Musial et al., *Energy from Offshore Wind* 1-2 (Nat'l Renewable Energy Laboratory Offshore Tech. Conference, Conference Paper NREL/CP-500-39450, 2006), *available at* http://www.nrel.gov/wind/pdfs/39450.pdf.

74 AM. WIND ENERGY ASS'N, THE ECONOMICS OF WIND ENERGY 1 (2005) [hereinafter AWEA ECONOMICS]. The American Wind Energy Association estimates that as wind speed increases per kilowatt hour, costs fall. *Id.*

75 Musial et al., *supra* note 72, at 3. *See also* Stephanie Ebbert, *Cape Wind moves on to federal review,* BOSTON GLOBE, Mar. 31, 2007, at A1.

76 Am. Wind Energy Ass'n, Wind Power U.S. Installed Capacity: 1981-2007, http://www.awea.org/faq/instcap.html (last visited Jan. 26, 2008).

77 Press Release, Am. Wind Energy Ass'n, Installed Wind Capacity Surged 45% in 2007 (Jan. 17, 2008), *available at* http://www.awea.org/newsroom/releases/AWEA_Market_Release_Q4_011708.html [hereinafter AWEA Press Release].

acceleration in wind power investment was buoyed by increasing fossil fuel prices, declining wind generation costs, and crucial federal tax subsidies.[78] As a result, the annual wind power growth rate over the last several years is twenty-two percent.[79] A predictable continuation of supportive governmental subsidies together with research and development funding will be necessary if the federal goal of 100,000 MW of wind power is to be achieved by 2020.

Large and small industrial firms and well-funded venture capital investors are attracted to the prospects of wind-generated electricity and are now actively involved in the promotion and expansion of the new industry.[80] The amount of invested capital is impressive. In 2005, seventeen billion dollars were invested in clean energy projects in the United States alone, and forty-nine billion dollars were invested worldwide.[81] The substantial flow of capital into the American wind power industry is undoubtedly influenced by the rise in fossil fuel prices and the availability of various federal tax incentives. It also reflects a substantial commitment to a rapidly growing industry with financial viability, at least under the current subsidy structure.

4. Where is Wind Power Currently Being Used in the United States?

In 2006, the total amount of installed utility-scale wind power electricity exceeded 11,600 MW,[82] and Texas surpassed California as the state with the greatest installed wind power capacity in the nation.[83] The top ten states in terms of year end installed wind power capacity in 2006 were Texas (2739 MW), California (2376 MW), Iowa (931 MW), Minnesota (895 MW), Washington (818 MW), Oklahoma (535 MW), New Mexico (496 MW), Oregon (438 MW), New York (370 MW), and Kansas (364 MW).[84] The optimis-

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[78] For information about the federal wind production tax credit, see *id.*

[79] Am. Wind Energy Ass'n, Wind Energy Fast Facts, http://www.awea.org/newsroom/pdf/Fast_Facts.pdf (last visited Jan. 27, 2008).

[80] *See, e.g.*, Kevin Kelleher, *Wind Power Generating a Higher Profile*, THE STREET, July 5, 2006, http://www.thestreet.com/markets/energy/10294781.html.

[81] Emily Thornton & Adam Aston, *Wall Street's New Love Affair*, BUSINESS WEEK, Aug. 14, 2006, at 48, *available at* http://www.businessweek.com/magazine/content/06_33/b3997073.htm.

[82] AWEA Press Release, *supra* note 76.

[83] W. N.C. Renewable Energy Initiative, Fact Sheet: Utility-Scale Wind Energy, http://www.wind.appstate.edu/reports/WindEnergyFactSheetWNCREIFeb07.pdf (last visited Jan. 26, 2008).

[84] U.S. Dep't of Energy, Wind Powering America: Installed U.S. Wind Capacity, http://www.eere.energy.gov/windandhydro/windpoweringamerica/wind_installed_capacity.asp (last visited Dec. 27, 2007) [hereinafter Installed Wind Capacity].

tic goal of the federal government's Wind Powering America initiative is to have at least thirty states with at least 100 MW of installed wind power capacity by 2010.[85] In 2006, there were only sixteen states that met that goal, but six additional states currently have between twenty-nine and seventy-five MW of generating capacity and could meet the goal in the next few years.[86] While the achievement of the 10,000 MW nationwide generating capacity represented a huge milestone for wind power, it must be kept in mind that U.S. wind power still accounts for less than one percent of existing domestic electricity generation.[87] The proclaimed national goal of reaching the six percent level by 2020 will consequently require substantial expansion of large American wind farms.

C. *The Benefits and Drawbacks of Wind Power as an Energy Choice*

1. *Benefits of Wind Power Electricity Generation*

Wind energy development spans a lengthy time period and encompasses a number of phases. The process runs from site monitoring to facility construction to plant operation and electricity generation to decommissioning of the development. As a process, wind power involves different advantages and disadvantages at varying stages of the development timeline. Comparisons of wind power technology with conventional fossil fuel or other energy methods should therefore occur in both a phase-by-phase and comprehensive fashion.

a. *Eliminating Fuel Costs in Electricity Generation*

Proponents of wind power technology emphasize a range of reasons to support the rapid expansion of wind-generated electricity and motive power. First and foremost, wind power is a renewable and indigenous form of non-fossil fuel electricity. Once a wind turbine is installed, there is no fuel cost for the generation of power and consequently no fuel cost volatility. Second, the wind follows

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85 U.S. Dep't of Energy, About Wind Powering America, http://www.eere.energy.gov/windandhydro/windpoweringamerica/wpa_about.asp (last visited Dec. 27, 2007). Wind Powering America is a commitment by the U.S. Department of Energy to dramatically increase the use of wind energy in the United States. This initiative is intended to establish new sources of income for American farmers, Native Americans, and other rural landowners, and to meet the growing demand for clean sources of electricity. *Id.*

86 Installed Wind Capacity, *supra* note 83.

87 Energy Info. Admin., U.S. Dep't of Energy, Total Electric Power Industry Summary Statistics, http://www.eia.doe.gov/cneaf/electricity/epm/tablees1b.html (last visited Dec. 27, 2006).

predictable patterns, yet its kinetic energy is available without cost to the turbine owner solely because of the siting location of the turbine in a windy area. Third, wind power is an inexhaustible supply without raw material or fuel costs, thereby making the inflationary characteristics of coal, natural gas, and oil irrelevant to the economic calculus of the project. As a result, the geopolitical complications of fossil fuels supplied from non-domestic sources cease to be a concern for the wind power electricity generator. Finally, since the fuel is naturally-occurring wind, there are no adverse impacts on workers, the environment, or local communities from fuel extraction. By comparison, coal—the nation's largest electricity supply fuel—imposes serious societal costs through air pollution, water pollution, water resource use, solid waste generation, and land contamination.[88]

b. Zero Air Pollution & Global Warming Emissions

Arguably the strongest advantage of wind power is the fact that it does not create significant air pollution or GHG emissions at any point in its life cycle. Fossil fuel combustion is the largest source of carbon dioxide emissions in the United States, and electricity generation comprises nearly half of that large source of emissions.[89] Conventional coal, natural gas, and oil-fired power plants annually emit thousands of tons of emissions of sulfur dioxide, nitrogen oxides, carbon monoxide, particulate matter, hydrocarbons, mercury, and other pollutants, while wind power produces zero emissions.[90] With increased domestic and international emphasis on the elimination of GHGs,[91] the substitution of fossil fuel-generated electricity with non-combustion-produced electricity will help alleviate climate change in the future. As U.S. policymakers embrace more rigorous GHG reduction goals, wind power will be emphasized as a viable alternative energy source.

