

**STATE AND LOCAL ISSUES FOR GREEN POWER: THE  
COMPLEXITIES INVOLVED IN FARMING THE WIND**

**FUNDAMENTALS OF GREEN POWER: A DEVELOPER'S  
PERSPECTIVE**

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**1. Introduction.**

This paper addresses big-picture issues surrounding green power development, focusing primarily on wind power. It is intended to introduce you to this "emerging" field of power generation<sup>2</sup> by giving you the lexicon of green power and wind power generation, a perspective for evaluating this important source of power generation, and the basics of wind power science and economics. This paper also discusses the current status of wind power development in the world and in Washington. And finally, it gives you a 10-step checklist for evaluating and developing a wind farm, all from a developer's perspective.

Because this paper is an overview of wind power development, it does not give you the details of state and/or local project permitting or a road map for navigating such a maze. That information is provided later in this chapter by the other authors. It is my goal in this subchapter to give you the basic tools and vocabulary to start a discussion about wind farms.

**2. Green Power-What Is It? Why Is It Relevant Today?**

**A. What Is It?**

Green power is electricity generated from renewable resources, including solar, wind, hydro, geothermal, and biomass. Because of this, green power has fewer environmental impacts as compared with traditional, nonrenewable based power sources. Many local utility companies now offer green power to their customers; to purchase it, consumers need only opt into a company's green power program. One drawback to these programs,

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<sup>2</sup> Although green power is often referred to as an emerging field of power generation, this form of power generation has been around for a very long time, going back to the earliest wind- and water-powered forms of power generation. It is called "emerging" because modern society is just now returning to these resources for its energy needs. It also is called "emerging" because green power generation technology, as it comes of age, is now able to compete economically with more entrenched, developed forms of power generation including coal, fossil-fuel fired, and nuclear power sources.

however, is that utilities typically charge more for green power than for power generated from traditional sources (*e.g.*, fossil fuel, coal, nuclear, etc.).<sup>3</sup>

The green power community claims there are two reasons utilities charge more for this energy. First, they claim that the "true" costs of traditionally generated power is not reflected in our utility bills, because the environmental and human health costs (*i.e.*, acid rain, pollution, increased human health effects, etc.) are not included in utility rates. Second, because green power generation technologies are still in their nascent stages, it costs more to produce as compared with "mature" forms of power generation, which have achieved economies of scale. This last factor is rapidly diminishing, however, as green power generation technology becomes more cost-competitive. For example, in the last two decades, wind energy generation costs have dropped approximately 80 percent, and this decline will only continue as this industry comes of age.

#### **B. Why Is It Relevant Today?**

Green power is relevant today because worldwide factors are affecting our local and national energy industries. In the United States, we currently generate electricity from the following sources:

- Over 50 percent is generated from burning **coal**. This typically costs approximately 4 to 6 cents per kWh<sup>4</sup> and is a relatively "dirty" fuel source, blamed for creating, among other pollutants, acid rain.<sup>5</sup>
- Approximately 20 percent of our power is generated by **nuclear power** plants, none of which have been built since 1978. Nuclear power costs approximately 11 to 15 cents per kWh.
- Another 15 percent is generated by **natural gas-fired** power plants, which costs approximately 4 to 4.5 cents per kWh. Natural gas-fired plants typically involve a turbine engine strapped to the ground, which, as it burns the fuel, turns an electric generator. In some, more modern "co-gen"<sup>6</sup> plants, the heat from the turbine is used to boil water, which in turn drives a steam turbine. This co-gen combination maximizes the energy potential from this fuel source. Even though natural gas is considered a relatively "clean" fuel source, it is subject to highly volatile price fluctuations, thereby undermining its desirability as a primary power generation resource.

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<sup>3</sup> Utilities typically charge approximately 1 to 2 cents more per kilowatt hour ("kWh") as compared with "traditionally" generated fuel sources, which, here in the West, may largely be generated by a green source, hydro. This extra charge translates to between \$5 to \$10 more per month for a typical residential consumer.

<sup>4</sup> All figures are 1996 levelized cost per kWh.

<sup>5</sup> This is the wholesale, not the retail, price for electricity paid by utilities to power producers under bulk, negotiated contracts called Power Purchase Agreements, or "PPAs".

<sup>6</sup> "Co-gen" refers to a generation facility that uses both the primary and secondary product from the fuel source to produce power. For example, in natural gas co-gen plants, the gas is burned to turn an electric generator and the waste heat is used to create steam, which is also used to turn an electric generator.

