THE NON-ECONOMIC PRICE BARRIERS TO WIND POWER

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Abstract

Currently, fossil fuels are the world's primary energy source. However, the burning of fossil fuels, for energy, has many negative side effects. There is a growing consensus that burning fossil fuels leads to the greenhouse effect and global warming. The supply of fossil fuels is also finite. Thus, a clean and renewable energy source must eventually replace fossil fuels as our energy source. Wind power is currently the fastest growing, and most efficient, form of renewable energy. Wind power has the potential to unite profitable business with the protection of the environment. However, there are currently many non-price barriers that prohibit wind power from achieving its full potential. This paper takes a qualitative approach. Seven people involved with the wind industry are interviewed. This data is used to determine what barriers to wind power exist and how these barriers can be overcome. It also explores the need for the development of a Smart Grid to achieve the large-scale integration of renewable energy. The majority of the non-price barriers can be alleviated; however, the need for a Smart Grid still remains.

KEYWORDS: (Wind Power, Renewable Energy, Barriers)

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CHAPTER I

INTRODUCTION

Alternative energy is going to play a large role in economics and the environment in the near future. The world's addiction to fossil fuels is rapidly becoming more of a problem. With supplies of fossil fuels quickly running out, and the problems created by burning fossil fuels growing, our energy dependant society has no choice but to switch to renewable, clean, energy sources.[1] Wind power is currently the fastest growing form of renewable energy and it only promises more growth. It has also been identified as the most cost-efficient form of renewable energy.[2] Globally, wind power capacity is growing at an astounding rate of around 30% annually.[3]

However, despite its promise, the widespread use of wind power, as an alternative to fossil fuels, has been limited by numerous non-price factors. This paper seeks to determine and discuss the major non-price factors that prevent wind generated electricity from being competitive with other energy sources. Additionally, it will explore what real world solutions exist to overcoming these barriers. The data for this project will be qualitative. The data collected will be based on interviews and literature

[1] Ezio Sesto and Claudio Casale, "Exploitation of Wind as an Energy Source to Meet the World's Electricity Demand." *Journal of Wind Engineering and Industrial Aerodynamics* 74-76 (1998): 375.

[2] Holly Klick and Eric R. A. N. Smith, "Public Understanding of and Support for Wind Power in the United States." *Renewable Energy* 35, no. 7 (2010): 1585.

[3] Joseph F. DeCarolis and David W. Keith, "The Economics of Large-Scale Wind Power in a Carbon Constrained World." *Energy Policy* 34, no. 4 (2006): 395.

on the subject. Seven people within the wind power industry will be interviewed. The overall goal of the project is to identify the potential for wind power, identify the non-price barriers that exist, and understand how to deconstruct these barriers to achieve the full potential of wind power.

Like any market, there are many barriers to entry within the wind power market. These barriers are the factors that limit wind energy's ability to compete with fossil fuels. The main barrier to competition is the price of the electricity generated by the turbines. Most wind generated electricity currently costs more than other electricity sources, such as fossil fuels or nuclear energy.[4] This barrier has been impacted by government programs that help to make wind power competitive with other sources of energy. There are many incentives to develop alternative energy. Ending, or decreasing, a dependence on foreign oil is one of the main financial incentives to move away from fossil fuels.

In addition to price barriers, there are also non-price barriers that inhibit entry to the wind market. Access to transmission lines, connection to the energy grid, variable wind speeds, local utility (local use of wind power), local by-laws and regulations, lack of storage capability, Not In My Back Yard (NIMBY),[5] and Public Utility Commission regulations are a few of the non-price factors that act as entry barriers to the wind market, and thus, harm wind power's ability to compete with fossil fuels in an open market.

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[4]Ahmet Duran Şahin, "Progress and Recent Trends in Wind Energy." *Progress in Energy and Combustion Science* 30, no. 5 (2004): 524.

[5] Eliza Krigman, "Will the Winds Favor Cape Wind?" *National Journal* (2009): 24.

Currently, these non-price factors act as serious barriers to entry into the wind power market. It is a practical research topic to determine what factors play the largest role and act as the largest barriers to entry. Discerning all the barriers to entry and researching each is helpful to wind developers.

It is important that his type of research be done because the continued development of the wind industry is important. The world's dependence on fossil fuels has become a major problem and will continue to be a problem as supplies of fossil fuels run out. The world's supply of fossil fuels is finite. Currently, we depend of fossil fuels for most of our energy needs. Unfortunately, there are many problems with using fossil fuels to generate our energy. We burn fossil fuels, such as coal, to produce our electricity and burn oil to run our cars. The act of burning these fossil fuels produces both energy and pollution.[6] The pollution created by burning these fossil fuels includes carbon dioxide. Carbon dioxide is an important green house gas, which contributes to the atmosphere's greenhouse effect. There is a consensus that carbon dioxide produced by burning fossil fuels leads to the greenhouse effect, which is largely responsible for the current trend of global warming.[7] Human caused global warming poses many major problems to our way of life and the functioning of almost everything on earth.

As a result of these many problems caused by fossil fuels, it is vitally important to find an alternative source of energy. Wind power is a viable alternative to fossil fuels. Wind generated electricity produces no pollution and thus is a much more desirable form of energy. Wind power is also a sustainable form of energy production, because

[6] Şahin, 506.

[7] Ibid., 504.

unlike fossil fuels, the supply of wind is unlimited, compared to the finite amount of fossil fuels. Thus, the two main advantages wind power has over traditional fuel sources are: no pollution and unlimited supply.

Wind energy is growing in importance. An understanding of the factors that affect wind powers ability to compete with fossil fuels is a critical aspect of the development process. If wind developers know all the obstacles they face, it will make it easier for them to overcome these barriers and realize success within the wind industry.

CHAPTER II

LITERATURE REVIEW

Currently, wind power is not competitive with fossil fuels. There are a number of reasons for wind power's inability to compete with fossil fuels. The most important reason is price; wind generated energy costs more per kilowatt hour than fossil fuel generated energy. In addition to price, there are many other issues that act as barriers to the wind industry. The three main barriers are: Not In My Back Yard (NIMBY), utility issues, and governing issues. Each of these three barriers contain additional issues within them. While most of the issues are unrelated, each acts as a barrier to wind development. This literature review is intended to individually address each of the three barriers to wind power, as well as the smaller issues contained within each barrier.

Not In My Backyard

NIMBY is one of the main non-price barriers that wind power faces. There are multiple issues created by, and contained within, NIMBY. This section will begin with a description of what NIMBY is. Next, the location problem created by NIMBY will be addressed. As a result of NIMBY, high potential sites near population centers often go undeveloped; thus, wind farms are generally built in remote areas. Finally, the problem of transmission will be discussed. When wind farms are built in remote locations, new transmission lines must be built to carry the electricity to the population center.

An article published in 2000 by Wolsink offers a traditional explanation of NIMBY. Wolsink lists many reasons as to why people would respond selfishly to the local construction of wind turbines. He cites the traditional NIMBY issues of noise pollution and visual degradation as the reasons why many people are opposed to wind turbines.[1] Aesthetic issues, noise pollution, and decrease in property value are some reasons people site for their opposition to local turbine construction.[2] Wolsink takes his explanation further and suggests that NIMBY can be explained by game theory.[3] He believes that when presented with the social dilemma of producing wind generated electricity, a public good, people act selfishly, and thus, the public good is not produced.[4] A 2007 article by Dan van der Horst supports Wolsink's claim. Van der Horst also believes that, in principle, renewable energy development would be beneficial to the majority of the population; however, proposed facilities are often opposed by local residents.[5]

Klick and Smith's article titled, "Explaining NIMBY Opposition to Wind Power;" take the NIMBY concept further and attempt to explain the origin of NIMBY views. Klick and Smith cite NIMBY views as one of the main challenges facing wind

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[1] Maarten Wolsink, "Wind power and the NIMBY-myth: institutional capacity and the limited significance of public support." *Renewable Energy* 21 (2000): 50.

[2] Dean Iandoli. Wind developer; President of Quabbin Wind. Personal Interview. 3 March 2011.

[3] Wolsink, 51-52.

[4] Ibid., 52.

[5] Dan van der Horst, "NIMBY Or Not? Exploring the Relevance of Location and the Politics of Voiced Opinions in Renewable Energy Siting Controversies." *Energy Policy* 35, no. 5 (2007): 2705-2714.

power.[6] They offer a concise synopsis of the problem created by NIMBY in the first few lines of their abstract: "Public opinion polls show that the American public strongly supports the development of wind power as an alternative to fossil fuels. Yet when specific wind farm proposals are made, they often meet intense local opposition."[7] In fact, public opinion polls show that 75% of Americans said they were willing to pay more for their electricity if it was generated by renewable energy.[8] However, the paradox remains that many of these same people do not want turbines near their homes.

Klick and Smith conducted a study to discover the real source of NIMBY. Prior to this study, their data showed that national surveys had neglected to examine both the positive and negative aspects of wind power; they only focused on the positive side. Thus, this study seeks to fill the gap, examine public opinion regarding the negative aspects, and explain NIMBY rather than just label it.[9] They used data from an internet survey of 610 American adults.[10]

Klick and Smith hypothesize that NIMBY may not just be local, but may actually reflect a national opinion. They believe that the national surveys could have simply neglected to ask questions about the negative aspects of wind power, such as noise, visual pollution, and harm to wildlife. Once these questions are asked, they

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[6] Eric Smith and Holly Klick, "Explaining NIMBY Opposition to Wind Power." *Conference Papers -- American Political Science Association* (2008): 4.

[7] Ibid., 2.

[8] Ibid., 4.

[9] Ibid., 3.

[10] Ibid., 11.

hypothesized that public support would diminish.[11] Ultimately, their data showed that their hypothesis was correct. When faced with the unpleasant aspects of wind power, support for wind power dropped from 72% to 53%.[12] Certainly, some NIMBY comes from local residents simply not wanting to live near turbines, but this study shows that NIMBY might not just be selfish, but rather the result of the negative aspects of wind power.

An article published by Jones and Eiser highlights the causes of NIMBY and the problems it creates; particularly the location problem created by NIMBY. Jones and Eiser set out to study if the opposition to wind power was localized near proposed sites.[13] They conducted their study by administering a questionnaire, asking how the respondents felt about wind development in general, and how they felt about local wind development. They used a paired samples t-test and found that the respondents were "significantly less favorable to local development than they were to development…in general."[14] They also suggest that it is the aesthetics of wind turbines lay behind most NIMBY views and create most location problems.[15] The location problem manifested itself in the form of wind farm approval rates. Jones and Eiser believe that local opposition to wind development is leading to the decrease of approval rates, particularly

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[11] Ibid., 7.