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88 *See* U.S. Envtl. Prot. Agency, Clean Energy: Electricity from Coal, http://www.epa.gov/cleanenergy/coal.htm (last visited Dec. 27, 2007).

89 U.S. ENVTL. PROT. AGENCY, INVENTORY OF U.S. GREENHOUSE GAS EMISSIONS AND SINKS: 1990-2005 ES-7 – ES-8 (2007). Coal-fired power plants are not yet required to perform carbon sequestration through "capture and store" techniques, although a recent MIT report indicates that technology for this exists, though not on a utility scale. *See* MASS. INST. OF TECH., THE FUTURE OF COAL: AN INTERDISCIPLINARY MIT STUDY 43-45 (2007).

90 BLM WIND DEVELOPMENT IMPACT STATEMENT, *supra* note 71, at 6-23.

91 *See, e.g.*, U.N. INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, *Summary for Policymakers*, *in* CLIMATE CHANGE 2007: THE PHYSICAL SCIENCE BASIS 2-3 (Susan Solomon et al. eds., 2007).

c. No Water Use for Cooling

Wind power generation requires minimal amounts of water during operation, in stark contrast to the water use of conventional thermoelectric fossil fuel plants. As a result, thermoelectric power plants use enormous quantities of water nearly equal to irrigation, which is mostly withdrawn from U.S. fresh water supplies. Both fuel-cycle and consumptive (evaporative) water use for coal and nuclear-generated electricity range in the billions of gallons per year.[92] This intensive water use is often the most serious limiting factor in the permitting of these plants, especially in arid areas where water is scarce. As competition for fresh water becomes more intense, non-water using energy technologies like wind power boast an additional advantage. Wind power does not use water because it employs kinetic, not thermal, energy to spin the turbines in its generators.

d. Elimination of Solid and Hazardous Wastes Resulting from Fuel Preparation and Pollution Control

After the construction of a wind power facility, there is no solid or hazardous waste requiring disposal as a byproduct of generation. By contrast, the DOE estimates that the preparation of coal prior to power plant combustion generates solid waste at ten percent of the coal mined, resulting in millions of tons of coal wastes in need of disposal as part of the process of electricity generation.[93] After combustion, large amounts of additional solid waste result from coal burning in the form of boiler slag, fly ash, and scrubber sludge produced by sulfur dioxide and particulate removal equipment.[94] The lack of solid waste disposal problems is yet another significant environmental advantage of wind power, since the leftover residue of coal combustion must be disposed of in landfills.

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[92] DEP'T OF GEOGRAPHY AND ENVTL. RES., S. ILL. UNIV. CARBONDALE, WATER USE BENCHMARKS FOR THERMOELECTRIC POWER GENERATION I-1 (2006), *available at* http://info.geography.siu.edu/geography_info/research/documents/ThermoReport.pdf (U.S. thermoelectric power plants used 195.5 billion gallons per year of water—equivalent to the amount used nationwide for agricultural irrigation).

[93] Union of Concerned Scientists, Environmental Impacts of Coal Power: Waste Generated, http://www.ucsusa.org/clean_energy/coalvswind/c02d.html (last visited Jan. 26, 2008).

[94] *Id.*

e. Community and Regional Economic Benefit of Wind Energy Facility

The development of wind farms often occurs in rural communities experiencing depressed or reduced economic conditions, and wind power projects often have a positive economic impact on the employment in a construction area. The assembly of prefabricated wind turbines and towers employs construction workers at an estimated average rate of 4.8 job years (direct and indirect employment) per one MW of wind power construction.[95] Using this ratio, a 50 MW wind farm would produce 240 job years of employment for workers who construct the facility. One estimate of employment impacts suggests that by 2015, wind energy projects in California alone would produce 2690 construction jobs and 121 million dollars in income.[96] It is also estimated that between nine and ten full-time service personnel would be need to maintain a 100 MW wind farm.[97] This continual employment benefit would occur in rural areas and be distributed over a large area. In addition to these employment benefits, state governments would collect sales and income taxes from new construction, and local governments would benefit from increases in real estate tax bases due to the presence of the new wind farm equipment.[98]

f. Supplementary Income to Rural Landowners

Wind farms use leased land, or land upon which royalties or land fees must be paid to the landowner. In these rural areas, there are often few leasing alternatives and none that pay the high level of lease or royalty payments of between 3000 and 4000 dollars per turbine per year.[99] Depending on the amount of land leased and the number of turbines, the lease payments would constitute much-needed income for rural land owners with few economic alternatives. New wind power lease payments supplement rural incomes, potentially allowing farmers and ranchers to remain on the land to

95 AWEA Tutorial, *supra* note 58.

96 BLM Wind Development Impact Statement, *supra* note 71, at 5-109.

97 For every 100 MW of installed wind power capacity, it is estimated that 310 full time manufacturing jobs, 67 contracting and installation jobs, and 95 annual operation and maintenance jobs are created. N.C. Coastal Wind Working Group, Benefiting North Carolina Communities with Offshore Wind Farms 3 (2007).

98 *See* Martin J. Pasqualetti, *Wind Power: Obstacles and Opportunities*, 46 Environment 23, 29 (2004) (citing evidence that a single 250 MW project in Iowa provides $2 million per year in property taxes and $640,000 in farmer lease income).

99 Am. Wind Energy Ass'n, Wind Energy for Your Farm or Rural Land 1 (2007).

continue traditional agricultural or ranching activities. This would maintain the rural life and culture that is rapidly disappearing in many areas. In addition, wind energy development would generally be compatible with other existing land uses, including livestock grazing, recreation, wildlife habitat, and oil, gas, and geothermal production.

2. *Potential Drawbacks of Wind Power Generation*

While there are many advantages to wind power, some disadvantages exist. Every energy-producing technology involves pros and cons that must be evaluated by government policymakers, private investors, and the general public. Some disadvantages are inherent in the nature of the wind energy technology itself, while others relate to the use of the technology at particular locations. As the nation considers its energy future, it will be necessary not only to identify the positive and negative aspects of this new technology, but also to compare these features with those of existing methods of generating power. Such a comparative analysis will be a crucial step in fashioning public policy. In the end, judgments must be made by balancing the environmental, economic, and social aspects of the U.S. energy mix.

a. *Consistency of the Wind Resource*

One potential disadvantage of wind power relates to the nature of the wind resource itself: the blowing of wind is intermittent and occurs according to atmospheric conditions, not human energy needs. Wind does not always blow when energy is required and, in general, cannot be stored for later use. Wind speed and availability—and consequently the amount of electricity generated—often varies day-to-day. It is feared that utilities relying on wind power will need to develop or purchase costly reserve capacity to fill in when wind power is not available. Advocates of wind power believe that wind resources, while not consistent, are predictable and can be connected into the electrical grid with small cost penalties.[100] The high level of private investment in wind power suggests that wind-generated electricity can provide a valuable flow of power that can be integrated into the utility transmission system.

