
POISED FOR PROFIT II:
WIND POWER PROSPECTS

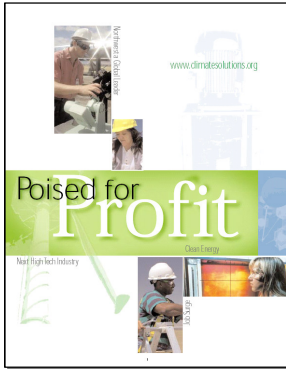
**Preliminary Findings
Official Progress Draft
April 25, 2003**

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PREFACE

POISED FOR PROFIT: PROMOTING A NORTHWEST CLEAN ENERGY INDUSTRY



In 2001, eight economic development and energy agencies from Oregon, Washington, and British Columbia commissioned a study: *Poised for Profit: How Clean Energy Can Power the Next High-Tech Job Surge in the Northwest*. The resulting report revealed that the clean energy sector could be twice the size of the aircraft industry within 20 years. What's more, it could generate tens of thousands of new jobs. That first report is available at www.climatesolutions.org in the publications section.

A new partnership has come together to fund follow-on research to support a world-class clean energy industry in the Northwest. Poised for Profit II, launched in November 2002, is producing a series of reports containing critical information for investors, entrepreneurs, and policymakers. These tools include:

- Research and analysis to pinpoint the biggest and best opportunities
- Surveys of investor and utility plans
- Directories to research reports, related companies and helpful programs, grants and support services.

This document is part of a research module called the Preliminary Analysis of Near-Term Opportunities. It reports on wind energy. Other documents in this module cover near-term prospects in solar, fuel cells and Smart Energy.

ACKNOWLEDGEMENTS: SPECIAL THANKS TO OUR STEERING COMMITTEE

The Athena Institute would like to recognize the following companies and individuals for their direct contributions to the Poised for Profit initiative in general and this report in particular.

Climate Solutions for conceiving and catalyzing the project and providing oversight, with special thanks to Rhys Roth.

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The co-funders and members of our Steering Committee, who provide initial research targets, plus ongoing advice and assistance. In alphabetical order:

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INTRODUCTION AND EXECUTIVE SUMMARY

Can wind energy provide near-term jobs and growth for the Pacific Northwest?

This document presents preliminary findings, divided into four sections:

1. **Market Overview**, in which we describe the industry's structure and the forces that serve to promote or retard its growth
2. **Market Potential**, in which we explain the possibilities for economic development and project future growth
3. **Regional Assets and Challenges**, in which we review the Northwest's strengths and weaknesses
4. **Regional Opportunities**, in which we provide a brief summary of economic development prospects

Our conclusions and recommendations will be provided to the Steering Committee in a separate document.

What is a “near-term opportunity?” As used in this report, it refers to a market niche that can generate hundreds of high-quality jobs within the next three to five years. In addition, that niche must create significant export opportunities, significant growth prospects for current companies and significant reasons for “latent entrepreneurs” to start related businesses.

Important Note: Do not confuse wind's value as an economic development opportunity with its value as an energy source. The two issues are separate. Whether or not wind power develops into a regional cluster like software and semiconductors, it should (and will) play an important role in generating clean, renewable energy for the Northwest.

EXECUTIVE SUMMARY:

STRONG GROWTH, BUT EUROPE GETS MUCH OF THE ECONOMIC BENEFIT

The following paragraphs give a quick scan of our findings. You will find a detailed discussion of each point in the pages that follow.

The wind industry is mature, vertically integrated and dominated by Europe. Large, vertically integrated European companies get roughly 85% of all wind power revenues. With well-established European supply chains and with most installations taking place in Europe, these companies have little reason to look to the Northwest for components or systems.

The wind industry has many factors in its favor. Wind energy is a clean, renewable resource. It is a proven technology that continues to undergo incremental

improvement. Equally important, the cost of wind energy is roughly comparable to traditional power plants. Numerous government incentives are in place to accelerate growth. The issue is not whether it will grow, but how fast.

Issues remain that could slow progress. The federal government's now-you-see-it-now-you-don't Production Tax Credit has led to boom/bust cycles and investor caution. Compared to natural gas plants, wind farms cost more to build (but less to operate). Wind is intermittent, requiring use of the grid as a "battery." Not all regions have good wind resources. The best sites are often far from population centers, making it expensive to get the power where it's needed.

Wind produces more jobs and economic development benefits than traditional power plants, but those benefits often flow to distant regions. The biggest benefits come from turbine manufacture, most of which occurs in Europe. All of the existing U.S. assembly plants are far from the Northwest.

The overall wind energy business is at least \$4B today and will grow to \$30B by 2012, with the lion's share to Europe. Although some analysts predict a market as large as \$50B by 2012, the Athena Institute believes the actual figure will be closer to \$30B. Even that smaller figure represents meaningful growth. Most of that growth, however, will occur in Europe, which claims 85% of the manufacturing and 75% of the installations.