[12] Ibid., 13.

[13] Christopher R. Jones and J. Richard Eiser, "Understanding 'local' Opposition to Wind Development in the UK: How Big is a Backyard?" *Energy Policy* 38, no. 6 (2010): 3108.

[14] Ibid., 3111.

[15] Ibid., 3108.

for onshore projects.[16] Between 2007 and 2009, Jones and Eiser discovered that the approval rate for onshore projects smaller than 50MW dropped from 57% to 29%.[17] This data shows that a significant portion of suitable locations were not developed, at least partially, as a result of NIMBY views. If a wind farm cannot be built near a population center, the developer is forced to look for another location, usually in a remote area where NIMBY is less of a problem. The construction of turbines in remote areas leads to the next sub-issue created by NIMBY: transmission.

Due to NIMBY, turbines are often built in remote locations. Thus, transmission lines need to be constructed to carry the power from the remote generation site to the population center, where the power will be used. In his 2007 article titled, “Developing Wind Projects in California – Or Anywhere,” Castro states that he believes transmission problems to be the largest long-term constraint to wind development.[18] Castro found that building new transmission lines can cost up to $2 million per mile; additionally, while it may only take a year to build a wind farm, it can take 5 to 6 years to interconnect the wind farm to the grid.[19] These are clearly large barriers to wind developers, and are often created as a result of NIMBY resistance.

[16] Ibid., 3107.

[17] Ibid.

[18] Robert D. Castro, "Developing Wind Projects in California--Or Anywhere." *Power* 151, no. 12 (2007): 60.

[19] Ibid., 60.

Utilities & Wind Power

Utility issues include the reliability of the wind, integrating wind power into the grid without compromising stability, and capacity factor. All three of these issues stem from the inconsistent nature of wind.

The primary issue is the reliability of the wind. The intermittent nature of wind causes utility companies problems because at any given time they need to supply enough energy to meet customer demand. Thus, the intermittent nature of wind causes reliability problems. The second issue is the stability of wind power transmission. Traditional sources of energy, such as fossil fuels, generate a constant level of power. Fossil fuels produce power on a binary scale; they are either fully online or fully offline.[20] On the other hand, the power output of wind generated energy can fluctuate as a result of different wind speeds. If a utility company does not have enough power on the grid, a brown out can result.[21] Thus, the fluctuation of power generation level causes stability problems for utility companies. The third issue is the capacity factor. The fluctuations in power level can lead to low capacity factors. The capacity factor is the ratio of actual energy produced to the full potential amount of energy that could have been produced over a given time period. The relatively low capacity factor for wind forces utility companies to fill the void of power with other sources. Capacity factor is different from stability but the two are related. The fluctuation of the capacity factor is what leads to grid instability. Wind turbines produce different amounts of power based

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[20] M. Carolin Mabel, R. Edwin Raj, and E. Fernandez, "Adequacy Evaluation of Wind Power Generation Systems." *Energy* 35, no. 12 (2010): 5222.

[21] William Payne. Senior Engineer; Raytheon Company. Personal Interview. 1 March 2011.

on the wind speed. Varying amounts of power supplied to the grid is what leads to grid instability.

Variable wind speed is a major barrier to the wind industry. Variable wind speed at each turbine is the single most influential factor that determines the success or failure of that turbine.[22] A study by Blanco published in 2009 found that during the infancy of wind power, advancements in turbine placement were more valuable to the wind industry than advancements in turbine technology.[23] Turbine placement literally refers to the micro-location of the turbine on the property. Certain locations are more suitable for wind production and thus produce more energy. More suitable locations have higher wind speeds and higher capacity factors. In addition to a general location being more suitable, the individual turbines can be arranged in certain ways to maximize potential at a particular location. For example, leaving sufficient space between turbines minimizes drag and the resulting wake effect; thus, all the installed turbines are able to operate more efficiently.

From the perspective of a utility company, wind reliability is a problem because they need to supply enough energy to meet customer demand. However, wind speed is not consistent. Wind speed typically changes on a day to day basis. Thus, utility companies must be able switch between wind power and fossil fuels depending on the wind speed.

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[22] María Isabel Blanco, "The Economics of Wind Energy." *Renewable and Sustainable Energy Reviews* 13, no. 6-7 (2009): 1376.

[23] Ibid., 1376.

Lehr and Prok assess the barriers to wind development in Colorado and deal with the issue of reliability. The report outlines a particular utility company's plan to integrate wind power over the course of many years. Lehr and Prok assess the problems that wind generated electricity would present a utility company. The report immediately recognizes the intermittent nature of wind as a major problem for utility companies.[24] Their report is valuable because it deals with the problem of wind reliability and actually offers a solution to the problem.

The utility company Lehr and Prok report on is Xcel Energy. Xcel Energy needs to begin switching from fossil fuels to renewable energy in accordance with the Public Utility Commission (PUC) regulations.[25] The report concludes that Xcel Energy will deal with the problem of wind reliability by staggering its acquisition of intermittent renewables over the course of multiple years. They will only add 100 MW of intermittent renewable power each year. This will allow time for the effects of the integration to be studied.[26] Clearly, the reliability of wind power is a concern to utility companies.

Mabel, Raj, and Fernandez also cover the subject of reliability. Perhaps the most important fact that comes out of Mabel, Raj, and Fernandez's case study is that the typical maximum wind power generation period does not match up with the typical

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[24] Ronald L. Lehr and Joshua D. Prok, "Barriers and Opportunities to Wind and Renewable Energy Development: Xcel Energy's 2007 Colorado Resource Plan." Interwest Energy Alliance. Company Report. (2008): 3.

[25] Ibid.

[26] Ibid.

peak load period.[27] This means that during the time of day with the highest energy demand, wind power production for that day is not at its peak. This mismatch exposes the problem of energy storage. Currently, there is no universal cost-efficient way to store electricity produced by wind power, and wind power does not typically reach its peak during the peak load period.[28]

The stability of the electrical grid is another issue created by wind power. Transmission lines do not deal well with the intermittent nature of wind.[29] Akhmatov lists the multiple problems with the stability of wind generated energy. Among them are short circuit failures, voltage sags, and power loss.[30] The fact that wind farms can produce anywhere along the scale, between completely on and completely off, compromises the stability of the grid and raises entirely new problems. Mabel, Raj, and Fernandez point out that when the installed turbines do not produce enough electricity, traditional forms of energy must be relied on to fill the void between energy production and energy demand.[31]

The capacity factor is another issue that emerges as a result of the intermittent nature of wind. Capacity factor is of concern to wind developers because it directly affects their profits. The higher the capacity factor, the more energy generated, and the

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[27] Mabel, Raj, and Fernandez, 5217.

[28] Van Wilgus. Vice President; Colorado Energy Management. Personal Interview. 20 September 2010.

[29] Ibid.

[30] Vladislav Akhmatov, "System Stability of Large Wind Power Networks: A Danish Study Case." *International Journal of Electrical Power & Energy Systems* 28, no. 1 (2006): 48.

[31] Mabel, Raj, and Fernandez, 5217.

more profit produced. Boccard finds that the capacity factor is an economic issue, not a physical issue.[32] Thus, maximizing capacity factor is of vital importance to wind developers.

The 2010 report published by Mabel, Raj, and Fernandez found that a turbine will generate electricity 70-85% of the time; and of the time that it generates electricity, it will not generate its maximum potential amount of electricity.[33] Castro states that wind capacity factors rarely exceed 40%.[34] These inconsistencies are the result of intermittent wind. Mabel, Raj, and Fernandez find that a whole new concept in energy production emerges as a result of the inconsistent nature of wind and it presents new problems to utility companies.[35]

Governing Issues

While many governments around the world have enacted laws that help to promote wind energy, there are also some policies that ultimately hinder the development of wind power. Harmful policies can be found, both, at the federal and local levels. The fist issue to be addressed in this section is federal policy. Federal policy issues deal mainly with the federal production tax credit (PTC), which offers aid to wind producers based on the amount of energy they produce. The PTC pays a wind farm 2.2 cents per kilowatt hour, for the first ten years of its existence, in addition to the

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[32] Nicolas Boccard, "Capacity Factor of Wind Power Realized Values Vs. Estimates." *Energy Policy* 37, no. 7 (2009): 2679.

[33] Mabel, Raj, and Fernandez, 5217.

[34] Castro, 60.

[35] Mabel, Raj, and Fernandez, 5217.

market price that the wind farm already receives for selling the energy it produces.[36] The second issue is problems created by local policy.

Barradale addresses some of the problems created by federal policies. She believes that the PTC which is intended to promote wind power actually harms it. The PTC is the main source of federal support for wind power.[37] However, the PCT creates a boom and bust cycle for wind power investment.[38] Barradale finds that the PTC ends up costing wind developers more money as a result of the rapid development and rapid decline in development that the PTC creates.[39] Perhaps the worst part of the PTC is that it does not encourage long-term investments.[40] A lack of long-term investment is not a solid base for future economic success. The PTC creates an atmosphere of instability and uncertainty. Barradale argues that it is not the absence of the PTC that leads to the downturn on wind investments, but rather the uncertainty about its return.[41] She finds that the uncertainty created by the PTC affects power purchasing agreements (PPA) and actual wind turbine purchasing negotiations, both of which are central to the development of the wind industry.[42] Power purchasing agreements are agreements made between a buyer and a seller of electricity. The owner of a wind farm agrees to sell

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[36] American Wind Energy Association, “Federal Policy.” 2011. <http://www.awea.org/issues/federal_policy/index.cfm> (accessed 24 April 2011).

[37] Merrill Jones Barradale, "Impact of Public Policy Uncertainty on Renewable Energy Investment: Wind Power and the Production Tax Credit." *Energy Policy* 38, no. 12 (2010): 7708.

[38] Ibid., 7698.

[39] Ibid.

[40] Ibid.

[41] Ibid., 7708.

[42] Ibid.

power to the utility company at a set rate over a set period of time. Thus, it is an agreement that assures wind farm owners will be able to sell the energy they produce at a fixed price.

Local policy issues often create problems for the wind industry. Local policy issues are often the result of NIMBY views that manifest themselves in local policy that is not conducive to wind development. The previously discussed Jones and Eiser article mentions that the approval process for wind projects is “sluggish.”[43] A delayed approval process is another problem that results from local opposition. If local residents are willing to pay to fight against the construction of turbines near their houses, then they are usually able to slow down the approval of a particular site. The Alliance to Protect Nantucket Sound was able to delay the approval of Cape Wind for almost a decade.[44] Local residents can also have an effect on the by-laws and zoning laws of each individual town, and use these laws to stop wind development.

[43] Jones and Eiser, 3107.