[100] Edgar A. DeMeo et al., *Wind Plant Integration*, IEEE POWER & ENERGY MAG., Nov.-Dec. 2005, at 45 (examining the impact of wind variability on system operating costs are not negligible but are relatively modest, normally costing less than ten percent of the wholesale energy value).

Further research will undoubtedly address this important question.[101]

b. The Availability of Optimal Wind Power Sites

Good wind sites with the highest wind power classifications are often located in remote places, far from the high-density metropolitan areas with the greatest energy demands. An examination of the U.S. Wind Energy Resource Atlas reveals that many of the highest potential class 6 and 7 wind areas are located in the upper Midwest, hundreds of miles from the closest population source.[102] Since many remote locations where wind energy resources exist are often not located proximate to high capacity utility transmission lines, power connections must be built to link the wind electricity generators to the utility power grid. The high costs of building this necessary connective infrastructure can create serious obstacles for wind power projects. In addition, frequent popular opposition to the construction of high voltage lines can makes it difficult, and in some cases impossible, to obtain the necessary governmental support for new construction.[103] Even if remotely-located wind power sources are able to connect, they may be charged high access fees to use existing transmission lines. Furthermore, these lines may have limited transmission capacity allocated on a first-in-time principle, with a discriminatory effect on new power generators like wind farms.[104] With the improvement in wind power operating efficiencies, however, less desirable sites can economically produce electricity, especially if transmission lines and capacity are well situated.

There are also large, high-potential wind sites in offshore locations in coastal waters and in the Great Lakes that represent potentially huge amounts of electrical generation.[105] In Europe, siting

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101 GAO WIND REPORT, *supra* note 65, at 21-22. *See also* Robert Zavadil et al., *Making Connections*, IEEE POWER & ENERGY MAG., Nov.-Dec. 2005, at 32-36 (describing the technical progress and remaining issues related to wind power integration).

102 Renewable Res. Data Ctr., Nat'l Renewable Energy Lab., Wind Energy Resource Atlas of the United States, http://rredc.nrel.gov/wind/pubs/atlas/maps/chap2/2-01m.html (last visited Jan. 26, 2008).

103 *See, e.g.*, Joel Garreau, *High Voltage, High Tension- In Virginia's Piedmont, Electric Company and Critics Both Draw a Line*, WASH. POST, Mar. 5, 2007, at C1 (describing staunch citizen opposition to utility's plan to locate a power distribution line throughout the Piedmont region of Virginia).

104 AM. WIND ASS'N, FAIR TRANSMISSION ACCESS FOR WIND: A BRIEF DISCUSSION OF PRIORITY ISSUES 10 (2007).

105 MINERALS MGMT. SERV., U.S. DEP'T OF INTERIOR, TECHNOLOGY WHITE PAPER ON WIND ENERGY POTENTIAL ON THE U.S. OUTER CONTINENTAL SHELF 2-3 (2006).

constraints for land-based wind farms have resulted in the construction of eighteen projects located in the North Sea providing 804 MW with over 11 GW of new offshore projects planned by 2010.[106] Offshore wind is identified as an attractive alternative for a number of reasons, including: first, the most forceful and consistent winds exist offshore; second, offshore sites exist within reasonable distances from the major urban load centers, especially in the mid-Atlantic and New England; and third, underwater transmission line siting and distant turbine location can minimize aesthetic and land use objections.[107] While offshore wind project construction costs can range between forty and seventy-five percent higher than land-based projects, they also boast compensating productivity advantages because the wind capacity factor is considerably greater than that of most on-shore facilities.[108] Offshore activities within three miles of the coast come under state regulatory authority, while those beyond the three mile limit are the responsibility of the federal government.[109] The federal Energy Policy Act of 2005 allocated jurisdiction over the development of alternate energy-related uses (including wind power) on the Outer Continental Shelf (OCS), including the power to grant permission to use the OCS for such purposes, to the Minerals Management Service (MMS) of the Department of the Interior.[110] Once in place, the final program rules will likely open up large tracts of offshore areas to wind farm development.

c. *Wind Power Technology and the Cost of Electricity*

If wind power is to be widely adopted, then the cost of production must be reduced to a level near that of fossil fuel plants. Fortunately, the economics of wind-generated electricity have changed considerably over the last quarter century, with costs dramatically

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106 Musial et al., *supra* note 72, at 3. *See also* Fiona Harvey, *London to Lead World in Output from Wind Farms Located at Sea*, FIN. TIMES, Dec. 19, 2006, at 3 (describing the London Array and the Thanet projects, which together provide 1.3 GW by 2010, sufficient to power one million English homes).

107 OFFSHORE WIND COLLABORATIVE, A FRAMEWORK FOR OFFSHORE WIND ENERGY DEVELOPMENT IN THE UNITED STATES 2 (2005), *available at* http://www.masstech.org/offshore/final_09_20.pdf.

108 AWEA ECONOMICS, *supra* note 73, at 1-2.

109 Submerged Lands Act of 1953, 43 U.S.C. § 1301-1315 (2000) (stating that the federal government has control over oceans three miles from the coastline).

110 Energy Policy Act of 2005, Pub. L. No. 109-58, 119 Stat. 594 (codified as amended at 43 U.S.C.S. § 1337 (2008)). In 2006, the MMS began developing a program and regulations to implement this provision of the Act. Alternate Energy-Related Uses on the Outer Continental Shelf, 70 Fed. Reg. 77,345 (Dec. 30, 2005).

lower than they once were. Improvements in turbine design and electronic controls have led to significant production efficiencies.[111] Technological improvements, however, must continue in order to assure competitive wind power pricing.

Production costs must also be reduced at secondary or sub-optimal wind power sites. The cost of wind energy varies greatly depending upon the wind speed at the site.[112] Most existing wind projects are located at the best sites (class 6 and 7) with the lowest generation costs. Recent DOE estimates put wind power electricity costs at these locations between three and six cents per kWh, making wind power cost-competitive when compared to fossil fuel plants.[113] However, prime sites will be exploited first, and wind power plants will eventually need to be constructed at secondary, less-desirable sites with lower wind speeds and higher generating costs. Either government subsidy programs or higher consumer prices would be necessary to assure that class 4 and 5 site electricity remains competitive. Federally-supported research is currently seeking ways to advance the technology in order to bring down the costs at sites with lower wind speeds.[114] Cost considerations must be kept in mind in order to spread the advance of wind power, especially at remote locations with high transmission costs.

d. Competition for Land for Wind Energy Projects

Wind power development must compete with other land uses that might be more highly prized or valued. While farming and ranching activities are generally compatible with the generation of wind energy, other types of uses might be considered incompatible with the installation of large wind turbines. Several preservation policies expressed in BLM documents exclude wind development construction from special public lands and recreation areas.[115] This kind of land competition pits renewable wind power energy goals against land preservation. As the controversy surrounding the

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111 AWEA ECONOMICS, *supra* note 73, at 1-2.

112 *Id.*

113 *See* Union of Concerned Scientists, Renewable Energy FAQs, http://www.ucsusa.org/clean_energy/clean_energy_policies/the-renewable-electricity-standard.html (last visited Jan. 17, 2008).