The Northwest has modest wind power assets. The Northwest has a few small research programs and a wind-friendly attitude. None of our assets provides a significant economic development advantage. Our best opportunity is the small turbine segment, which is, however, a minor market with little revenue and little economic development potential.

The Northwest faces challenges. Our wind farming potential is small compared to states such as Montana, Texas and the Dakotas. Other hurdles include the lack of major market players, the lack of Renewable Portfolio Standards and poor access to the best markets.

The Northwest has no existing wind concentrations or clusters. Although the Northwest has several important wind farms, those scattered operations do not constitute a cluster opportunity. The region currently has none of the characteristics of an emergent cluster. Wind power is likely to become a significant Northwest industry only through an unexpected event, such as a breakthrough by a regional startup or the relocation of a major company.

MARKET OVERVIEW

This section provides a brief overview of wind energy and the industry that has grown around it. It then examines the market drivers and market barriers that will influence its growth.

BASICS:

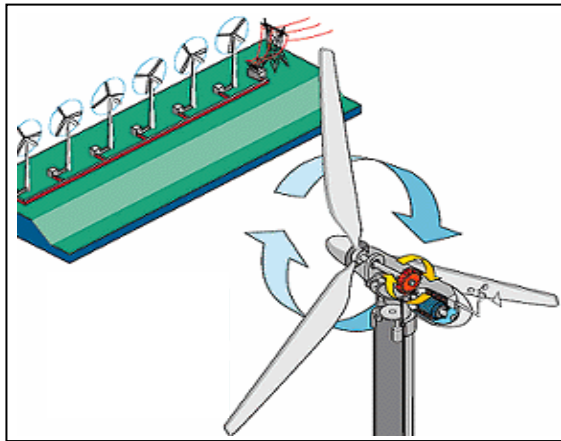
WIND TURBINES AND WIND FARMS

The *wind turbine* is the basic device for converting wind into electricity. (See Figure 1.) Propeller-like rotors on a tall tower turn the wind's force into rotational energy. A gearbox transforms that rotation into faster speeds for a generator. Many turbines also have systems for speed control, positioning, braking, blade angle and emergency shutdown.

Figure 1
A wind turbine

Rotors translate the wind's energy into rotational force, which spins a generator to produce electricity. Most wind turbines are found in large wind farms that feed power into the transmission grid.

Source: DOE Wind Energy Program



The electricity from the generator is conditioned by power electronics and then is typically fed to the power grid. The electricity can also be used directly (to pump water, for instance) or stored in batteries.

Small-scale turbines generate less than 50 kW. Today's small wind turbines are highly efficient and designed for a 20-40 year life span. They are typically used in rural and remote settings for off-grid power.

Utility-scale turbines generate more than 50 kW -- usually far more. Today's utility-scale turbines are highly reliable. Their size and efficiency have increased steadily. Most current models fall in the 500 kW to 2000 kW (2 MW) range. The trend is toward larger, taller turbines with ever-greater efficiency (and, therefore, a lower cost of power). GE Wind Energy is already shipping a 3.6 MW model and several companies are prototyping 5 MW versions for off-shore wind farming.

Wind farms group together tens or hundreds of utility-scale turbines to generate bulk electrical power. (See Sidebar 1.) Electricity is fed into the local grid and distributed to customers just as it is with conventional power plants. The power generated by a turbine varies by the cube of the wind speed. A site with twice the wind speed generates roughly eight times the power -- a fact that helps to explain the growing interest in off-shore sites, since wind speeds over the ocean average 30-50% higher than on land.

Sidebar 1 -- Stateline Wind Farm Ranks as World's Largest



January 23, 2003. The Stateline Wind Project along the Oregon-Washington border has surpassed a Texas wind ranch to become the world's largest.

The Stateline project added 37 MW of wind power in 2002, pushing it past the 278-MW King Mountain Wind Ranch in Texas. At 300 MW capacity, Stateline creates enough electricity to power 70,000 households.

Stateline is about 20 miles north of Pendleton, OR. It is owned by FPL Energy, a subsidiary of Florida Power & Light Co. The power is marketed by PPM Energy, part of the PacifiCorp organization.

**VALUE CHAIN:
FROM COMPONENTS TO MANUFACTURE TO WIND FARM DEVELOPMENT**

The wind power industry value chain is relatively straightforward (see Figure 2):

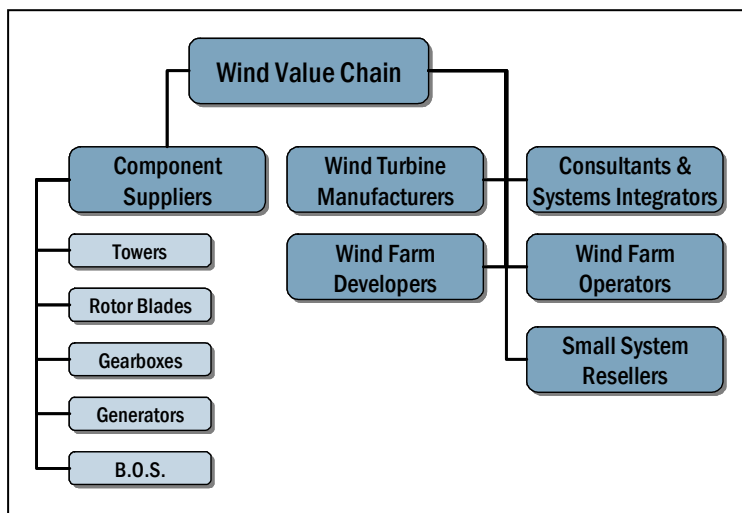
- Component makers produce the individual parts
- Manufacturers assemble complete systems
- Consultants study, design and site wind farms
- Developers assemble the land rights, the financing and the installation crew
- Operators maintain wind farms, often making lease payments to landowners
- Small system resellers supply small-scale turbines for rural and remote uses.