[44] Pam Hunter, "'Cape Wind' Offshore Project Gets Go-Ahead, After Review." *ENR: Engineering News-Record* 264, no. 15 (2010): 18.

CHAPTER III

BACKGROUND

Alternative energy is going to play a large role in economics and the environment in the near future. Currently, fossil fuels are burned to satisfy the world's energy demands. However, there is a growing consensus that the burning of fossil fuels is leading to many problems, including the greenhouse effect and global warming. Additionally, the total supply of fossil fuels is finite, and rapidly running out. Our energy dependant society has no choice but to switch to renewable and clean energy sources.[1] Wind power is currently the fastest growing form of renewable energy, and all signs point towards continued growth. Between 2004 and 2008, wind power capacity in the United States grew at a rate of 32% annually.[2] Wind power is fortunate because it has the ability to unite profitable business with the protection of the environment.

There are both internal and external factors that influence the development of wind power. Both the internal and external factors tend to promote the development of wind power. The external factors include global warming, peak oil, and rising energy prices. Internal factors include wind potential in the United States, installed capacity, and electricity demand. In addition to the internal and external factors, there are many

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[1] Ezio Sesto and Claudio Casale, "Exploitation of Wind as an Energy Source to Meet the World's Electricity Demand." *Journal of Wind Engineering and Industrial Aerodynamics* 74-76 (1998): 375.

[2] Angela Neville, "Top Plants: Fowler Ridge Wind Farm, Benton County, Indiana." *Power Magazine,* (2009).

non-price barriers that negatively affect the development of wind power. The non-price factors include: Not in My Back Yard (NIMBY), utility issues, and governing issues. The external factors, internal factors, and non-price barriers are discussed in this chapter.

External Factors

Currently, fossil fuels are burned in order to satisfy the world's energy demands. There is a growing consensus that burning fossil fuels contributes to the greenhouse effect and global warming. The greenhouse effect is the process by which heat leaving the earth is trapped and re-directed towards the earth's surface. The major greenhouse gases are: water vapor, carbon dioxide, methane, chlorofluorocarbons, and nitrous oxide.[3] Even though all of these gases are naturally occurring, the human production of carbon dioxide is currently a major problem. Carbon dioxide is one of the most impactful greenhouse gases. When fossil fuels are burned they produce energy, and carbon dioxide as a bi-product. Thus, the burning of fossil fuels adds more carbon dioxide to the atmosphere and makes the greenhouse effect worse.[4] The worsening of the greenhouse effect contributes to the current trend of global climate change. Unlike fossil fuels, wind generated energy does not emit greenhouse gases.[5]

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[3] Ahmet Duran Şahin, "Progress and Recent Trends in Wind Energy." *Progress in Energy and Combustion Science* 30, no. 5 (2004): 505-6.

[4] Ibid., 506-7.

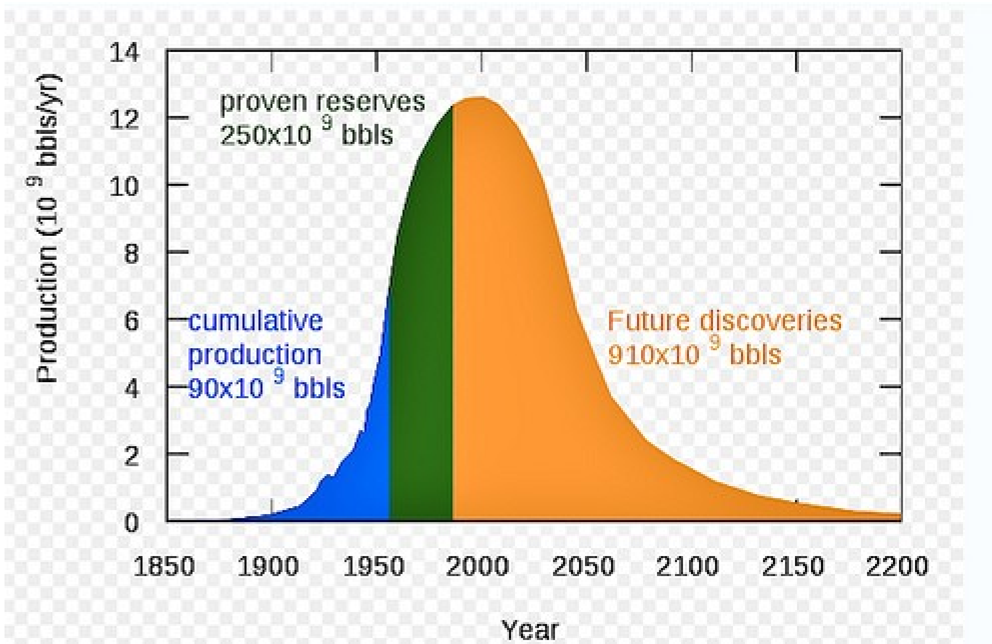
[5] Joseph F. DeCarolis and David W. Keith, "The Economics of Large-Scale Wind Power in a Carbon Constrained World." *Energy Policy* 34, no. 4 (2006): 396.

In addition to the problems caused by the greenhouse effect and global warming, the total supply of fossil fuels is finite, and rapidly running out. Fossil fuels, such as petroleum and coal, have been used by humans for the past few centuries to meet our energy demands. Since the industrial revolution humans have burned through vast quantities of fossil fuels. We are now approaching what is referred to as peak oil, which is explained by the Hubbert peak theory.[6] The Hubbert peak theory suggests that the total supply of the earth's petroleum can be represented by a bell curve. The peak of the bell curve represents the point in time that half of the petroleum in the earth has been discovered. The slope of the bell curve represents the rate of discovery. After peak oil has been reached, the rate of discovery will decrease as time progresses. The consequences of this will be ever increasing prices of petroleum. The original peak oil graph created by Hubbert in the 1950's can be seen below:

[6] Hubbert Peak, "Hubbert Peak of Oil Production." 2010. <http://www.hubbertpeak.com/> (accessed 14 December 2010).

FIGURE 3.1

HUBBERT PEAK



SOURCE: Peaknix, "Asimov, Peak Oil, If Only 20 Years Ago." 2009. <http://peaknix.com/2009/01/13/asimov-peakoil/> (accessed 28 April 2011)

Currently, our energy demands could not be satisfied without petroleum. However, the supply of petroleum is finite and it will eventually run out. Many people suggest that we have already reached peak oil.[7] [8]

Wind power can help to solve the peak oil problem. Wind is not a finite resource; the supply of wind is unlimited. Studies suggest that wind power could viably

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[7] Brian Gallagher, "Peak Oil Analyzed with a Logistic Function and Idealized Hubbert Curve." *Energy Policy* 39, no. 2 (2011): 790.

[8] Hubbert Peak.

support around 20% of our energy needs.[9] Wind power currently provides only 3% of the electricity in the United States.[10] This means that wind power could conceivably help to replace a significant portion of the energy currently produced by fossil fuels. Alternative energy is also the answer to curbing with global warming. Wind power does not emit carbon dioxide; in fact, wind power does not emit any pollution at all. No pollution and unlimited supply are the two main advantages wind power has over fossil fuels. However, there are many obstacles that wind power needs to overcome in order to be completely competitive with fossil fuels in the open market.

Currently, the price of wind power is higher than the price of fossil fuels. This is the biggest factor that makes wind power uncompetitive with fossil fuels. In order for wind power to achieve its full potential, it is essential for it to be competitively priced with fossil fuels. A profit maximizing firm is always going to choose the less expensive option. If the price of wind energy is not less than or equal to that of fossil fuels, then it will not be chosen as the source of energy. As of 2004, depending on the type of turbine, the location, and the average wind speed, the price of wind generated electricity ranged from between about 12 cents per kilowatt hour down to about 3 cents per kilowatt hour for the most efficient turbines.[11] During the same time period, the price of

[9] Holly Klick and Eric R. A. N. Smith, "Public Understanding of and Support for Wind Power in the United States." *Renewable Energy* 35, no. 7 (2010): 1585.

[10] Tiffany Hsu, “Interest in Renewable Energy May Stick as Oil Prices Surge.” *Los Angeles Times*. 11 March 2011.

[11] Şahin, 525.

natural gas hovered around 4 cents per kilowatt hour, which means that only extremely efficient turbines could generate competitively priced electricity.[12]

Studies show that because of the constant increase in technology, wind power could drop as low as 2 cents per kilowatt hour within the next two decades.[13] This would make wind power competitive with fossil fuels and less expensive than nuclear. As more turbines are sold, the market should grow, the price of each turbine should decline, and thus wind power should become more affordable.[14] This was the trend during the infancy of wind power and it continued until very recently. Between 1999 and 2004 alone, the costs of wind generated electricity decreased by 20%. [15] However, another interesting market phenomenon has since occurred. As more turbines are ordered, the materials used for making the turbines have become more expensive, and thus, as a result, in recent years the price of wind generated electricity has increased.[16]

The price barrier has been aided by government programs that help to make wind power competitive with other energy sources. The Renewable Energy Target, recently implemented by the Australian government, is a good example of a federal policy that promotes renewable energy. The Australian government plans to have 20%

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[12] Ibid., 524.

[13] DeCarolis and Keith, 395.

[14] Şahin, 528.

[15] Ibid., 525.

[16] María Isabel Blanco, "The Economics of Wind Energy." *Renewable and Sustainable Energy Reviews* 13, no. 6-7 (2009): 1372.

of their electricity generated by renewables by 2020.[17] The United States has state level programs that promote alternative energy. Currently, 29 states have some form of a Renewable Portfolio Standard (RPS); however, there is currently no federal RPS.[18] The RPS is intended to promote the development of alternative energy in each state by mandating that a certain percentage of the electricity be generated by alternative energy.

There are many incentives to develop alternative energy. Decreasing a dependence on foreign oil is one of the main financial incentives to move away from fossil fuels. The domestic production of energy reduces dependence and increases control of energy sources. Fortunately, the United States has large potential for the domestic production of wind energy. Thus, it would be advantageous for the federal government to promote the development of wind power.