114 *See, e.g.*, Wind & Hydropower Techs. Program, U.S. Dep't of Energy. http://www1.eere.energy.gov/windandhydro/wind_low_speed.html (last visited Jan. 26, 2008).

115 BLM WIND DEVELOPMENT IMPACT STATEMENT, *supra* note 71, at 2-3. The BLM Programmatic Environmental Impact Statement analyzes potential wind power development after screening out BLM-administered lands that were determined off limits for wind energy development due to statutory or administrative controls. These include wilderness areas, wilderness study areas, national monuments and national conservation areas. *Id.*

Cape Wind offshore wind project near Cape Cod demonstrates, land use compatibility questions can be central to the objections raised against the siting of a wind power facility, even if the objectors approve of wind power generally.[116] Land use considerations are often the heart of objections to large wind power projects and require that project siting choices be made in a decision-making process designed to identify and balance multiple values. Even in England, where strong government and popular support for renewable wind power exists, disagreements occasionally surface.[117]

e. Potential Adverse Land Use Impacts of Wind Power Projects

The construction and operation of wind farms or utility-sized projects present a number of potential conflicts with neighboring residents and land uses. As with any large-scale energy generation project, background land use patterns will be changed by the new energy development. The construction phase of a wind power facility carries with it the potential of interference with a number of different interests, including wildlife habitat, water quality, cultural resources, geologic features, air quality, vehicular traffic, and occupational safety. Once a wind generation project is operational, prominent concerns include the aesthetic impact of a large number of wind turbines,[118] interference with communications,[119] shadow

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116 *See* Beth Daley, *Cape Wind Proposal Clears Big Obstacle Agency Calls Impact on Environment Minor*, BOSTON GLOBE, Jan. 15, 2008, at A1; Peter J. Howe, *Changes May Buoy Cape Wind Project- Patrick Seeks to Alter State Law*, BOSTON GLOBE, Dec. 11, 2007, at B3.

117 *See* Marc Horne, *Royal Botanist Clashes with Prince Charles over Wind Farms*, SUNDAY TIMES (London), Jan. 21, 2007, at 1-7.

118 The visual impact of wind power facilities is extremely difficult to assess, partly because of subjects' responses to the change in scenery. Some advocates of wind power describe a common reaction to wind projects to be "a mixture of inquisitiveness, admiration and incomprehension." *See* HAU, *supra* note 51, at 558-59; *see also* D.W. Bisbee, *NEPA Review of Offshore Wind Farms: Ensuring Emission Reduction Benefits Outweigh Visual Impacts*, 31 ENVIRONMENT 349 (2003).

119 Much of modern communication occurs through electromagnetic signals. Many state wind power siting rules require consideration of television interference, microwave beam paths, AM/FM stations, and land mobile communication sites. *See, e.g.*, Wisc. Electric Power Co., PSC Docket No. 6630-CE-294, Application for Certificate of Public Convenience and Necessity: Blue Sky Green Field Wind Project (2006), *available at* http://www.we-energies.com/environmental/certpubconvnec_app.pdf.

flicker,[120] noise produced by rotating blades,[121] impact on aircraft communications and navigation systems,[122] ice throws from the blades of turbines,[123] and effects on resident or migrating bird and bat populations.[124] Some also criticize wind power for potential adverse effects on adjacent property values, although recent analysis has not borne this out.[125] As research and experience with wind

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120 Shadow flicker refers to shadows cast by the rotating blades of wind turbines. The amount of shadow flicker is dependent on the angle of the sun in relation to the turbine; the lower the sun is in the sky, the more shadows are cast by the blades. For most parts of the United States, the sun is never low enough in the sky to pose a problem with turbine shadow flicker. BLM WIND DEVELOPMENT IMPACT STATEMENT, *supra* note 71, at 3-20.

121 Low frequency sound can be generated by wind turbines as the result of changes in the aerodynamic lift forces on the rotor blades. These sound emissions may be reduced by careful turbine design and the establishment of sufficient safety zones or setbacks from other land uses. *See generally* HAU, *supra* note 51, at 537-48. Noise during construction would be similar to construction noise from other projects. The BLM concluded in its Programmatic Environmental Impact Statement that noise generated during the wind facility operational phase "would approach typical background levels for rural areas at distances of 2000 feet (600 meters) or less and, therefore, would not be expected to result in cumulative impacts to local residents." BLM WIND DEVELOPMENT IMPACT STATEMENT, *supra* note 71, at 6-17.

122 The Federal Aviation Administration (FAA) Obstruction Evaluation Service (OES) has principal authority over the evaluation of potential threats to aircraft navigation. Both the Department of Defense and the FAA present radar obstruction analysis to the OES for an obstruction determination. The OES has not yet issued formal rules or guidance, but it has mapped red zones (up to twenty miles), yellow zones (twenty to sixty miles) and green zones (beyond sixty miles) around long range radar facilities. Construction of obstructions such as wind farms is presumptively prohibited within the red zone, potentially acceptable within the yellow zone, and permissible within the green zone. In 2006, 13,398 wind turbine sitings were studied by the FAA and no hazard determinations were issued. E-mail from Bruce Beard, OES Nat'l Operations Manager, to Ronald Rosenberg, Professor of Law, William and Mary Law School (Mar. 7, 2007, 17:20 EST) (on file with author).

123 Neil Rhines, *Debate Rages Over Wind Energy Farms*, HERALD TIMES REP., Mar. 6, 2005, at 1A; Susan Squires, *Worries in the Wind for Calumet*, APPLETON POST-CRESCENT, Aug. 4, 2006, at 1A.

124 One frequently cited avian fatality study indicates that the most common response to wind turbines is for birds to recognize them as obstacles and fly around them. This study estimated 33,000 bird fatalities per year from the then-estimated 15,000 operating wind turbines in operation in 2001. W.P. ERICKSON ET AL., NAT'L WIND COORDINATING COMM., AVIAN COLLISIONS WITH WIND TURBINES: A SUMMARY OF EXISTING STUDIES AND COMPARISONS TO OTHER SOURCES OF AVIAN COLLISION MORTALITY IN THE UNITED STATES 1-2 (2001). Turbine characteristics, tower design, and turbine placement affect avian deaths. *See* K.S. SMALLWOOD & C.G. THELANDER, DEVELOPING METHODS TO REDUCE BIRD MORTALITY IN THE ALTAMONT PASS WIND RESOURCE AREA 6 (2004).

125 In 2003, the Renewable Energy Policy Project, a federally supported non-profit organization, undertook an economic analysis of the impact of wind power development from 1998 to 2002 on surrounding property values in the viewshed of ten wind projects in seven different states. It focused on the impact of wind power projects ten MW or larger on property sales within a five mile radius, comparing the sales data with information from sales occurring in comparable communities during the same time. The study concluded that "property values within the view shed of wind developments suffer or perform poorer than in a comparable region. For the great majority of projects . . . the property values in

power technology becomes increasingly available, it is possible to separate verifiable claims of harm from those without basis in fact. Additionally, research is likely to indicate useful methods of planning turbine locations so as to mitigate some of the potentially harmful effects of wind power siting.