Figure 2
The Wind Power Value Chain

The wind industry has a high degree of vertical integration. Many companies manufacture components, *and* assemble turbines, *and* develop wind farms.

B.O.S. stands for *balance of system*, which is comprised mostly of power electronics and connections.

Source: The Athena Institute



Most of the cost of a wind farm is in the turbines, as shown in Table 1 at right. This is an important point to remember for our discussion of economic development. These installation costs have a rough correlation to the economic benefits from different parts of the value chain. Although there is not a direct, one-to-one relationship, the relative importance remains the same. Turbine manufacturers receive the majority of the initial revenue. The regions that host the manufacturing receive the majority of the economic benefits.

TABLE 1 -- TYPICAL WIND FARM COST BREAKDOWN

Component	Percent
Turbines	71.0%
Grid Connection	7.5%
Miscellaneous	7.0%
Internal Grid	6.5%
Foundations	5.5%
Engineering/Admin	2.5%

Renewable Energy World, April 2003

The wind power industry has already undergone considerable consolidation. Giant companies dominate. Five companies own 75% of the market. (See Table 2.)

TABLE 2 -- TOP 10 WIND TURBINE VENDORS

	Vendor	% Share	Headquarters
1.	Vestas	24.1	Denmark
2.	Enercon	15.3	Germany
3.	NEG Nicon	12.8	Denmark
4.	GE Wind Energy	12.7	United States
5.	Gamesa	9.5	Spain
6.	Bonus	8.7	Denmark
7.	Nordex	6.7	Denmark/Germany
8.	Made	2.8	Spain
9.	Mitsubishi	2.6	Japan
10.	REpower	1.9	Denmark

Source: BTM Consult World Market Update 2001

What's more, the industry is vertically integrated to a high degree. Large wind turbine companies such as Vestas are active in virtually all segments, from R&D to manufacturing to distribution to installation. This vertical integration makes it harder for small companies and startups to find a niche.

MARKET DRIVERS: CLEAN, COST COMPETITIVE AND SUPPORTED BY PUBLIC POLICIES

We note at least seven drivers at work in this market. In approximate order of importance, they are:

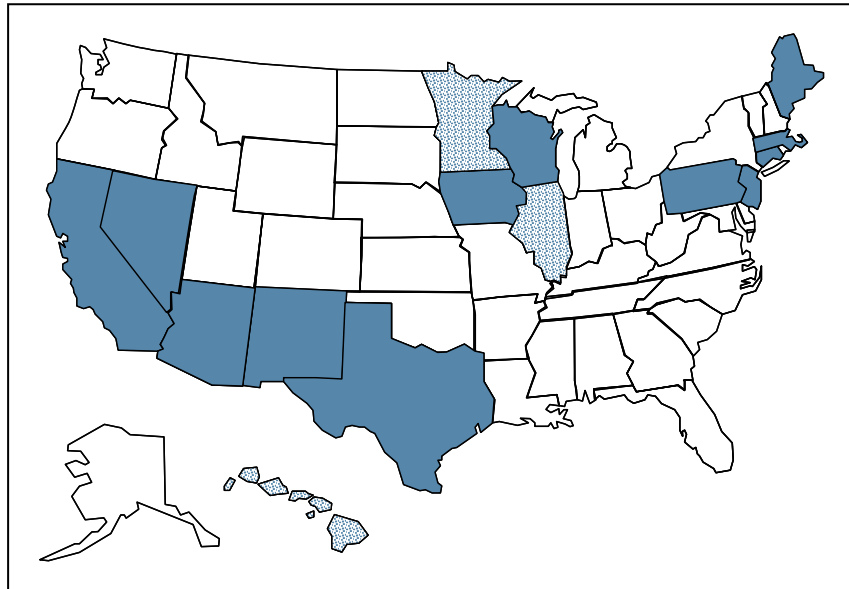
Wind is green and clean. Wind power is renewable and emits no greenhouse gases. According to DOE calculations, a 50 kW turbine produces about 120 kWh per year, avoiding roughly 91 tons of carbon dioxide that would have been produced by a fossil-fuel plant.