Internal Factors

The United States has high potential for wind power development. High average wind speeds and large land area are two of the main reasons for the high potential. The graph below, produced by the National Renewable Energy Laboratory (NREL), shows the average wind speeds in the United States. The average wind speeds are divided into

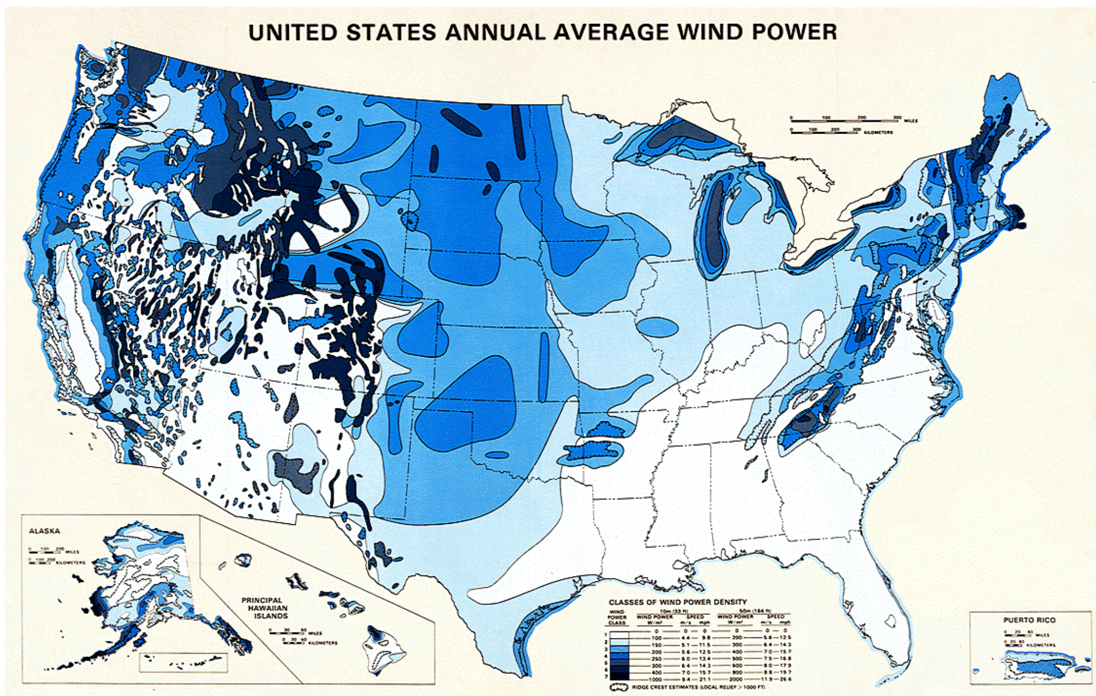
[17] Shayle Kann, "Overcoming Barriers to Wind Project Finance in Australia." *Energy Policy* 37, no. 8 (2009): 3139.

[18] Federal Energy Regulatory Commission, "Renewable Power & Energy Efficient Market: Renewable Portfolio Standards." 2010. <http://www.ferc.gov/market-oversight/othr-mkts/renew/othr-rnw-rps.pdf> (accessed 21 December 2010).

seven categories. Category three and higher is suitable for most wind power development.[19]

FIGURE 3.2

UNITED STATES ANNUAL AVERAGE WIND POWER



SOURCE: National Renewable Energy Laboratory, “United States Annual Average Wind Power.” <http://rredc.nrel.gov/wind/pubs/atlas/maps/chap2/2-01m.html> (accessed 14 December 2010).

As one can see, the potential for wind power in the United States is large, as the majority of the land area is suitable for wind development. There is more than enough wind potential in the United States to exceed energy demand. A recent NREL study

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[19] National Renewable Energy Laboratory, “Map Description.” <http://rredc.nrel.gov/wind/pubs/atlas/map_descript.html> (accessed 14 December 2010).

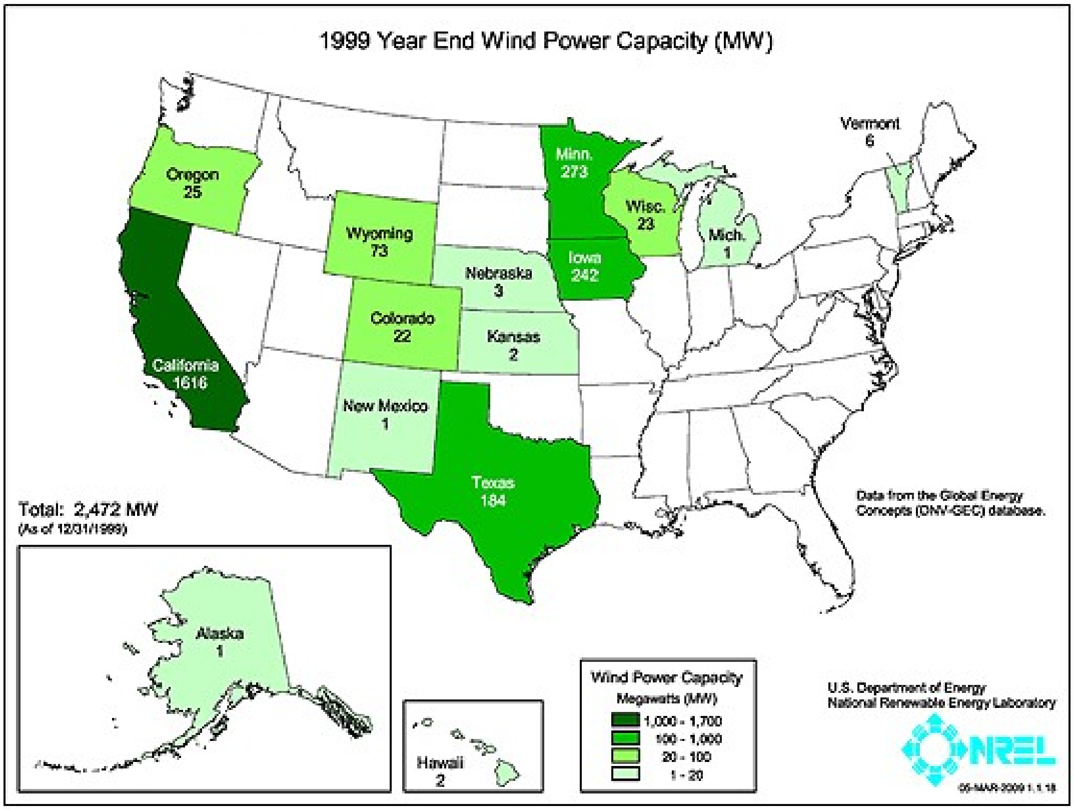
found that off-shore wind alone could produce enough energy to exceed the United States' energy demand.[20]

The installed wind capacity in the United States has grown steadily over the last decade. In 1999 the total installed wind capacity in the United States was 2,472 megawatts (MW); by 2010, the total installed capacity had grown to 40,180 MW. That is a 1625% increase in installed wind capacity over an eleven year period. The two maps below display the installed wind capacity, measured in megawatts, for each individual state in 1999 and 2010.

[20] Mother Earth News, "Offshore Wind Power Could Meet United States' Energy Demand." 2009. <http://www.motherearthnews.com/Renewable-Energy/Offshore-Wind-Power.aspx> (accessed 14 December 2010).

FIGURE 3.3

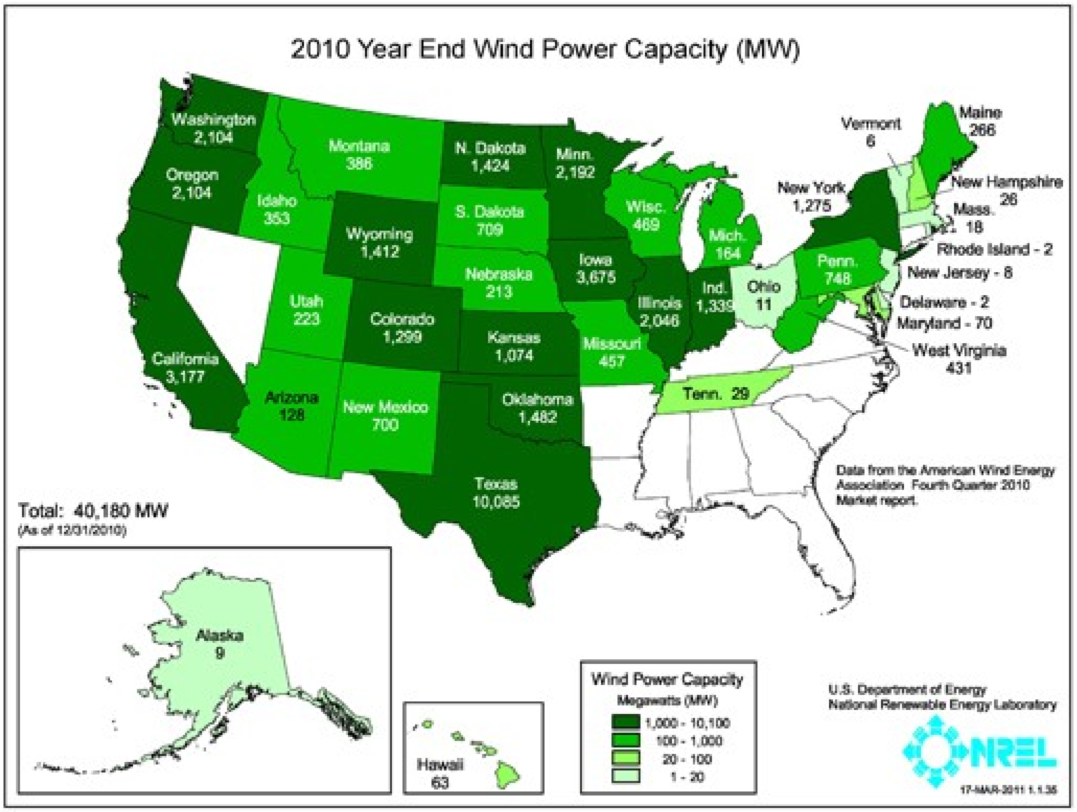
1999 YEAR END WIND POWER CAPACITY (MW)



SOURCE: United States Department of Energy, “U.S. Installed Wind Capacity and Project Locations.” 2011. <http://www.windpoweringamerica.gov/wind_installed_capacity.asp#current> (accessed 28 April 2011).