D. Wind Power Policy in the U.S.

1. Federal Policy

Since electricity production is largely privately financed and operated, there is no national control over investment in the industry. Private market decisions, however, are undoubtedly influenced by governmental policies that make investing in a particular energy production technology financially advantageous. At the national level, there are a number of executive programs encouraging renewable wind energy supply,[126] but there is no comprehensive long term strategy. As a result, federal policy on wind power must be pieced together from a series of largely disconnected federal actions. Overall, the federal government encourages private investment in wind power production, but does so without utilizing the complete range of support possible. By contrast, true initiative exists at the state level, where legislatures and governors take the lead in advancing wind power by adopting accommodating policies and procedures.

a. Financial Subsidies

While federal energy production subsidies tend to favor conventional energy sources, Congress does provide direct federal financial support for wind power production. The most important federal policy for wind power is the federal production tax credit (PTC), which provides a per kWh tax credit for electricity from wind plants for a period of ten years from initial plant operation.[127] It is estimated that this incentive could provide a moderately-sized thirty MW wind farm with up to 1.6 million dollars in annual federal subsidies.[128] This credit is adopted for limited periods and periodically

the view shed actually go up faster than the values in the comparable region." GEORGE STERZINGER ET AL., RENEWABLE ENERGY POLICY PROJECT, THE EFFECT OF WIND DEVELOPMENT ON LOCAL PROPERTY VALUES 1–4 (2003).

126 Most prominent is the DOE's Wind Powering America program. *See* L.T. FLOWERS & P.J. DOUGHERTY, NAT'L RENEWABLE ENERGY LABORATORY, WIND POWERING AMERICA: GOALS, APPROACH, PERSPECTIVES AND PROSPECTS 1 (2002).

127 26 U.S.C.S. § 45 (2008).

128 GAO WIND REPORT, *supra* note 65, at 23.

odically renewed; each short extension of the PTC has negative effects on long-term project planning and manufacturing costs, leading to uncertainty among wind power developers, financiers, and states regarding the extent of long term federal support for wind-generated electricity.[129] The subsidy provision is currently set to expire December 31, 2008, but wind power advocates are pushing to extend the credit for an additional five years.[130]

In addition to the PTC, wind power projects are eligible for other tax preferences, including a five-year accelerated depreciation schedule allowable for renewable energy system investments, which further offsets the high initial capital costs of wind power projects.[131] Other forms of federal financial assistance for renewable energy and wind power are also authorized, including Clean Renewable Energy Bonds, to help finance municipal and cooperative utilities.[132]

b. *Research and Development Funding*

The federal government also supports wind power development through the funding of research activities into technological improvements. This financial support is part of the President's Advanced Energy Initiative, which targets small wind applications and improvements in the efficiency of wind turbines in low-speed wind environments. This initiative would supply forty-four million dollars during the 2007 fiscal year.[133] Other federal funds are available through the 2002 Farm Bill, which provides grants and loan guarantees to farmers and rural business owners for the purchase of renewable energy systems, including wind power.[134]

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129 *Id.* at 32.

130 Mark Clayton, *Wind, Solar Tax Credits to Expire,* CHRISTIAN SCI. MONITOR, Jan. 22, 2008, at 3.

131 Economic Recovery Tax Act of 1981, Pub. L. No. 97-034, 95 Stat. 230 (1981) (codified at 26 U.S.C.S. § 168(e)(3)(B)(vi) (2008)).

132 *See* Information Release, Internal Revenue Serv., Clean Renewable Bond Volume Cap Allocation Information (Nov. 20, 2006), *available at* http://www.irs.gov/newsroom/article/0,,id=164423,00.html.

133 *See* NAT'L ECON. COUNCIL, *supra* note 11, at 13. This initiative, announced by President Bush in February 2006, called for a twenty-two percent increase in Department of Energy funding for clean energy technology research in the fiscal year 2007 budget. This increase pales by comparison to the Solar America Initiative, which increases federal solar research funding by 65 million dollars to a total of 148 million dollars in fiscal year 2007. *Id.*

134 *See* U.S. Dep't of Energy, Wind Powering America: Farm Bill, http://www.eere.energy.gov/windandhydro/windpoweringamerica/ag_farm_bill.asp (last visited Dec. 27, 2007). For example, during the first four years of the program, the Department of Agriculture awarded 84 million dollars in grants and 34 million dollars in loan guarantees to 807

c. *Wind Power on Federal Lands*

The federal government is working to make high wind quality federal lands available for the development of wind energy projects under right-of-way authorizations. Historically, the BLM is the only federal agency that grants permission for wind energy development on public land and it has permitted approximately 500 MW of installed capacity, or five percent of the nation's total.[135] Due to their location of in prime wind locations, BLM lands will continue to be an important focus of wind energy development.[136] The agency recently established comprehensive policies and best management practices (BMPs) for analyzing wind energy developments through a Final Programmatic Environmental Impact Statement (PEIS).[137] The proposed Wind Energy Development Program would affect all BLM-administered lands in eleven western states and would set general mitigation standards.[138] The comprehensive approach taken in the BLM policy suggests that federal lands will increasingly be available to private firms wishing to develop wind energy resources.

The U.S. Forest Service recently developed national guidance to evaluate wind energy proposals on national forest system lands, and the Department of the Interior also recently proposed a general authorization of energy development project on Native American tribal lands.[139] The federal government can further support wind power by permitting wind power development projects on public lands under its control. A large limitation on such a policy, however, is the inability of such projects to find transmission lines with which to connect.

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projects in 44 states. The grants fund a wide range of wind, solar, biomass, geothermal, and conservation technologies. *Id.*

135 U.S. GOV'T ACCOUNTABILITY OFFICE, GAO-05-906, U.S. WIND POWER: IMPACTS ON WILDLIFE AND GOVERNMENT RESPONSIBILITIES FOR REGULATING DEVELOPMENT AND PROTECTING WILDLIFE 32 (2005) [hereinafter GAO WILDLIFE REPORT].

136 As of September 2005, the BLM approved eighty-eight applications for new projects and had sixty-eight pending applications to review. *Id.*

137 *See* BLM WIND DEVELOPMENT IMPACT STATEMENT, *supra* note 71.

138 *Id.* at ES-3.

139 *Renewable Energy on Federal Lands: Testimony Before the S. Comm. on Energy and Natural Resources,* 109th Cong. (2006) (statement of Sally Collins, Assoc. Chief, U.S. Forest Serv.), *available at* http://www.fs.fed.us/congress/109/senate/oversight/collins/071106.html.

d. Federal Regulation

The federal government's role in regulating wind power projects is limited. Generally, federal project control is restricted to projects taking place on federal lands or having some other form of federal involvement. While the Federal Energy Regulatory Commission (FERC) regulates interstate energy transmission, it has no authority to regulate the actual construction of electricity generation and transmission facilities, which is reserved for state and local governments.[140] Federal rules and regulations that could affect wind power development include environmental rules[141] and civilian and military radar interference controls.[142] Some of these federal regulatory restrictions have the potential to slow or derail wind power developments.

e. Federal Renewable Portfolio Standards

One recently proposed House Bill, H.R. 969, establishes a federal Renewable Portfolio Standard (RPS) that requires electric utilities to increase their share of generation from wind, solar, and other renewable energy sources from one percent in 2010 to twenty percent by 2020 and thereafter.[143] If enacted, this bill would establish a renewable energy floor for most American utility companies and would drive the production of renewable power to a higher level, while still allowing states to maintain higher RPS standards if desired.[144] Energy suppliers would be able to meet these national requirements either by producing renewable energy or by purchasing credits from other entities.[145] The policy proposal embodied in this Bill was made at the same time the European Union (EU)

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140 *See* Fed. Energy Regulatory Comm., About FERC, http://www.ferc.gov/about/ferc-does.asp (last visited Jan. 22, 2008) (stating that FERC does not regulate the construction of energy generation and transmission facilities).