Public policy supports wind power. Thanks to its potential to reduce emissions, wind power has been greatly advanced by government policies in the U.S. and abroad. The most important program is the *Renewable Portfolio Standard* (RPS). Currently, most European nations and more than a dozen states have an RPS in place or due soon. (See Figure 3.) This quota requires utilities to get a certain percentage of their power from renewable sources. Since wind is the most economical renewable, it gains the most from these standards. Wind is often the only cost-effective option.

Figure 3
Renewable Portfolio
Standards

More than a dozen U.S. states have renewable portfolio standards or renewable portfolio goals. These quotas require utilities to purchase a certain percentage of their power from renewable sources. They provide a powerful incentive for wind power production.

Source: www.dsireusa.org



Wind has also benefited from substantial tax credits and incentives. Most developed countries and most states have one or more incentives in place, including grants, rebates, tax credits, tax exemptions and low-costs.

Important: Public policy incentives are a double-edged sword. As discussed later, they can distort or discourage a market if they are designed incorrectly or withdrawn suddenly.

Wind is becoming cost competitive. The cost of producing electricity from wind has declined by more than 80%, from about 38 cents per kilowatt-hour in the early 1980s to a current range of 4-6 cents/kWh (leveled over a plant's lifetime). In the not-too-distant future, costs could fall even lower than conventional sources, reaching an unsubsidized cost of 2.5 cents/kWh.

When you look at the world like an economist and you consider *all* the costs, alternative energy sources begin to look much better. If you add together both generation costs and external costs (such as pollution), wind power is already competitive with traditional sources, as shown in Table 3 below. However, current regulations do not consider all costs. In fact, many existing policies create a subsidy effect for coal and nuclear generation.

TABLE 3 -- COSTS OF GENERATION TECHNOLOGIES BEFORE TAX CREDITS

Technology	Generation Costs Cents/kWh	External Costs* Cents/KWh	Gen. + Ext. Low Estimate**	Gen. + Ext. High Estimate**
Coal	3.11 - 3.41	1.94 - 14.6	5.05	18.01
Nuclear	3.31 - 5.74	0.19 - 0.58	3.50	6.32
Gas Turbine	2.54 - 3.41	0.97 - 3.89	3.51	7.30
Good Wind Site	5.84	0.05 - 0.24	5.89	6.08
Optimal Wind Site	3.89	0.05 - 0.24	3.94	4.13
Solar PV	30 - 80	n/a	n/a	n/a

As cited in Johnson 2002 EIA, Wind Power Monthly

*External costs include negative effects such as pollution and greenhouse gases

**Right-most columns combine cost of generation with cost of negative externalities

Even without factoring in external costs, wind is cost competitive in regions with higher-than average energy costs. Tax credits can make wind's position even better. The federal Production Tax Credit equates to approximately a 1.1 cent/kWh reduction. State and local tax credits can also be significant, sometimes reducing the cost of wind energy by another 0.5 cents/kWh.

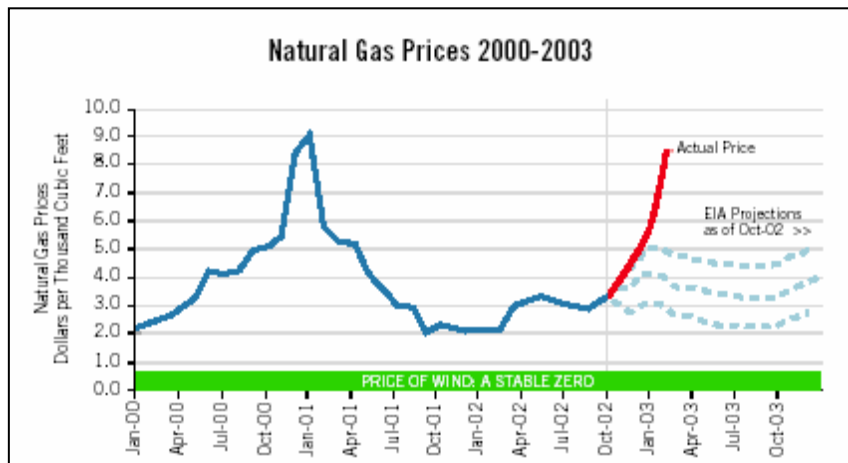
Wind power is relatively fast and easy to install. It can be difficult to find an appropriate site for a wind farm, as discussed below under market barriers. But once a site has been approved, it is relatively quick and easy to get a wind farm up and running.

Wind diversifies a utility's power mix. Just as pension funds need to diversify their investment portfolios, utilities need to diversify their power portfolios. Wind is a stable, mature, predictable power source. It provides a valuable hedge against uncertainty when included in a portfolio with other generation sources. Hydropower, for instance, has seasonal and annual variations. Natural gas, to name another example, is subject to swings in fuel prices. (See Figure 4.) Wind provides a hedge against such volatility. One study estimated this hedge value is worth a half cent per kWh to the average utility. Although wind has its own risks, it should be part of a well-balanced portfolio.

Figure 4:
Volatile Natural Gas Prices

Many utilities use gas-fired turbines to produce electricity. Natural gas prices fluctuate wildly, as seen at right. Wind power costs are stable and predictable. They provide a valuable hedge against this uncertainty.