FIGURE 3.4

2010 YEAR END WIND POWER CAPACITY (MW)



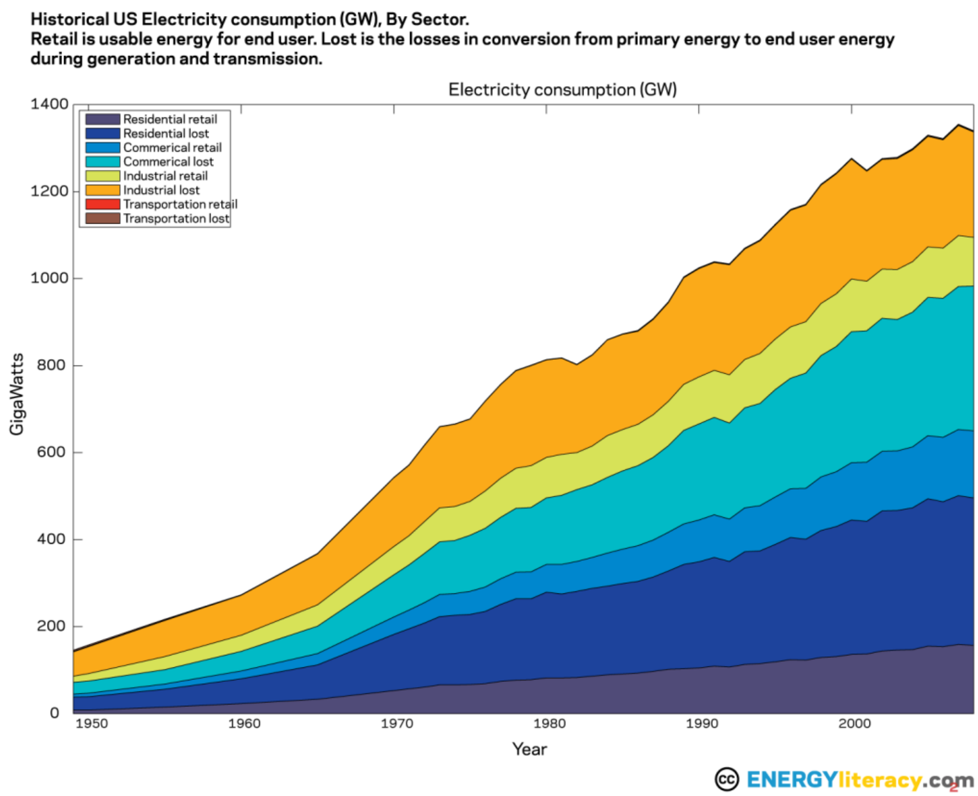
SOURCE: United States Department of Energy, “U.S. Installed Wind Capacity and Project Locations.” 2011. <http://www.windpoweringamerica.gov/wind_installed_capacity.asp#current> (accessed 28 April 2011).

As demonstrated by the maps, in 1999, there was sparse installed capacity and it was mainly located in the mid-west and on the west coast. By 2010, the installed capacity had grown to cover almost every state, with the exception of the southeast because of the low average wind speed.

The demand for electricity in the United States is constantly growing. Forecasts for the future predict the constant increase in energy demand to continue. The last half century has also shown a constant increase in energy production within the US. Graphs displaying the increase in consumption and production are shown below:

FIGURE 3.5

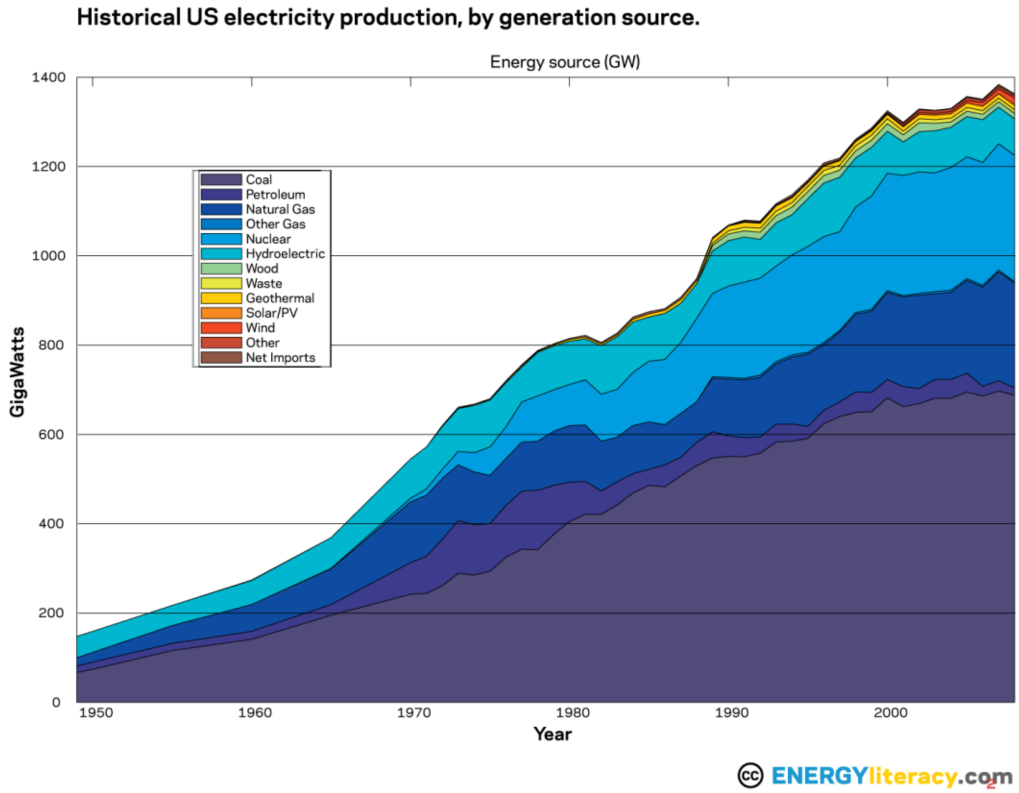
ELECTRICITY CONSUMPTION



SOURCE: Energy Literacy, "Historical US Electricity Production, by Generation Source, and Consumption by Sector." <http://www.energyliteracy.com/?p=142> (accessed 14 December 2010).

FIGURE 3.6

ENERGY SOURCE



SOURCE: Energy Literacy, "Historical US Electricity Production, by Generation Source, and Consumption by Sector." <http://www.energyliteracy.com/?p=142> (accessed 14 December 2010).

The graphs above clearly show the growth in both electricity consumption and production in the United States over the last 60 years. If fossil fuels follow the Hubbert peak theory then an alternative energy source will be needed to fill the gap between the increasing demand and the declining supply. The large potential for wind energy in the United States, coupled with the continued increase in electricity demand, make the future of wind energy promising.

Non-Price Barriers

Despite the large potential for wind energy and the increasing demand, there are many factors that inhibit wind energy's ability to compete with fossil fuels. In addition to price barrier, there are also many non-price barriers. NIMBY, access to transmission lines, variable wind speed, utility issues, and federal and state policies are a few of the non-price factors that act as entry barriers to the wind market. All these barriers affect the competitiveness of wind power with fossil fuels in the open market.

The potential for wind development in the United States is large. However, proposed wind farms are often met with harsh resistance. NIMBY is one of the main barriers to wind developers. A person can hold NIMBY views even if they support the development of wind power in general. NIMBY tends to result in local by-laws and regulations that inhibit the development of wind power.

Wind power development in Massachusetts exemplifies this problem. Off-shore wind farms offer huge potential. While the cost of construction and maintenance is higher, wind speeds are higher and more consistent over the ocean.[21] The Cape Wind project promises to be the first major off-shore wind farm in the United States. However, it has been met with intense opposition. While the proposed turbines in Nantucket Sound promise renewable and clean energy for years to come, many local groups, residents, and politicians have done everything they can to stop the approval of

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[21] Gaetano Gaudiosi, "Offshore Wind Energy in the World Context." *Renewable Energy* 9, no. 1-4 (1996): 899.

the project, including the late Senator Ted Kennedy.[22] The project was delayed for almost a decade by the opposition, but was finally approved in April 2010.[23]

The opposition was lead by an extremely wealthy and politically connected group called the Alliance to Protect Nantucket Sound.[24] Essentially, the opponents are concerned about the water view from their homes on Cape Cod and Nantucket. This is a perfect example of how NIMBY inhibits wind development. In total, the company behind the Cape Wind project, Energy Management, has spent $40 million on a wide range of studies aimed at proving the validity of the project, while the Alliance to Protect Nantucket Sound has spent millions lobbying against the project.[25] As exemplified by the Cape Wind situation, a wind developer can face large barriers to entry from local groups and politicians. Also exemplified by this situation is the necessity for a wind developer to have the financial means to overcome NIMBY opposition and the barriers it creates.

NIMBY creates different problems for on-shore wind development. As a result of NIMBY, wind farms are often built in remote areas far from the population centers that use the energy they produce. This location problem creates a transmission problem. There are often no transmission lines running from the remote location of wind farms to cities. Building new transmission lines is expensive. Building new lines could cost as much as $80 per meter; thus, the cost of connection would be $800,000 for every

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[22] Eliza Krigman, "Will the Winds Favor Cape Wind?" *National Journal* (2009): 24.

[23] Pam Hunter, "'Cape Wind' Offshore Project Gets Go-Ahead, After Review." *ENR: Engineering News-Record* 264, no. 15 (2010): 18.

[24] Krigman, 24.

[25] Ibid.

10km.[26] Access to transmission cables is a huge barrier faced by wind farm developers. It is essential for a wind farm to be able to connect to transmission cables at a reasonable price. This can make or break the feasibility of a project, as connection to transmission cables is extremely expensive. Minimizing the distance from the turbine site to the nearest transmission cables is a strategy employed by wind developers to cut the cost of connection.

Variable wind speed at a particular location is the most important factor that determines the success or failure of an individual turbine.[27] Wind, by nature, is inconsistent and unreliable. The majority of the difference in the price per kilowatt hour of wind generated electricity has to do with the individual site and the average wind speed at the hub of each individual turbine.[28] Turbine locations are chosen very carefully. Computer modeling is used to map the local wind characteristics and topography. Based on this data, wind developers are able to choose the specific turbine and layout that is best suited for the conditions of the site.[29]

The inconsistent nature of wind is a problem for utility companies. It is a serious concern for many utility managers.[30] Utility companies need to constantly supply enough energy to meet customer demand, thus the inconsistent nature of wind presents

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[26] Scott Victor Valentine, "A STEP Toward Understanding Wind Power Development Policy Barriers in Advanced Economies." *Renewable and Sustainable Energy Reviews* 14, no. 9 (2010): 2802.

[27] Blanco, 1376.

[28] Ibid.

[29] Ibid.

[30] Valentine, 2802.

a problem since a cost effective way to store electricity have not been perfected.[31] Utilities companies now have to be able to switch between wind energy and fossil fuels based on the productivity of the wind on a given day. Unfortunately, wind energy production typically reaches its daily peak at a different time than the peak usage of electricity.

There are many governing issues that act as barriers to wind power. The Production Tax Credit (PTC) is the main source of federal support for wind power.[32] The PTC is based on how much electricity a wind farm produces. The PTC pays a wind farm 2.2 cents per kilowatt hour, for the first ten years of its existence, in addition to the market price that the wind farm already receives for selling the energy it produces.[33] The PTC is a well intentioned program; however, it has a negative effect on the development of wind power. The PTC is only renewed for short periods of time, which creates a state of constant uncertainty. Thus, the PTC creates a boom and bust cycle for wind power investment.[34] Despite the apparent positive aspects of the PTC, it actually ends up costing the wind industry more money as a result of the rapid increase and decrease in development. The PTC does not encourage long-term investment. Some argue that it is not the absence of the PTC that causes a decrease in investment, but

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[31] Ibid, 2803.