141 *See, e.g.*, National Environmental Policy Act of 1969 § 102(2)(C), 42 U.S.C.S. § 4332 (2008).

142 National Defense Authorization Act § 358, Pub. L. No. 109-163, 119 Stat. 3136 (2006), requires the Department of Defense to study and report to Congress on the effects of wind projects on military readiness, specifically whether windmill facilities interfere with military radar. In September 2006, the Department of Defense issued its report to Congress. *See* OFFICE OF THE DIR. OF DEF. RESEARCH & ENG'G, DEP'T OF DEF., THE EFFECT OF WINDMILL FARMS ON MILITARY READINESS (2006). The report concluded that air defense radars could be adversely affected by wind power projects but that mitigation practices did exist to preclude such effects. It left the primary responsibility to the FAA and to the National Weather Service to determine effects on Air Traffic Control radar and weather forecasting radars. *Id.* at 4.

143 H.R. 969, 110th. Cong. § 610(c) (2007).

144 *Id.*

145 *Id.*

endorsed binding GHG targets, which require EU nations to provide twenty percent of their power from renewable sources, including wind, solar, and hydroelectric power, by 2020.[146]

2. *State Policies on Wind Power*

States and local governments are enacting a broad array of policies and programs to promote renewable energy and wind power development and, thus far, are the leaders in the development of renewable energy in the United States. State policies generally fall into two categories: regulatory techniques and economic subsidy devices. The initiative taken in most states reflects a belief in the potential of renewable energy as an important, non-polluting contributor to the electrical supply, and as a force for local economic development.

a. *Regulatory Techniques*

States have taken the lead with wind power development by providing regulatory mechanisms that facilitate wind power facility siting and electrical utility policies that support the growth of renewable energy projects. While state policies in these areas possess similarities, there is no general template that all states follow.

i. *Wind Power Siting Procedures*

Since most wind power development takes place on non-federal land, the state and local governments maintain primary responsibility for siting regulation. This permitting or approval control is undertaken in a variety of ways, including procedures directed by the local government, the state government, or a hybrid of state and local governments. Some states maintain exclusive control over energy facility siting at the state level of government, with a state board responsible for wind facilities and other energy plants. In Connecticut and Oregon, for example, state statutes grant approval authority to specialized siting boards.[147] Other states, such as Minnesota and Vermont, allot permitting authority to gen-

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[146] Dan Bilefsky, *Europe Sets Ambitious Limits on Greenhouse Gases*, N.Y. TIMES, Mar. 10, 2007.

[147] The Connecticut Siting Council regulates the siting of renewable energy projects of more than one MW. CONN. GEN. STAT. §§ 16-50(g)-(aa), 16-50(j)-(z) (2006). Oregon law requires that energy facilities with generating capacities of 105 MW or more must be approved by the Oregon Energy Facility Siting Council. OR. REV. STAT. §§ 469.300-469.560 (2006); OR. ADMIN. R. 345-001-000 *et seq.* (2006).

eral utility commissions rather than facility siting panels.[148] State agencies in Kansas and Wisconsin use voluntary guidelines or model local government codes to deal with wind power siting regulation.[149]

In sum, the regulatory regimes adopted by states vary in sophistication and are "evolving."[150] Some state and local regulators have developed an expertise in evaluating project impacts, while others have little experience in assessing and mitigating the environmental and other effects. These latter jurisdictions should draw on the experience and regulations developed by those states with substantial experience in siting issues. Perhaps with time, wind power projects will be assessed in a fashion that carefully considers site-specific characteristics so as to minimize adverse impacts.[151] Important questions remain concerning the most appropriate procedure for making significant decisions with respect to large facility siting.

ii. Renewable Energy Portfolio Standards

One of the most significant state policy devices that encourages renewable electricity development is the state-based RPS—a utility regulation that requires firms to supply a minimum percentage of their electrical load with eligible sources of renewable energy.[152] The overall goal of an RPS is often to reduce statewide GHG emissions.[153] As of 2006, twenty-three states and the District of Columbia maintained RPS requirements in some form.[154] Some states

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148 MINN. STAT. §§ 116C.691-697 (2006); VT. STAT. ANN. tit. 30 § 248 (2006).

149 In 2005, the Kansas Energy Council issued a Wind Energy Siting Handbook, which provides cities and counties non-binding advice based on the experience of four Kansas counties. KAN. ENERGY COUNCIL, WIND ENERGY SITING HANDBOOK: GUIDELINE OPTIONS FOR KANSAS CITIES AND COUNTIES (2005). In Wisconsin, the Department of Administration developed a model wind ordinance to guide towns and counties. DEP'T OF ADMIN., STATE OF WIS., DRAFT MODEL WIND ORDINANCE FOR WISCONSIN (2007).

150 GAO WILDLIFE REPORT, *supra* note 134, at 22.

151 In 2002, the Sierra Club issued a Wind Siting Advisory Document that identifies relevant issues to consider in a wind power siting application. The Document creates a useful four-level hierarchy of development preferences for particular lands, ranking them most appropriate, more appropriate, less appropriate and not appropriate. Sierra Club, Sierra Club Conservation Policies: Wind Siting Advisory http://www.sierraclub.org/policy/conservation/wind_siting.asp (last visited Mar. 16, 2008).

152 Database of State Incentives for Renewable Energy, Glossary, http://www.dsireusa.org/glossary/glossary.cfm?EE=1&RE=1&CurrentPageID=8#renewables (last visited Jan. 27, 2008) [hereinafter DSIRE Glossary].

153 *See, e.g.*, *Five Western Governors Announce Regional Greenhouse Gas Agreement*, CLEAN EDGE NEWS, Feb. 27, 2007, http://www.cleanedge.com/story.php?nID=4583.

154 Database of State Incentives for Renewable Energy, Renewable Portfolio Standards Map, http://www.dsireusa.org/documents/SummaryMaps/RPS_Map.ppt (last visited Jan. 27, 2008) [hereinafter DSIRE Map].

require achievement of target percentages in the near term (five percent by 2006 in New Mexico) while others set their standards farther out (fifteen percent by 2025 in Arizona); the more distant attainment dates have the highest required percentages of renewable energy.[155] California, Colorado, Connecticut, Illinois, Maine, Massachusetts, Montana, New Mexico, New York, and Nevada all have RPS targets ranging from ten to twenty percent to be achieved by 2017.[156] In February 2007, the Minnesota legislature passed the most advanced state policy on renewable power in the nation. Its RPS legislation requires electric utilities in the state to meet a twenty-five percent RPS by 2025, with its largest utility expected to reach thirty percent renewable by 2020.[157] While the specific elements of each particular state's RPS system differ, wind energy is always included within the definition of renewable energy in a state-based RPS.

iii. Utility Regulatory Policies

A range of regulatory policies are employed across the nation to provide information for energy consumers and encourage the production of renewable power. Each type of policy is summarized below.