Source: Lawrence Berkeley Labs



Wind power has special benefits for economically depressed rural areas. Wind turbines co-exist nicely with grazing and agricultural uses, allowing farmers to add a new source of income (lease payments from wind developers) while continuing their traditional activities. Wind power can provide a welcome income stream and improved tax base to struggling rural communities. In many cases, they can be sited on land of marginal value.

Large players have validated the market. In the past three years, the wind power category has been further legitimized by the entry of General Electric into the market (via purchase) and the gradual but continued expansion of large European players into the U.S.

**MARKET BARRIERS:
UNSTABLE POLICIES, SITING CHALLENGES AND INSTALLATION COSTS**

Despite the good news and positive trends, the wind power market also faces challenges. In approximate order of magnitude, they are:

The absence of a stable national policy. The uncertainty around national policy presents a major challenge to the American wind energy industry. The 1992 wind

energy production tax credit (PTC) provided a 1.5 cent-per-kilowatt-hour credit (adjusted for inflation). The PTC has been extended twice over the past five years, but each time Congress allowed the credit to expire before acting. The federal wind energy production tax credit expires again on December 31, 2002. At this point it is unclear whether a national energy bill will make it through Congress. If it does pass, a five-year extension of the credit is likely, but not guaranteed.

This on-again, off-again uncertainty creates a boom/bust mentality and scares away many investors. Likewise, the current debates over deregulation, regional transmission organizations and standard market design create a chaotic climate for all types of energy, wind included. This chaos has led many energy investors to stay on the sidelines.

Siting challenges make it difficult to get wind farms approved and running. A wind farm location must meet several tests. First and most obviously, it must have high wind speeds year round. Second, it must be near the end users or near transmission lines. (The high cost of connecting a remote wind farm to the grid can make a site unviable.) Third, it must meet a variety of environmental constraints, especially since the better sites are often in areas of natural beauty. Even in urbanized areas, today's NIMBY atmosphere (Not In My Back Yard) often makes it virtually impossible to construct tall wind turbines or high-voltage lines to carry the power to where it is needed.

High installation costs. It typically costs twice as much to install a wind farm compared to a gas turbine producing comparable power, as shown in Table 4 at right. Once installed, the "fuel" is free, and the wind farm gradually pays for itself. Despite the eventual payback, many locales are not in a position to pay the higher up-front cost. Wind farms are cash intensive at a time when countries, companies and utilities are cash poor.

TABLE 4 -- INSTALLATION COSTS

Technology	Installation Cost \$/Watt
Coal	1.0 - 1.3
Nuclear	1.2 - 2.0
Gas Turbine	0.5 - 0.7
Wind	0.8 - 2.0
Solar PV	6.0 - 8.0

Renewable Energy World, April 2003

Intermittent production. It is impossible to predict how much electricity a wind farm will produce on any given day. Sometimes the wind farm's peaks and valleys coincide nicely with power needs. Other times and other places, the match is not as good. Utilities must use other power sources to make up for wind's variability, creating significant challenges for certain regions at certain times of the year.

Utility turmoil and barriers. Wind growth slowed in 2002 not only because of the tax credit issue, but also because of the upheaval in the electricity sector. The result was a slowing of all forms of power production, including wind. What's more, some utilities still make it difficult for wind farms to interconnect to the grid or to use the grid as a "battery." They often exact a steep penalty to account for wind's variability -- even if that variability doesn't cause problems for their particular system.

MARKET POTENTIAL

This section outlines the prospects for the global wind industry and concludes with comments on its economic development implications.

MARKET PROJECTIONS: RAPID GROWTH WITH THE LION'S SHARE TO EUROPE

Global wind power capacity has quadrupled over the past five years, growing from 7,600 MW at the end of 1997 to more than 31,000 MW at the end of 2002 -- enough to power 7.5M American households. Wind is the world's fastest-growing energy source, with installed generating capacity increasing by an average 32% annually for the last five years. (Source: American Wind Energy Association.)

U.S. wind farms stand at 6,000 MW of installed capacity, enough to power 1.5M American households. U.S. wind capacity expanded by nearly 10% in 2002. The growth was down sharply from 2001. The AWEA blames the uncertainty around the Production Tax Credit for the slowdown.

Despite its rapid growth, wind still provides only a tiny fraction of the world's total energy. Consultant and former Shell International Renewables director Peter Langcake estimates that wind produces 0.2% of today's global electricity. Clearly, there is plenty of room for expansion. Most experts predict annual growth of 25% or more for the next decade. The IC2 Institute at the University of Texas estimates the worldwide market will reach \$18.2B worldwide by 2010, \$4.4B of which will be in the U.S. (See Table 5.)

**TABLE 5 --WIND POWER
2002-2020 (BILLIONS)**

	2002	2010	2020
World	4.2	18.2	112.7
U.S.	1.0	4.4	27.1

IC² Institute, November 2002.