[32] Merrill Jones Barradale, "Impact of Public Policy Uncertainty on Renewable Energy Investment: Wind Power and the Production Tax Credit." *Energy Policy* 38, no. 12 (2010): 7708.

[33] American Wind Energy Association, "Federal Policy." 2011. <http://www.awea.org/issues/federal_policy/index.cfm> (accessed 24 April 2011).

[34] Barradale, 7698.

rather the uncertainty about its return.[35] The federal government has been reluctant to establish a permanent PTC. The poor design of the PTC is one of the main governing barriers to wind development.

The RPS is another program that is intended to help wind power, but actually harms it. The RPS is a state level program aimed at promoting the growth of renewable energy. As previously stated, 29 states currently have some form of an RPS.[36] The basic goal of an RPS is to generate a certain amount of electricity from renewables by a certain year. One major weakness with the RPS in the United States is that there is currently no federal RPS.[37] The lack of a federal RPS means not every state has to participate. While many have chosen adopt an RPS, many still have not. The lack of a federal RPS leads to less development of wind power.

[35] Ibid., 7708.

[36] Federal Energy Regulatory Commission.

[37] Lisa Hickey. Wind power lawyer. Personal Interview. 2 December 2010.

CHAPTER IV

ANALYSIS

The data collected was based on personal interviews. The object of the interviews was to determine the non-price barriers to the wind industry. The interview subjects were chosen based on their connections to the wind industry. The goal was to have each sector of the wind industry represented in the interview process. The purpose of speaking to a person from each different sector of the wind industry was to assure that every possible barrier was identified.

Seven people were interviewed. The first participant was, Van Wilgus, Vice-President of Colorado Energy Management and general counsel to the SunZia Southwest Transmission Project. Wilgus represents the transmission sector and he was chosen because of his experience with the transmission of wind power. The next participant was Lisa Hickey, a Colorado based wind power lawyer. Hickey represents the legal side of the wind industry and she was chosen because of her knowledge of the federal and local laws governing wind power development. The next participant was Mike Staiti, Owner of Keystone Development, a commercial and residential construction company. Staiti is also the part owner of Quabbin Wind, a Massachusetts based wind company. Staiti was chosen for his expertise in construction and wind development. Dean Iandoli was the next participant. He is also a part owner of Quabbin Wind. He was chosen for his experience with every aspect of wind development. He has experience dealing with everything from local opposition to financing projects. The next participant was Dustin Rand. Rand is an engineer at Northern Power Systems. He works on the design and construction of new turbine technologies. He was chosen for his extensive knowledge of the design and engineering of turbines. Jim Kantelis was the next participant. He is the CEO at the National Institute for Renewable Energy. He was chosen for his experience in the development and sale of renewable energy technologies. Finally, William Payne was interviewed. He is a Senior Engineer at Raytheon Company. Payne was selected because of his expertise in electrical engineering and transmission.

The interviews were conducted over the telephone, with the exception of one. The participants were asked a series of questions, designed to determine what barriers they each faced in their particular field within the wind industry. The interview with Dustin Rand took place at the Northern Power Systems plant in Montpelier, Vermont. During the interviews, the participants were asked address three main barriers, as well as selected sub-issues. The participants were shown the list of issues displayed below:

<u>Not In My Back Yard</u>

- Location issues
- Transmission problems
    - Siting
    - Connection to grid
    - Construction costs (of building transmission)
- Environmental problems
    - Birds, bats, etc.

<u>Utility Issues</u>

- Reliability
    - Inconsistent nature of wind
- Lack of storage capability
- Capacity factor
- Grid stability

- Local utility (using the power close to where it is produced)

<u>Governing Issues</u>
- Public utility commission (PUC)
- Federal level
  - Production tax credit (PTC)
    - Creates boom and bust cycle
- Local / state level
  - Renewable portfolio standard (RPS)
    - No national RPS

<u>Additional Issues</u>
- High capital cost
- Increasing cost of turbine materials

As one can see, the three main barriers the participants spoke about were NIMBY, utility issues, and governing issues. These three issues were identified to be the most important during the literature review. The participants were asked to describe their experience with each issue. They were also asked to identify any issues not on the list. Each interview lasted roughly an hour.

As suspected, the issues that surfaced during the literature review act as major barriers to the development of the wind industry. Nearly every person who was interviewed had experience with most of the issues on the list. Participant's experiences varied based on their particular involvement with the wind industry.

Not In My Backyard

NIMBY was an issue that nearly every participant had encountered. It was clear that NIMBY is a major barrier to the success and development of wind power. Mike Staiti of Keystone Development described NIMBY as "the primary barrier to entry" for wind developers in Massachusetts.[1] NIMBY is the main issue Staiti deals with on a day to day basis. He finds that no matter where he tries to develop wind in Massachusetts nearly every project is opposed by someone who is anti-wind.[2] The NIMBY issue experienced by Staiti leads to other problems for him and his company. As a result of NIMBY the permitting process for wind development becomes more complicated and riskier. The process becomes riskier because zoning laws in Massachusetts rarely allow for the construction of turbines. The lack of zoning, coupled with NIMBY makes the permitting process a struggle for Massachusetts developers. Without zoning a developer has no legal right to obtain a permit.[3] Thus, the developer is largely as the mercy of the local zoning authority for approval. Opponents of wind power are easily able to petition the local authorities to slow or even stop the approval of the project. Even with underlying zoning, opponents of the project can tie it up for years with appeals.[4] Staiti states that "without any zoning in place, developers are taking a huge risk trying to get permits."[5] The permitting process is lengthy and expensive; the lack of zoning prolongs and complicates the process. With all the odds stacked against developers in Massachusetts, NIMBY is often the tipping point that stops a project.[6]

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[1] Mike Staiti. Owner; Keystone Development. Personal Interview. 28 February 2011.

[2] Ibid.

[3] Ibid.

[4] Ibid.

[5] Ibid.

[6] Ibid.

Much like his partner, Dean Iandoli, part owner of Quabbin Wind, experiences many problems with NIMBY. Iandoli encounters NIMBY in some form or another everywhere he goes. The hypocrisy of the issue is what frustrates him the most.[7] Iandoli finds that people who are anti-wind are rarely truthful regarding their opposition to wind turbines.[8] He believes that the actual reason people are against turbines is because they find them unsightly. However, they never actually come out and state this as the reason for their opposition. Instead, they site numerous other reasons for their opposition; many of which with they have no first-hand experience. Iandoli sited blade flicker and noise as two reasons for NIMBY opposition.[9] Iandoli has extensive experience with these types of NIIMBY issues. One reason for this is the type of business model that Iandoli and Quabbin Wind follow. Quabbin Wind specializes in single-turbine development. They do this because it offers clean energy with less of an effect on the surrounding environment. However, single turbines are often placed closer to buildings than large wind farms. Thus, blade flicker and noise are two NIMBY problems that Iandoli and Quabbin Wind often encounter.[10]

Blade flicker occurs when the sun strikes the turbine blades at a certain angle; this causes a pulsating shadow effect. The blade flicker of a turbine can be compared to the pulsating shadow created by a ceiling fan. Blade flicker is a localized issue; it only occurs in a certain location for a few minutes each sunny day. The shadow created by

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[7] Dean Iandoli. Wind developer; President of Quabbin Wind. Personal Interview. 3 March 2011.

[8] Ibid.

[9] Ibid.

[10] Ibid.

the turbine moves throughout the day, depending on the angle of the sun in the sky.[11] It can be irritating to local homes and businesses. Noise is another serious NIMBY obstacle that Iandoli faces.[12] The rotation of the turbine blades makes a swooshing noise. The noise made by the turbines is often faint and can really only be heard during periods of high wind. Fortunately, during periods of high wind other noises are often created as a result of the wind; rustling leaves are one example. Ambient noise often completely blocks the sound produced by a turbine.[13] However minimal these problems might actually be, noise and blade flicker present a large problem for Iandoli and Quabbin Wind.[14]

Van Wilgus of SunZia also sees NIMBY as a major barrier to wind development. However, the NIMBY problem Wilgus experiences manifests itself in a different form than the one experienced by Staiti in Massachusetts. Wilgus works in the western United States; he has experience in Colorado, New Mexico, and Wyoming. He mainly deals with transmission. As a result of NIMBY, wind farms are often located far from population centers. The remote location of wind farms means that transmission lines have to be constructed to deliver the electricity to the cities where it is used. It is common for people to not want transmission lines near their homes, as they are considered to be unsightly, and even unsafe due to the electromagnetic field they produce. However, transmission lines are needed to deliver electricity to the population.

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[11] Ibid.

[12] Ibid.

[13] Ibid.

[14] Ibid.

Wilgus often sees NIMBY opposition to the construction of transmission lines.[15] The case of Wyoming provides a good example of NIMBY. In order to construct transmission lines, private property often has to be condemned. As a result of NIMBY, Wyoming no longer allows condemnation of private property for the construction of transmission lines.[16] This causes problems for transmission companies who no longer have a way to transport electricity.

Wilgus finds that environmental concerns also present a barrier to wind development.[17] Turbine blades have been proven to kill bats and birds.[18] The actual construction of the turbines and transmission lines also present environmental concerns.[19] Turbines are large and thus large access roads must be built to transport the turbines to the site. This construction process can be disruptive to the animals in the surrounding area. As a result of the environmental impact of turbines, many environmental groups try to stop the construction of wind farms in their area.[20]

Interestingly, Jim Kantelis finds that NIMBY is not a problem for him and the National Institute for Renewable Energy (NIRE).[21] NIRE is a Texas based company. Kantelis finds that in general Texans are not opposed to wind farms or transmission

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[15] Van Wilgus. Vice President; Colorado Energy Management. Personal Interview. 20 September 2010.

[16] Ibid.

[17] Ibid.

[18] Ibid.

[19] Ibid.

[20] Ibid.