- Approximately 8 percent comes from **hydroelectric** generation. The price for hydro power fluctuates greatly, ranging from approximately 6 to 12 cents per kWh. As we well know in the West, this green power source has recently come under fire because of competing environmental concerns over fisheries habitat.
- **Oil-fired** power plants provide approximately 3 percent of our electricity needs. Oil has two main drawbacks: one, it is a relatively "dirty" fuel; and two, it is subject to highly volatile price fluctuations driven by worldwide events beyond our control.
- **Green power** (including wind, solar, geothermal and other sources, but excluding hydro) provides the remaining 3 to 4 percent of our power needs. This power costs approximately 4 to 6 cents per kWh without the production tax credit, or "PTC," and approximately 3 to 5 cents per kWh with the PTC.<sup>7</sup>

In the Northwest, we have a different mix. Locally, we receive nearly 54 percent of our power needs from hydro, 32 percent from coal, 8 percent from natural gas and oil combined, 3 percent from nuclear, and approximately 3 percent from green power sources.

Although the Northwest is blessed with a relatively abundant supply of green hydro power, it is not enough to meet our growing energy demands. Last year, the Northwest Power Planning Council forecast that by winter 2003, our region would need almost 3,000 megawatts ("MW") of new generation capacity. Without this, we would have to institute load reductions (i.e., conservation) to avoid an impending crisis of "generation insufficiency."

We are not alone in needing more power. On the national level, the Bush Administration is calling for approximately 1,900 new power plants to be constructed over the next 20 years. This translates into nearly two new power plants every week for 20 years—just to meet Bush's vision for our energy supply needs.

The problem is that, even assuming we needed that many more power plants because we cannot reduce consumption through conservation, we can no longer do business as usual. The collapse of Enron and the rapid decline in energy-company values highlighted the instability in existing energy pricing and supply systems. As the bottom fell out of energy, so did the economic impetus to build new generation capacity. Without this, companies simply are not building, or cannot build, new power plants, largely because they cannot obtain financing to do so.

Additionally, it is becoming more difficult for us to rely on traditional generation sources to meet our increased demand for power production. In the Northwest, we can no longer simply assume that cheap hydro power will meet our energy needs. The combination of

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<sup>7</sup> The PTC, first adopted in 1992, is set to expire on December 31, 2003. The PTC provides 1.7 cents per kWh tax credit during the first ten years of operation for each utility-scale wind turbine brought on-line before the PTC expires. The federal tax code also provides a five -year accelerated depreciation schedule for these machines.

recent dry winters reducing the snowpack and the listing of salmonoid species has undermined our ability to rely on hydro power. Natural gas-fired generation is also no silver bullet for our energy supply problems. This source is plagued by permitting obstacles, pipeline opposition, and pricing volatility, which eliminate it as the panacea for our region's power supply problems.

It is this combination of factors and a number of others—some psychological, some financial, and others technological—that makes green power attractive to developers and utility companies. Green power provides an alternative to these sources and enables generators to diversify their energy production portfolios.

Green power, and particularly wind power, meets the twin goals of producing power while enabling generators to be good stewards of our natural resources. Green power also makes financial sense today with the federal PTC. The PTC provides financial incentives to wind power developers by providing a 10-year federal tax credit in the amount of 1.7 cents per kWh for wind turbines brought on-line by the end of 2003.<sup>8</sup> Another factor favoring wind generation is technological advances which have dramatically increased production efficiencies while reducing the price per turbine; today, modern wind turbines can generate 1.5 MW or more per machine as compared to the .3 to .5 MW per machine generated by "old" turbines such as those originally installed at Altamont Pass in California. This combination of federal support and technological advances has made wind farming more relevant than ever.

### **3. Wind Power-How It Works; The Economics of Wind.**

#### **A. How Wind Farming Works.**

A schematic illustrating how wind power works is attached as Appendix 1.

Essentially, wind turns the turbine blades, which in turn rotate an electric generator housed in the "nacelle" (or generator housing), that sits atop a tubular steel tower mounted on a concrete foundation. Power generated by the spinning blade is transmitted down the inside of the tubular tower by cables leading to a pad-mounted transformer, which then feeds the electricity into a projectwide power collection system. This energy is transmitted to a project substation, where the voltage is stepped up for transmission on the regional power grid.

Although this sounds simple, modern wind turbines are state-of-the-art, computer-controlled machines. New turbines are highly efficient, capable of producing power even in relatively low-wind environments. This capability allows modern turbines to generate more-constant power, thereby increasing the overall output capacity. Modern turbine blades are made of lightweight materials and are computer-controlled to "feather" into the wind so as to maximize efficiency.