Other sources are even more optimistic. The European Wind Energy Association estimates the global wind power market will reach \$25B per year by 2010. The Business Communications Co research firm believes the global wind industry was worth \$5.5B in 2002 and predicts it will grow to \$6.7B in 2003 and \$16.1B in 2007 -- an annual growth rate of 24%. The Clean Edge consulting firms agrees that the global market was \$5.5B in 2002 and predicts it will grow to \$49B by 2012.

At the Athena Institute, we are less optimistic about wind's long-term growth. We concur with the Energy Information Administration Annual Energy Outlook for 2003, which concluded that "mid-term prospects for wind power . . . are uncertain, depending on future cost and performance, transmission availability, extension of

the production tax credit . . . and environmental preferences.” Shortly after the publication of that study, Denmark provided a case in point. Long the world’s number one proponent of wind power, the country announced it was scaling back its ambitious plans and now expects to build far fewer wind farms in the future.

Denmark discovered what many other regions may also figure out -- that it can be 5-50 times cheaper to reduce carbon through sequestration than through alternative energy. Put simply, it is much cheaper to plant some trees (or to pay a developing country not to cut them down) than to replace fossil fuels with alternative energy. Likewise, it is also much cheaper to avoid carbon by using less energy through energy efficiency products and practices.

Although we believe wind power will experience excellent growth, we doubt that it can sustain 25% expansion year over year for an entire decade. We predict that the overall market will be \$30B by the end of 2012.

Europe Dominates Both Production and Consumption

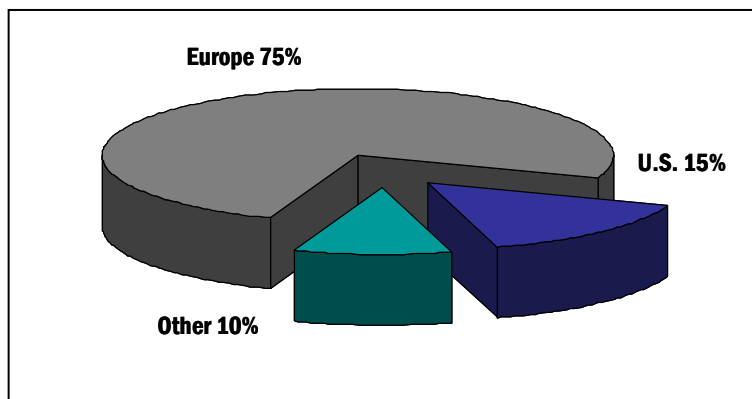
Regardless of the exact market size, it’s important to realize that Europe dominates both production and consumption. European companies own roughly 85% of the market. The U.S. has only one of the top 10 wind turbine vendors, California-based GE Wind Energy with approximately 12% of the global market. (See Table 2, page 9.)

Europe dominates the consumption side as well. Seventy-five percent of the world’s wind power is generated in Europe, and the region continues to grow much faster than the U.S. In 2002, European countries installed 5,871 MW (worth \$6.2B), growing its total capacity 33% to 23,056 MW. By contrast, the U.S. grew only 10%, adding 410 MW to reach a total of 4,685 MW. Today, both Germany and Spain generate more wind power individually than all of the U.S. combined. (See Figure 5.)

Figure 5

Europe generates 75% of the world’s wind power, and its lead over the U.S. is growing every year.

Source: AWEA



Small-scale turbines

The figures above represent utility-scale turbines. Small-scale turbines shipped about 13,400 units in 2001 with a cumulative value near \$20M, according to the AWEA. Those shipments brought the installed base to about 150,000 units. American companies are the leaders in small-turbine technology and installations (though none of the national leaders is based in the Northwest). We expect growth of 20% or more for this segment over the next five years. However, this growth is on such a small base that it still does not constitute a significant opportunity.

ECONOMIC DEVELOPMENT: WIND'S POTENTIAL DEPENDS ON THE REGION

Wind power has significant economic development potential, especially when compared to power from fossil fuels. One study conducted by the New York State Energy Office found that wind energy generated 27% more jobs than the same amount of energy produced by a coal plant and 66% more than a natural gas power plant.

According to the IC2 Institute at the University of Texas, one MW of installed wind power creates jobs for 15-19 people. As shown in Table 6, this may result in 1.5M new jobs worldwide between now and 2020.

TABLE 6 -- WIND EMPLOYMENT POTENTIAL TO 2020

	Avg. New Jobs Per Year	Total New Jobs by 2020
World	83,756	1,507,600
U.S.	20,162	362,917

IC² Institute

However, *the jobs and the economic benefits do not necessarily stay in the region where the wind farm is built.* The best jobs and largest revenue streams often flow to other areas.

Table 7 describes the typical economic benefits and where those benefits flow. As you can see, the Northwest gets little profit from manufacturing or wind farm development, because those activities are headquartered in other regions. The Northwest does receive short-term construction jobs, long-term maintenance jobs and land lease payments. On the plus side, most of these benefits occur in rural areas, where economic development is needed most. (See Sidebar 2, page 18.)