[21] Jim Kantelis. CEO; National Institute for Renewable Energy. Personal Interview. 3 March 2011.

lines. As a result of the vast amount of open land, wind farms and transmission lines do not have to be placed near many houses. Kantelis finds that, in general, Texans see the development of un-used land as an improvement and a positive.[22]

Utility Issues

There are many utility issues that act as barriers to the wind industry. Utility issues present a small barrier to Jim Kantelis.[23] Issues with grid stability have led to wind power interconnection fees; it is these fees that present a problem.[24] William Payne explains that when integrating wind into an electrical grid, there are often problems with grid stability.[25] The utility companies need a constant supply of power in order to keep the power grid stable. Wind power presents a problem to grid stability because it fluctuates in power level.[26] It fluctuates in power level as a result of variable wind speed. Utility companies are generally used to dealing with coal fired plants which produce a constant output of power; thus, the grid stays stable. However, when wind power is introduced into the system, the fluctuating power level can cause grid instability.[27] A utility company needs a constant amount of electricity in the grid because they always need to be able to supply enough power to meet the demand of

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[22] Ibid.

[23] Ibid.

[24] Ibid.

[25] William Payne. Senior Engineer; Raytheon Company. Personal Interview. 1 March 2011.

[26] Wilgus. 20 September 2010.

[27] Payne. 1 March 2011.

their customers. If a utility company does not have enough power on the grid, a brown out can result.[28]

To integrate wind power, utility companies have to change the way they regulate the power grid. As a result of this added difficulty, utility companies often charge wind farm owners a fee to integrate their power into the system. Jim Kantelis sees this fee occurring more frequently.[29] However, Kantelis believes that the process should not be so difficult for utility companies, as they already integrate coal fired plants with nuclear, natural gas, as well as other sources of electricity.[30] Despite the apparent ease with which utility companies can integrate all sources of power into the grid, there is still a fee to integrate wind power, and this fee is a minor barrier for Kantelis.[31]

Van Wilgus also sites that wind interconnection fee as a barrier.[32] Additionally, he encounters many other utility and transmission problems. When transmission lines were originally constructed, they were built in such a way that allowed for 20-30% growth in transmission capacity.[33] Unfortunately, grid surplus has been exhausted and new transmission lines now have to be built.[34] Building new transmission lines presents a problem for the development of the wind industry. As a result of NIMBY, transmission lines often have to cover large distances. Transmission lines are expensive;

[28] Ibid.

[29] Kantelis. 3 March 2011.

[30] Ibid.

[31] Ibid.

[32] Wilgus. 20 September 2010.

[33] Ibid.

[34] Ibid.

they can cost as much as $2 million a mile.[35] Wilgus explains that utility companies now offer to build transmission lines if the wind developer pays for the construction; however, the utility company then owns the transmission line.[36] Building new transmission is an expensive and long process. The lack of transmission acts as a huge barrier to the wind industry.[37]

Van Wilgus sees additional utility issues. Wilgus finds that there is a problem with the storage of electricity produced by wind power.[38] Dustin Rand explains that electrical power must be used almost as soon as it is produced, it does not have an extensive storage capability if left on its own.[39] While there are ways of storing electricity, they tend to be complicated and expensive; and thus, impractical.[40] Wilgus explains that one of the main challenges faced by the producers of wind energy is storage capability.[41] Storage of electricity was not been a problem in the past, as a constant supply of electricity could be generated by fossil fuels.[42] Coal plants can operate at a constant output level, 24 hours a day, seven days a week. However, wind power presents a new problem for utility companies. Wind power production level is based on the varying speed of the wind. Unfortunately, peak daily wind speeds rarely

[35] Ibid.

[36] Ibid.

[37] Ibid.

[38] Ibid.

[39] Dustin Rand. Turbine Engineer; Northern Power Systems. 20 January 2011.

[40] Ibid.

[41] Wilgus. 20 September 2010.

[42] Rand. 20 January 2011.

match with peak daily usage of electricity.[43] This disconnect means that while individual opinions vary, the general consensus is that there is currently no cost efficient way to store wind generated electricity.[44] However, there are a few storage methods that are currently being developed. Hydro pump storage, battery storage, and gas pressure storage are three ways of storing electrical power; however, all need further development.[45] The lack of storage capability is a limiting factor for wind development. Since the power cannot be stored effectively, only a certain portion of total electrical power can be supplied by wind power. Wind power can be relied on to meet about 20% of the electricity demand.[46] Thus, the storage of electricity remains a major barrier to the development of the wind power industry.[47]

Governing Issues

Governing issues present a significant barrier to Mike Staiti. Staiti mainly sees local and state level policies as barriers, as opposed to federal policies. He finds that while the incentives for wind developers in Massachusetts are excellent, there is very little zoning that allows for wind turbines.[48] The previously discussed lack of zoning

[43] Wilgus. 20 September 2010.

[44] Ibid.

[45] Ibid.

[46] Ibid.

[47] Ibid.

[48] Staiti. 28 February 2011.

creates many problems for Staiti and other wind developers in Massachusetts. Again, without any zoning in place, a developer has no legal right to construct turbines.[49]

Another governing issue that presents a barrier to Staiti is the Massachusetts net metering incentive. While the incentive itself is beneficial to wind developers, the way it is implemented creates issues.[50] In Massachusetts, the Green Communities Act, passed in 2009, promotes the development of renewable energy in the state by mandating that the utilities allow up to 3% of their peak capacity to come from renewable energy sources; this policy is referred to as net metering.[51] Two percent of this peak load has to come from municipally owned facilities, and 1% is set aside for private developers, such as Staiti and Iandoli.[52] Clearly, net metering is intended to promote wind development; however, it also has unintended consequences. Net metering allows turbine owners to sell the electricity they produce at an increased rate, currently that is 15 cents per kilowatt hour.[53] Once the net metering cap of 3% has been reached, the rest of the renewable energy produced receives the “avoided cost” rate of around 7 cents per kilowatt hour.[54] Avoided cost is essentially the marginal cost of energy production, or the wholesale price.[55] Clearly, there is a large difference between these two rates. The bottom line of a project is significantly affected depending on

[49] Ibid.

[50] Ibid.

[51] Ibid.

[52] Ibid.

[53] Ibid.

[54] Ibid.

[55] Ibid.

which rate the wind farm owner receives. Additionally, the financial projections and viability of a project are often based on the presumption that the increased net metering rates will be received. [56] The uncertainty about net metering rates creates a problem for Massachusetts wind developers. This problem is exacerbated by the long development cycle for turbines. A project does not qualify for net metering until it goes online and a single turbine project can take between 18 to 24 months to complete; multi turbine projects can take much longer.[57] "A project could be 90% through development and the cap could get exhausted, leaving your project at avoided cost rates."[58] Receiving avoided cost rates significantly decreases the profit margin and can ruin the financial viability of the project. Thus, net metering, a program that was intended to promote the development of alternative energy, can also have devastating financial effects on individual developers.

On the governing side, Jim Kantelis finds that the lack of a federal Renewable Portfolio Standard (RPS) presents a problem.[59] The lack of a federal RPS means that developers like Kantelis need to apply for treasury credits from the federal government in order to lower the capital cost of wind farm construction. Kantelis believes that if there was a federal RPS it would eliminate the need for treasury credit because the market would naturally push the price of electricity high enough to cover construction

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[56] Ibid.

[57] Ibid.

[58] Ibid.

[59] Kantelis. 3 March 2011.

and operating costs.[60] Lisa Hickey also finds that the lack of a federal RPS causes problems for the wind industry.[61] She believes that a federal RPS would encourage wind development because it would reward the producers of clean energy; as opposed to the current cap and trade system which works in a negative way by charging polluters.[62] Hickey finds that the federal credit programs, such as the Production Tax Credit (PTC), cause a boom and bust cycle within the wind industry.[63] Kantelis also believes that a boom and bust cycle is the result of federal tax credit policies.[64] The federal government creates uncertainty within the wind industry by offering credits and subsequently retracting them.[65] The wind industry experiences rapid development, interspersed by periods of no development; the uncertainty caused by the federal government's actions is what creates the boom and bust cycle.[66]

Lisa Hickey finds that her clients are negatively affected by a combination of a slow project approval process and the PTC.[67] NIMBY often leads to stringent local laws that create a slow approval process for wind developers. Hickey believes that the sluggish planning and approval process hinders wind development. Federal policy

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[60] Ibid.

[61] Lisa Hickey. Wind power lawyer; Personal Interview. 2 December 2010.

[62] Ibid.

[63] Ibid.

[64] Kantelis. 3 March 2011.

[65] Ibid.

[66] Hickey. 2 December 2011.

[67] Ibid.

makes the problems created by slow approval process worse.[68] Hickey believes that companies cannot take the risk to plan a wind farm if they are not certain that the PTC will still be in affect after the wind farm is approved; the sluggish local approval process exacerbates this problem.[69]

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[68] Ibid.

[69] Ibid.

CHAPTER V

CONCLUSION

There are many non-price factors that act as barriers to the wind industry. The interview process confirmed that the issues revealed in the literature review do act as barriers to the wind industry. As suspected, the three main barriers are Not In My Backyard (NIMBY), utility obstacles, and governing problems. There are many smaller factors that fall under each of these larger issues.

In addition to the previously identified problems, the interview process revealed additional obstacles that were not on the original list. Net metering and its repercussions appear to create problems for developers.[1] Zoning laws, or the lack thereof, also act as a barrier to wind development.[2] Finally, the grid interconnection fee created a small financial obstacle for developers.[3]

The literature review and interview process has revealed that there are many issues that act as barriers to the wind industry. Fortunately, the interview process also revealed that there are solutions to some of the barriers; even the seemingly unchangeable price barrier.

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[1] Mike Staiti. Owner; Keystone Development. Personal Interview. 28 February 2011.

[2] Ibid.

[3] Jim Kantelis. CEO; National Institute for Renewable Energy. Personal Interview. 3 March 2011.

Iandoli and Kantelis both say that the general public needs to look at wind production and prices in a different light. Both pointed to the fact that while wind may be more expensive to produce now, it will still be the same price thirty years from now. While, on the other hand, the price of fossil fuels will only continue to rise.[4] [5] Thus, the growth of the wind industry can be seen as an intelligent investment in our future. Additionally, Iandoli believes that many difficulties he faces now are the result of the current bad economic conditions in the US; and he expects these difficulties to diminish as the economy improves.[6]

The NIMBY issue of disrupted views cannot be directly solved. However, it can be diminished by locating turbines a considerable distance from homes. The NIMBY issue of flicker effect cannot be completely cured either. However, distance from the turbine and physical features of the landscape often drastically diminish the flicker effect. The flicker effect is only a problem for a very specific area for a few minutes each sunny day.[7] The NIMBY issue of sound is one that can be improved. First of all, sound decreases significantly with distance from the source. In addition to allowing reasonable distance between houses and turbines, new turbine technology focuses on reducing sound.[8] [9]

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[4] Dean Iandoli. Wind developer; President of Quabbin Wind. Personal Interview. 3 March 2011.

[5] Kantelis. 3 march 2011.

[6] Iandoli. 3 March 2011.

[7] Ibid.