- Generation Disclosure Rules: Twenty-four states and the District of Columbia require that electrical utilities disclose to their customers information about the electrical energy they purchase.[158] In particular, utilities must provide fuel mix data and emissions information to educate consumers about the source of their electricity.[159] Some states go one step further and require that electrical utilities certify the actual

155 Am. Wind Power Ass'n, State-Level Renewable Energy Portfolio Standards, http://www.awea.org/legislative/pdf/RPS_Fact_Sheet.pdf (last visited Dec. 27, 2007).

156 DSIRE Map, *supra* note 153.

157 *See* Press Release, Minn. Office of the Governor, Governor Pawlenty Signs Strongest Renewable Energy Requirement in the Nation (Feb. 22, 2007), *available at* http://www.governor.state.mn.us/mediacenter/pressreleases. In 2007, Governor Tim Pawlenty signed legislation setting the "25 x '25" goal for renewable energy in Minnesota. The law specified that Xcel Energy, the state's largest utility, would be obligated to meet a thirty percent renewable standard by 2020, with twenty-five percent of that standard to be supplied by wind power. *Id.*

158 Database of State Incentives for Renewable Energy, Generation Disclosure Rules for Renewable Energy, http://www.dsireusa.org/library/includes/seeallincentivetype.cfm?type=Disclose&currentpageid=7&back=regtab&EE=1&RE=1 (last visited Jan. 17, 2008).

159 *See id.*

sources of their power and assure their customers that the firm actually uses them.[160]

- o Green Power Purchasing and Aggregation Policies: Ten states and twenty localities allow individuals and government units to purchase "green power," generated by renewable sources.[161] Municipalities, state governments, businesses, and other non-residential customers such as universities can play a critical role in supporting renewable energy technologies by purchasing electricity from renewable sources.[162] At the local level, green municipalities may purchase this kind of electrical power for municipal facilities, streetlights, and water-pumping stations, among other uses.[163] Several states require that a certain percentage of green power be purchased for use in state government buildings.[164] A few states allow local governments to aggregate the electricity loads of the entire community to purchase green power,[165] while others allow localities to join with other communities to form a large purchasing block, often called "Community Choice."[166]
- o Interconnection: Thirty-four states and the District of Columbia have developed or are developing interconnection rules that establish technical standards for independent electrical generation sources to use when they wish to sell their power to the utility grid.[167] These sources, known as distributed power sources, must meet FERC-specified engineering standards so that their power can safely and efficiently flow into utilities lines.[168]

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160 New Jersey, Pennsylvania, and Vermont all require this extra step. *See* N.J. STAT. ANN. § 48:3-87 (West 2007); 54 PA. CODE § 54.6 (2007); VT. STAT. ANN. tit. 30, § 209(f) (2007).

161 Database of State Incentives for Renewable Energy, Green Power Purchasing/ Aggregation Programs for Renewable Energy, http://www.dsireusa.org/library/includes/seeallincentivetype.cfm?type=Purchase&currentpageid=7&back=regtab&EE=1&RE=1 (last visited Jan. 27, 2008) [hereinafter DSIRE Green Power].

162 DSIRE Glossary, *supra* note 151.

163 *See id.*

164 DSIRE Green Power, *supra* note 160.

165 *See id.*

166 Cape Code and Martha's Vineyard are two localities participating in "Community Choice" programs. *See id.*

167 Database of State Incentives for Renewable Energy, Interconnection Incentives for Renewable Energy, http://www.dsireusa.org/library/includes/seeallincentivetype.cfm?type=Interconnection&currentpageid=7&back=regtab&EE=0&RE=1 (last visited Jan. 27, 2008).

168 *See id.*

b. *Economic Subsidies and Incentives*

A significant number of states employ policies to encourage both the development of renewable energy supply and the consumption of renewable power. States take a broad range of approaches, such as encouraging particular regulatory policies and implementing tax rules or financial support mechanisms.

i. *Net Metering Laws*

Thirty-five states and the District of Columbia use net metering laws.[169] For consumers with their own electricity generating units, net metering allows for the flow of electricity both to and from the customer through a single, bi-directional meter. With net metering, during times when the customer's generation exceeds use, electricity from the customer moves to the utility and is credited to the customer's account.[170] The consumer offsets costs of utility-supplied electricity with the possibility of having the utility pay the small generator.[171] Net metering laws may be beneficial for small wind turbine owners such as farmers and ranchers.

ii. *State Tax Incentives*

States offer at least four types of tax incentives to assist and attract renewable energy production. These financial incentives can act to subsidize the cost of energy produced by wind power facilities and make wind-generated electricity competitive in cost with other forms of production.

- Property Taxes: Twenty-nine states offer property tax exemptions, exclusions, and credits for renewable power, including wind energy.[172] These policies take many forms, but the net result is to reduce state or local government property taxes on renewable energy equipment.[173]

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169 Database of State Incentives for Renewable Energy, Net Metering Rules for Renewable Energy, http://www.dsireusa.org/library/includes/seeallincentivetype.cfm?type=Net&currentpageid=7&back=regtab&EE=0&RE=1 (last visited Jan. 27, 2008).

170 DSIRE Glossary, *supra* note 151.

171 *See id.*

172 Database of State Incentives for Renewable Energy, Property Tax Incentives for Renewable Energy, http://www.dsireusa.org/library/includes/seeallincentivetype.cfm?type=Property&currentpageid=7&back=fintab&EE=0&RE=1 (last visited Jan. 27, 2008).

173 DSIRE Glossary, *supra* note 151.

- o Personal and Corporate Income Taxes: Seventeen states make personal income tax incentives available.[174] Twenty states allow corporate income tax payers benefits for the expense of purchasing and installing renewable energy equipment.[175] In some instances, tax credits are provided for between ten and thirty-five percent of the costs.[176]
- o Sales Taxes: Eighteen states allow for sales tax exemptions on the purchase of renewable energy equipment, including wind turbines.[177] This policy effectively provides a subsidy for the acquisition of wind power mechanical units in the amount of the state's sales tax rates.

iii. State Financial Support

A relatively large number of states provide financial support that promotes renewable energy production. This financial support takes various forms, each with different levels of use: grants (eighteen states),[178] loans (twenty-two states),[179] rebates (eighteen states),[180] bonds (two states),[181] and production incentives (six states).[182] Furthermore, eighteen states and the District of Columbia have public benefit funds that charge customers utility bills to

174 Database of State Incentives for Renewable Energy, Personal Tax Incentives for Renewable Energy, http://www.dsireusa.org/library/includes/seeallincentivetype.cfm?type=Personal&currentpageid=7&back=fintab&EE=0&RE=1 (last visited Jan. 27, 2008).

175 Database of State Incentives for Renewable Energy, Corporate Tax Incentives for Renewable Energy, http://www.dsireusa.org/library/includes/seeallincentivetype.cfm?type=Corporate&currentpageid=7&back=fintab&EE=0&RE=1 (last visited Jan. 27, 2008).