TABLE 7 -- WIND POWER ECONOMIC BENEFITS

Type	Description	Northwest Impact
Manufacturing	Excellent family-wage jobs	European manufacturers build roughly 85% of all turbines. Some have U.S. plants, but they are in areas such as Illinois, North Dakota and California.
Consulting	High-skill, high-pay	Very few jobs overall. Kirkland, WA, is home to a leading firm.
Wind Farm Development	High-risk, high-reward	High revenue streams, but few jobs overall. Firms outside the region develop almost all existing and planned Northwest wind farms.
Construction	Typically lasts less than one year	Short-term benefit. Often goes to rural areas most in need of jobs.
Operations / Maintenance	Family wage jobs.	2-5 permanent jobs per 100 MW.
Land Lease	\$1,000 to \$2,500 per MW per year	Can provide much-needed additional revenue to farmers.
Property Taxes	~ \$10 annually per \$1,000 investment	Some areas provide property tax relief to spur development.

National Wind Coordinating Committee

Construction jobs and lease payments are very welcome, but they do not constitute a concentrated cluster. A cluster has a high multiplier effect, since the core industry attracts suppliers, service companies and capital. The only significant wind power clusters are in Denmark and Germany.

Sidebar 2 -- Kittitas Wind Farm Could Bring Economic Benefits



A recent study concluded that wind farms could bring substantial economic benefits to central Washington's Kittitas county. Operating under the assumption that 265 turbines would be built, the study concluded the construction phase would bring 185 short-term jobs and \$12M in income. Operations and maintenance would provide 53 long-term jobs and \$4M per year (counting an estimated \$1.2M per year in lease payments to landowners). Property tax revenue would come to nearly \$3M per year.

A recent study concluded that wind farms could bring substantial economic benefits to central Washington's

Kittitas County is a prime spot for wind farms. The area is windy and is crossed by several high-voltage transmission lines, making it easy to connect the power into the grid.

The study also concluded the proposed turbines would not negatively impact property values. Even so, the project has drawn the wrath of a group of residents who don't want a wind farm in their backyard. A judge recently lifted an injunction against wind development, and two companies have formally filed permits to begin construction

Source: ECONorthwest, *Economic Impacts of Wind Power in Kittitas County*, Oct. 2002.

REGIONAL ASSETS AND CHALLENGES

When it comes to developing a vibrant industry cluster, the Pacific Northwest has only modest assets and several significant challenges. (We emphasize that we are speaking of wind's importance to economic development, not of its importance as an energy source.)

ASSETS:

WIND-FRIENDLY, MODEST RESEARCH, SOME EXPERIENCE

The Pacific Northwest has only a few advantages that contribute to wind's economic growth potential.

Wind-friendly Utilities, Consumers and Policy Makers

Northwest utilities are generally favorable toward wind power -- or, at least, less reluctant than utilities in some other parts of the country -- and willing to add it to their portfolios. (See Sidebar 3.)

Sidebar 3 -- Puget Sound Energy Experiments with Wind Power

Bellevue, WA, April 1, 2003. Puget Sound Energy, Washington's largest utility, made its first-ever commitment to renewable energy when it signed a one-year contract for wind power generated by the Stateline Wind Farm. (See Sidebar 1, page 8.) The Bellevue-based utility plans to buy roughly 7 MW of wind power, enough to supply the energy needs of about 7,500 households.

The utility's goal is to meet 5% of its needs with renewable energy by 2013. That number could grow to 10%, depending on this experiment. "This is really our first hands-on experience with wind," Charlie Black, told the *Puget Sound Business Journal*. Black is the head of PSE's resource planning group. "This will allow us learn how to integrate that resource into our portfolio."

Northwest consumers are generally "green-conscious" and the region boasts a long list of green power, wind power, rural power and sustainable development groups, associations, alliances, coalitions and initiatives. These efforts are dedicated to the advancement of wind and other renewable energy sources. (*Note:* many of these programs apply to small-scale installations and rural development. While laudable, these programs have little impact on the creation of a viable industry cluster.)

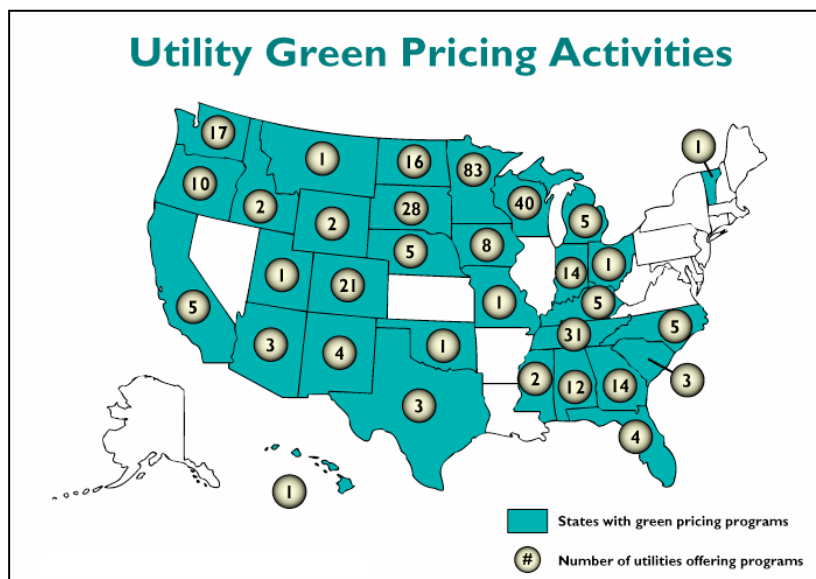
Washington and Oregon offer both tax incentives and net metering for alternative energy such as wind. In addition, both states have some form of green power marketing allowing consumers to buy alternative energy at a small premium. Typically, consumers can buy power from renewable sources for 1 cent more per hour, or \$7 to \$8 per month. Many utilities have green power programs in place already. (See Figure 6.) Consumers not served directly by their utility can