[8] Ibid.

[9] Dustin Rand. Turbine Engineer; Northern Power Systems. 20 January 2011.

There are many utility obstacles that can be solved, and a few that cannot. The inconsistent nature of the wind and low capacity factors are major issues that cannot be solved directly. These are obstacles that the wind industry needs to learn to work around. Increasing storage capability is something that could help to alleviate the fact that peak wind periods do not match up with peak usage periods. Increased ability to store electricity would also help alleviate the low capacity factor and the inconsistent nature of wind because when extra power is produced it can be saved for periods of low wind and power production. The problem of storage capability in itself is something that could potentially be solved in the future. There are currently a few ways of storing electricity, however, they have not been developed enough and are currently not cost effective.

The governing issues are all theoretically able to change. The implementation of a federal Renewable Portfolio Standard (RPS) would significantly aid the development of wind power by forcing utility companies to purchase wind produced electricity. The implementation of a permanent Production Tax Credit (PTC) would also significantly help the industry. A permanent PTC would eliminate the current boom and bust cycle.

The majority of the non-price barriers to wind power can be minimized. The question then becomes: is the United States willing to fully commit to the development of wind power; and if it is: what needs to be done to achieve this goal? A full commitment to wind power would mean a larger percentage of wind power on the electrical grid. A greater percentage of wind power on the grid requires more than just dealing with the non-price barriers; the grid itself must change to be able to handle the increased percentage of intermittent capacity. A complete commitment to wind power could also mean significant changes in public policy.

It would be beneficial for the United States to commit to wind power and renewable energy in general. Countries like Denmark and the Netherlands have proven that the switch to wind energy can be made. As of 2008, 23% of Denmark's energy use was provided by wind power.[10] Additionally the European Union as a whole appears ready to commit to alternative energy, and take the necessary steps to achieve this goal. The EU is poised to make €51 billion investment in Smart Grid technology, with the goal of 20% renewable energy by 2020.[11] [12] It would be beneficial for the United States to get a larger percentage of its energy from renewables. Adopting renewable energy promises to reduce carbon emissions, curb global warming, reduce dependence on foreign oil, and reduce energy costs in the long run. The development of a Smart grid is central to making wind and other renewable energies work in the United States. A 2011 report by the International Energy Agency (IEA) concludes that the development of a Smart Grid is centerpiece to the future of energy production and use. The IEA finds that

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[10] T. J. Hammons, "Integrating Renewable Energy Sources into European Grids." *International Journal of Electrical Power & Energy Systems* 30, no. 8 (2008): 468.

[11] Ahmad Faruqui, Dan Harris, and Ryan Hledik, "Unlocking the €53 Billion Savings from Smart Meters in the EU: How Increasing the Adoption of Dynamic Tariffs could make Or Break the EU's Smart Grid Investment." *Energy Policy* 38, no. 10 (2010): 6222.

[12] Kari Larson, "Smart Grids – A Smart Idea?" 2009. <http://www.renewableenergyfocus.com/view/5030/smart-grids-a-smart-idea/?sms_ss=facebook&at_xt=4d9dcba33e704823,0> (accessed 28 April 2011).

a Smart Grid will “optimize and accelerate technology development and deployment while reducing costs for all stakeholders.”[13]

A Smart Grid is a digitally monitored electricity network that with an integrated communication system.[14] The goal of the Smart Grid is the same as the traditional energy grid: to deliver electricity from the producer to the consumer. However, the process by which the Smart Grid does this is different from the traditional grid. The Smart Grid integrates new communications technology systems that balance supply, demand, and storage, in real time.[15] A smarter grid would allow for large-scale integration of renewable energy. It would also increase energy efficiency, reduce costs, and maximize energy efficiency.[16]

At any given time, a utility company needs to supply enough energy to meet customer demand. Failing to do so can result in brown outs. Balancing peak energy demand can be complicated. Renewables create added problems with peak balancing because of their inconsistent nature. Currently, coal and gas generators are used to balance peak load. If the Unites States makes the transition to a renewable energy based electrical grid it would require alternative fuel sources such as wind and solar to balance the peak load.[17] The Smart Grid is the answer to solving this problem. An increased

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[13] International Energy Agency, “Smart Grids Roadmap.” 2010. <http://www.iea.org/Papers/2010/SmartGrids_Roadmap_Foldout.pdf> (accessed 28 April 2011).

[14] Peter Crossley and Agnes Beviz, "Smart Energy Systems: Transitioning Renewables Onto the Grid." *Renewable Energy Focus* 11, no. 5 (2010): 55.

[15] Ibid.

[16] Ibid.

[17] Ibid.

installed capacity of renewables would allow them to cover peak load while the Smart Grid would enable them to balance supply and demand.[18]

Demand side management will be vital to the success of the Smart Grid.[19] Consumers will need to change their current mode of energy use. In the future, there will be higher average demand, higher peak demand, and increased distribution of generation (increase in number of electricity sources).[20] Demand shifting will be a central part of future energy use. Currently the majority of energy use occurs during the afternoon and early evening hours. The Smart Grid will help to spread out the energy use to accommodate the intermittent nature of renewables. Smart meters installed in homes will allow this to happen. Social awareness could also help to drive demand side change. Smart meters could be designed to give home owners daily updates on their energy use and compare their use to the "average" customer. This information could be accessible online, or through a smart phone app.

The Smart Grid will need to incorporate smart home systems and smart meters that communicate with the energy supplier. These meters will work to dissipate energy use during peak load periods and automatically turn on and off certain appliances based on pricing signals received from the energy supplier. When overall energy demand is low, the price of energy use drops. Smart meters will be able to communicate this information to smart appliances and spread out energy demand. For example, washer machines could be automatically set to run when demand is low, during non-peak

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[18] Ibid.

[19] Ibid.

[20] Ibid., 56.

hours; the smart meters would be able to tell these smart appliances when to run.[21] Whirlpool is one company that is in the process of developing appliances that are compatible with the Smart Grid. Whirlpool plans to have all of its electronically controlled appliances Smart Grid compatible by 2015.[22] Along with household appliances, transportation is a major source of energy use and a major source of greenhouse gases.[23]

Electric cars hold great potential to help reduce greenhouse gas emissions and fossil fuel energy use.[24] The future already looks bright for hybrid electric transportation; and renewable energy coupled with Smart Grid technology offer a whole new realm of opportunity for electric vehicles. Electric cars work perfectly with the need to spread out energy demand. Electric cars could be charged at night when energy use is lowest, thus working to shift energy demand.

Laws could change to facilitate wind development. Public policy could be changed to replicate that of mineral rights. In the United States, land ownership typically includes surface, subsurface, and air space ownership. However, this is not the case everywhere in the world, even some places within the United States. Mineral ownership is often separated from surface ownership. This means that one person can

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[21] Ibid.

[22] GreenBiz, “Whirlpool Set to Launch Smart Grid Compatable Appliances by 2015.” 2009. <http://www.greenbiz.com/news/2009/05/08/whirlpool-set-launch-smart-grid-compatible-appliances-2015> (accessed 28 April 2011).

[23] Pertti Järventausta, Sami Repo, Antti Rautiainen, and Jarmo Partanen, "Smart Grid Power System Control in Distributed Generation Environment." *Annual Reviews in Control* 34, no. 2 (2010): 284.

[24] Ibid.

own the surface land, while another retains the right to access and extract the minerals below the surface. For the sake of facilitating wind development, the ownership of land and air space could be severed as well. Air space law could be changed to mimic that of mineral rights. This change would make it significantly easier for wind developers because it would not require them to have surface rights, it would only require air space rights to construct turbines.

Many companies are currently selling utility companies the privilege to shut off power when wind production drops.[25] This is called load shedding. Policies aimed at promoting load shedding would further aid in the development of renewable energy and the Smart Grid. Allowing utility companies to temporarily lower the amount of energy an individual household or building uses would help to lower load placed on the grid when renewable production drops. For example, a household could sell their utility company the ability to temporarily turn their air conditioning up five degrees when energy demand is greater than supply. This would help to reduce the overall load on the grid. Load shedding can be achieved with the installation of demand response software.[26] EnerNOC, a Massachusetts based company, sells demand response software.[27] EnerNOC is a leader in the field of demand response and energy efficiency.[28] They "help commercial, institutional and industrial organizations use

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[25]Iris Kuo, "Use Less Power at Peak, and Pay Less? Everyone's Jumping In." 2010. <http://venturebeat.com/2010/10/29/demand-response-gets-crowded-and-primed-for-deals/> (accessed 28 April 2011).

[26] Ibid.

[27] Ibid.

[28] EnerNOC, "We're Changing the Energy Industry." <http://www.enernoc.com/about/> (accessed 28 April 2011).

energy more intelligently, pay less for it, and generate cash flow that benefits the bottom line."[29] DemandSMART is one demand response application that EnerNOC provides. DemandSMART allows companies to get paid for reducing their energy use during peak load periods.[30]

The implementation of Smart Grid technology is necessary for the large-scale development of wind power and renewable energy in general. The Smart Grid would solve many of the practical issues with wind power, such as intermittency. There is huge economic potential driving the development of Smart Grid technology. Google is one company that has invested in the development of a Smart Grid. [31] Certain utility companies now offer the Google PowerMeter, which is a smart meter for household use.[32] The development of the Smart Grid has already begun in the United States. Austin, Texas, and Boulder, Colorado, are two examples of cities that have begun to incorporate Smart Grid technology into their electricity grids.[33] The further development of a nation-wide Smart Grid is necessary for wind power to succeed.

There are clearly many non-price factors that act as barriers to the development of the wind industry. However, many of these problems can be alleviated. The wind

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[29] Ibid.

[30] Ibid.

[31] Smart Grid News, "Google Jumps into Smart Grid." 2009. <http://www.smartgridnews.com/artman/publish/companies/Google_Jumps_Into_Smart_Grid.html> (accessed 28 April 2011).

[32] Google, "Start Saving Energy and Money Now With Google PowerMeter." 2011. <http://www.google.com/powermeter/about/get-powermeter.html> (accessed 28 April 2011).

[33] Smart Power News, "10 Cities Adobting Smart Grid Technology." 2011. <http://www.smartpowernews.com/?p=753> (accessed 28 April 2011).

industry shows fantastic promise despite the barriers that currently exist. Changes in government policies, both state and federal, could result in the drastic growth of the industry. Smart Grid technology will enable the further development of renewable energy. Ultimately, the price of fossil fuels will continue to rise while the price of wind power will stay the same. Thus, it is only a matter of time before wind power is completely competitive with fossil fuels. The barriers that currently restrain the development of the wind industry will become obsolete when wind power becomes less expensive than fossil fuels.

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