As a result, these turbines begin producing power at wind speeds of 9 to 10 miles per hour, reaching "rated" capacity at wind speeds of 27 to 35 miles per hour. Turbines

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<sup>8</sup> The PTC is set to expire at the end of 2003 unless it is renewed by Congress.

include numerous safety features, including computer-controlled braking systems that shut the machine down in excessively high winds (over 50 mph) and lightning strike protection systems to minimize fire risk and lightning damage. Typical turbines reach rated capacity approximately 30 percent of the time but, because of these advances, will produce power 60 to 80 percent of the time.

#### **B. The Economics of Wind.**

The energy that can be tapped from the wind—and thus the amount of power and revenue that can be generated—varies widely depending on the wind speed at a given project. As is the mantra in real estate, so is the mantra in wind farming: location, location, location.

Wind speed is so important because the amount of energy that can be produced is proportional to the cube of the wind speed. As a result, a slight increase in wind speed results in a large increase in power production, which in turn translates into greater revenue. For example, consider two wind farm locations, one with an average wind speed of 16 miles per hour and the other with average winds of 18 miles per hour. Using the exact same machines, and all other things being equal, **a two-mile-an-hour increase in wind speed translates into a nearly 50 percent increase in energy production.**

Other factors contributing to the economics of wind are turbine size, turbine efficiency, economies of scale, financing, and the availability of the PTC. When it comes to wind, size does matter. A fivefold increase in rotor diameter translates to a **55-fold** increase in yearly electric output, partly because the blade-sweep area is 25 times larger (therefore being able to capture more energy), and partly because wind speeds increase as you move higher from the ground. Modern turbines are also more efficient than older models, being capable of generating 120 times more energy at only 20 times the cost. As with so many other industries, economies of scale apply to wind farming. A 51-MW wind farm will produce electricity 40 percent more cheaply as compared to a 3-MW wind farm operating in exactly the same conditions because costs can be better spread over the larger project. And last, because wind farming is highly capital intensive, the availability and cost of financing, along with the availability of the PTC, both play a large role in wind farm economics, because these factors affect the developer's cost of money. Although this may seem insignificant, it is not. Money costs can add up to 30 percent to the levelized project costs, thereby creating major disincentives for wind power development. Likewise, without the PTC, some projects become unfeasible.

### **4. The Current Status of Wind Power Generation.**

#### **A. Worldwide.**

Recently, wind power development has exploded worldwide. In 2002, 6,868 MW of new wind power capacity was installed around the world. This is a 28 percent increase in one year, worth some \$7.3 billion.

With this addition, there is now approximately 31,000 MW of wind power capacity worldwide, enough to power 7.5 million U.S. homes.<sup>9</sup>

2002's explosive growth represents the continuation of a trend. Wind power capacity quadrupled worldwide between 1997 and 2002, growing from 7,600 MW to more than 31,000 MW. This makes wind power development the fastest-growing green power sector, with a yearly average increase of 32 percent between 1998 and 2002.

Although wind power development is happening around the world, most of the development is in Europe and the United States. In 2002, 93 percent of the new capacity developed occurred in Europe and the United States. This makes sense because ninety percent of the world's wind power projects are in these two areas. In the United States, wind energy grew by 10 percent in 2002. If this trend continues, wind energy could provide over 6 percent of our country's power needs by 2020.

The five countries with the most installed wind power capacity are:

- Germany with over 12,000 MW;
- Spain with approximately 4,830 MW;
- United States with 4,685 MW;
- Denmark with 2,880 MW; and
- India with 1,702 MW.

Wind energy power currently provides 2 percent of Europe's energy. With more political and economic support, wind power could provide 12 percent of the world's energy needs by 2020.

#### **B. In Washington and the United States.**

Wind farming is thriving in Washington. The American Wind Energy Association (the "AWEA") estimates that there is currently 228.2 MW of installed wind capacity in Washington.<sup>10</sup> Washington is currently home to a portion of the world's largest wind farm<sup>11</sup>—FPL Energy, Inc.'s 300-MW Stateline facility—and this facility is slated for further expansion.<sup>12</sup>

Additionally, there are numerous other projects in various stages of planning and development. For example, two projects are currently in the permitting pipeline: *enXco's* 180-MW Desert Claim Wind Power Project and Zilkha Renewable Energy's 181.5 MW Kittitas Valley Wind Power Project, both in Ellensburg. *enXco* is going through Kittitas County's permitting process while Zilkha is seeking permits from the state, through the Washington Energy Facility Site Evaluation Counsel ("EFSEC").