176 DSIRE Glossary, *supra* note 151.

177 Database of State Incentives for Renewable Energy, Sales Tax Incentives for Renewable Energy, http://www.dsireusa.org/library/includes/seeallincentivetype.cfm?type=Sales&currentpageid=7&back=fintab&EE=0&RE=1 (last visited Jan. 27, 2008).

178 Database of State Incentives for Renewable Energy, Grant Programs for Renewable Energy, http://www.dsireusa.org/library/includes/seeallincentivetype.cfm?type=Grant&currentpageid=7&back=fintab&EE=0&RE=1 (last visited Jan. 27, 2008),

179 Database of State Incentives for Renewable Energy, Loan Programs for Renewable Energy, http://www.dsireusa.org/library/includes/seeallincentivetype.cfm?type=Loan&currentpageid=7&back=fintab&EE=0&RE=1 (last visited Jan. 27, 2008).

180 Database of State Incentives for Renewable Energy, Rebate Programs for Renewable Energy, http://www.dsireusa.org/library/includes/seeallincentivetype.cfm?type=Rebate&currentpageid=7&back=fintab&EE=0&RE=1 (last visited Jan. 27, 2008).

181 Database of State Incentives for Renewable Energy, Bond Programs for Renewable Energy, http://www.dsireusa.org/library/includes/seeallincentivetype.cfm?type=Bond&currentpageid=7&back=fintab&EE=0&RE=1 (last visited Jan. 27, 2008).

182 Database of State Incentives for Renewable Energy, Production Incentives for Renewable Energy, http://www.dsireusa.org/library/includes/seeallincentivetype.cfm?type=Production&currentpageid=7&back=fintab&EE=0&RE=1 (last visited Jan. 27, 2008).

create a fund to be used for renewable energy research, development, and education.[183]

V. Recommendations for Policy Development

The United States runs on a great deal of electricity. It is currently the world's largest consumer of electric power and is projected to maintain that position for at least the next two decades.[184] The nation should work towards improving the energy efficiency of all aspects of life and should accelerate the diversification of its energy supply for both environmental and economic reasons. Encouraging the development of an increasingly larger wind power industry can make an important contribution to American energy supply in a sustainable and environmentally-responsible manner. The existing wind power development trend should be reinforced by supportive governmental policies. Wind power boasts clear benefits that deserve serious consideration by policy makers and the public as the nation makes choices concerning its energy future.

The transformation of American energy policy towards a greater reliance upon wind power will be achieved, if at all, by private market investment in the technology. The role of public policy in this endeavor should be the establishment of a mix of incentives and supportive policies that reinforce market decisions. Energy policy should seek to reinforce the technologies and practices that advance larger societal goals. If wind power is to become an important contributor to American energy supply in the future, at least six steps must be taken.

First, favorable local, state, and federal governmental policies must be established to provide the wind power industry with a stable and predictable regulatory environment. Policy predictability is necessary to assure those taking risks a consistent policy landscape upon which to base their decisions. It is also necessary to assure that turbine manufacturers and component suppliers will expand their own capacity to provide a steady flow of the necessary parts for a new wind power project. Government energy policy should have longer time horizons so that market participants can plan long term investments. State and federal governments should work

[183] Database of State Incentives for Renewable Energy, Public Benefit Funds for Renewable Energy, http://www.dsireusa.org/library/includes/seeallincentivetype.cfm?type=PBF&currentpageid=7&back=regtab&EE=0&RE=1 (last visited Jan. 27, 2008).

[184] *See* Energy Info. Admin., U.S. Dep't of Energy, International Energy Outlook tbl. H1 (2007), *available at* http://www.eia.doe.gov/oiaf/ieo/excel/ieoecgtab_1.xls.

together to maximize wind power's long-term potential to provide a significant amount of electricity well into the future.

Second, some form of financial incentives should be utilized to subsidize wind energy through higher power payments or favorable tax policy. Such payments could be combined with a tax on fossil fuels to remove their hidden subsidies and to ease the shift to new energy technology. This program of financial assistance must remain stable for at least ten years so that developers, investors, and consumers can accurately predict their streams of revenue. Over time, as wind technology becomes more cost-effective, further consideration can be given to whether financial policies such as these should be scaled back or dropped altogether. This would depend upon the future cost structure of wind power, and on the desire to develop non-fossil fuel-based sources of electricity.

Third, government policy, at both the state and federal levels, should include comprehensive, non-financial government assistance to the wind power industry. This form of assistance should include greater support for research and development of generating technology, product testing and certification, wind resource mapping, advance site acquisition, and encouragement of small community ownership and operation. Public land policy should be developed to make appropriate lands with high wind resources available to wind power developers on a fair lease or royalty basis. The wide array of supportive and effective policy instruments should be broadly publicized so that they may be extended to other jurisdictions.

Fourth, wind power siting and operational considerations must be addressed. As with coal-fired or natural gas-fired plants, potential wind power sites could be considered off-limits for power plant development. Deciding these questions of siting preference and exclusion requires a careful identification of important societal values and prioritization of interests. Ultimately, decisions must be made on the overall desirability of the proposed project. Perhaps the best choice would incorporate a larger conception of the public interest by vesting the project decision at the state level with a required consideration of local opinions.

Fifth, the problems associated with wind power should be identified and seriously analyzed so that those problems can be accurately addressed and mitigated. Certain technical questions, such as those involving wildlife, lighting and radar effects, transmission connectivity, and turbine safety should be studied and resolved with optimal solutions for the industry and surrounding communities. Not every constituency will be satisfied, but the decision-making process should be a transparent one, based on the best technical data available, and made by a politically-accountable decision maker. Operating experience at existing wind power facilities should also be assessed and used to predict new plant impacts.

Finally, the public must be better informed about the costs and benefits of wind power so that it can fully understand the implications of embracing the new technology. There are undoubtedly objective aspects to the promotion of wind generated electricity, but subjective factors also have an effect in public perceptions about the desirability of wind generation. Perhaps the public will increasingly view wind turbines as benign, non-polluting generators of electrical power generally of benefit to American society. Recent polling data suggests that the American public strongly supports non-polluting renewable energy technologies and would therefore be likely to accept increased reliance on such forms of electrical supply.[185] Evidence from Europe also suggests a high level of public support and acceptance of wind power facilities.[186] This positive public view would greatly assist the shift towards wind power. Solidly popular attitudes, in combination with careful siting and project design, can make electricity from the wind an important part of America's energy future.

[185] Am. Wind Energy Ass'n, Americans Overwhelmingly Support Federal Incentives for Renewable Energy: Zogby Poll, http://www.awea.org/newsroom/releases/poll_renewable_energy_012208.html (last visited Feb. 8, 2008) (noting that eighty-five percent of Americans responding to a Zogby poll agreed that the federal government should "encourage greater use of renewable energy technologies such as wind and solar power").

[186] *See, e.g.*, EUROBAROMETER, EUR. COMM'N, ATTITUDES TOWARDS ENERGY 7 (2006), *available at* http://ec.europa.eu/public_opinion/archives/ebs/ebs_247_en.pdf.