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<sup>9</sup> This figure more than doubles to 16 million when it is applied to European homes, which apparently use far less energy than U.S. homes.

<sup>10</sup> See [www.awea.org/projects/washington.html](http://www.awea.org/projects/washington.html).

<sup>11</sup> As its name implies, the Stateline Project is located in both Washington and Oregon.

<sup>12</sup> This may soon change if an Iowa utility, MidAmerican Energy, completes its proposed 310-MW project.

The AWEA estimates that another 439.6 MW of wind energy capacity is planned for development in Washington. When you add in *enXco's* 180-MW Desert Claim Wind Power Project, this figure rises to 619.6 MW.

The AWEA also estimates that there is the potential to develop some 3,740 MW of wind energy capacity in our state. Although this may seem large, Washington ranks only 24<sup>th</sup> in wind energy capacity in the United States, with the following 20 states having the greatest potential wind energy capacity<sup>13</sup>:

1. N. Dakota – 1,210	6. Nebraska – 868	11. Colorado – 481	16. Illinois – 61
2. Texas – 1,190	7. Wyoming – 747	12. New Mexico—435	17. California – 59
3. Kansas – 1,070	8. Oklahoma – 725	13. Idaho – 73	18. Wisconsin – 58
4. S. Dakota – 1,030	9. Minnesota – 657	14. Michigan – 65	19. Maine – 56
5. Montana – 1,020	10. Iowa – 551	15. New York – 62	20. Missouri – 52

Maps showing the location of a state's wind resources can be viewed at [windpowermaps.org](http://windpowermaps.org).

##### **5. Ten Steps for Developing a Wind Farm—A Developer's Perspective.**

The AWEA provides the following 10-step checklist for developing a wind farm:

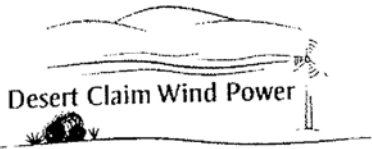
1. "Understand Your Wind Resource." This is the golden rule of location, location, location. For a site to even be considered, it must have "commercially viable wind"—in other words, the site must have average wind speeds of at least 11 to 13 miles per hour.
2. "Determine Proximity to Existing Transmission Lines." Again, location, location, location. The cost and permitting constraints of constructing new power lines will kill most wind projects. To be viable, the site must have ready and cheap access to regional power transmission facilities that can deliver the energy produced by the project to market.
3. "Secure Access to Land." Developers need land to construct turbines. Land access can be gained through long-term leases and/or easements. Assembling a few landowners with large holdings is often easier than assembling many owners with small lots.
4. "Establish Access to Capital." Wind farming is not cheap—turbines cost more than a million dollars on average—and access to capital may be difficult to

<sup>13</sup> Measured in potential annual energy output in billions of kWh's and factoring in constraints such as environmental and land use issues. For more information, see [www.awea.org](http://www.awea.org).

- secure. To do this, the project must achieve economies of scale, often requiring projects to be 20 MW or greater in size. Another key is to sign a PPA with a utility, thereby guaranteeing an income stream from the project that will make it easier to obtain debt financing.
5. "Identify Reliable Power Purchase or Market." Again, securing a PPA will increase the chances for success of a project.
  6. "Address Siting and Project Feasibility Considerations." Just because a site is windy does not mean it is a great site for a wind farm. Developers should be sensitive to local land uses and strive to site projects in areas where wind farming is more compatible with established patterns of land use. For example, siting wind farms on active agricultural land can achieve a win-win by providing subsidies to farmers, thereby enabling them to sustain their ongoing operations.
  7. "Understand Wind Energy Economics." Successful developers, and their counsel, must understand the science, economics, and politics of wind farming.
  8. "Obtain Zoning and Permitting Expertise." As with all matters of land use, competent counsel can be the key to success. For wind farming, this often requires a knowledge of the codes and local politics.
  9. "Establish Dialogue with Turbine Manufacturers and Project Developers." Different sites require different technology. Some machines are better suited for one climate/site as compared with another.
  10. "Secure Agreement to Meet Operation and Maintenance Needs." Wind farming does not stop at permit issuance. Wind farms require professional, ongoing Operation and Maintenance expertise to be successful.

*Sources:*

McMahan, Timothy L., *The Alternative Energy Revolution: The Promise of Wind Power*  
American Wind Energy Association, [www.awea.org](http://www.awea.org). Various fact sheets.  
Desert Claim Wind Power Project application.



Kittitas County, Washington

# HOW WIND ENERGY PROJECTS WORK