accomplish the same thing using a “Green Tag” program sponsored by the Bonneville Environmental Foundation.

Figure 6
Northwest Green Power
Alternatives

The Northwest is a national leader in green pricing activities by utilities. In addition to the official utility programs, Northwest consumers benefit from the Bonneville Environmental Foundation’s Green Tag program, which extends the concept to areas without a participating utility.

Source: NREL, February 2003



Several Research Programs Support Wind Topics

The Northwest has several research programs relevant to wind power. In addition to research devoted to wind itself, several regional institutions study grid interconnection and power engineering issues that apply to all forms of alternative energy. It is worth noting that regions can sometimes “force-feed” a cluster by establishing a major research facility. Wind technology, however, is already so mature that fundamental research has less value than in areas such as fuel cells, solar and Smart Energy.

The Oregon Institute of Technology hosts the Oregon Renewable Energy Center, which includes research into grid interconnection and other topics of relevance to wind power. In particular, OREC emphasizes the integration of technologies into energy systems of practical use to businesses and the public. OIT also has an incubator that could be used to accelerate the growth and commercialization of wind technologies.

The Oregon State University has an energy extension program in its College of Engineering that helps solve energy-related problems for homes and businesses. In cooperation with the Bonneville Power Administration, the Energy Resources Research Laboratory (ERRL) collects and manages data from BPA’s wind energy resource studies.

Washington State University operates the Energy Program for the State of Washington. That program includes a library, consulting and clearinghouse services for energy professionals worldwide, including materials on wind power.

Early Experience with Large Wind Farms

The presence of the country's largest wind farm (see Sidebar 1, page 8), along with a leading consultancy (see Sidebar 4, page 21), along with several other early wind projects has left us with some expertise in understanding the challenges and opportunities of utility-scale wind farming. However, a good percentage of that expertise was "imported" for the duration of the project.

Sidebar 4 -- Kirkland, WA Wind Consulting Firm Ranks as Global Leader



When it comes time to determine whether a wind project makes sense, many of the world's largest organizations turn to Kirkland, WA-based Global Energy Concepts. GEC consults in the analysis, economics and operation of renewable energy systems, with a particular emphasis on wind energy.

Since its founding in 1994, the company has done work for the World Bank, the Departments of Energy, Defense and Agriculture, national research laboratories and major utilities in the U.S. and abroad.

In addition to an extensive library of wind reference materials and supplier directories, GEC also boasts, advanced computer facilities, specialized wind energy analysis tools and an inventory of specialized monitoring and test equipment

A Strong Entrepreneurial Infrastructure

One of the secrets to economic development is to unlock "latent entrepreneurs" -- those individuals inside companies who have ideas for startups. Our entrepreneurial infrastructure is an asset in allowing those people to grow their ideas into new companies. Washington State ranks high in most measures of entrepreneur energy and infrastructure. Oregon typically ranks in the top third. The region is well-served by angel investors, venture capital firms, law firms, accounting firms, banks, trade associations and serial entrepreneurs. Although this infrastructure is concentrated near Seattle and Portland, nearly all communities have local economic development organizations to assist.

Potential Synergy with Hydro Power or Hydrogen Production

In theory, the Northwest's hydro facilities could act as a "battery," storing water when wind output is high and releasing more water when wind output is low. A recent report for the Northwest Energy Coalition concluded that our region's "extensive storage hydro facilities . . . might enable a higher fraction of wind to be supported in the Northwest, especially compared with other regions." (Tellus Institute, *Clean Electricity Options for the Pacific Northwest*, October 2002.)

Some experts believe that wind, solar and off-peak hydro power should be used to produce hydrogen through electrolysis. Should that occur, it would provide further incentive to build wind farms. At the present time, it is much cheaper to obtain hydrogen by reforming natural gas. The combination of expensive renewable energy, expensive electrolysis and expensive hydrogen storage has many cost hurdles to overcome before it becomes a serious alternative for hydrogen production.

Both of these concepts are just possibilities at this point, not realities. And both of them speak only to the region's ability to justify more wind farms, not to its ability to create a manufacturing cluster.

HURDLES:

No Concentration, Modest Resources, No RPS, Market Access

The Northwest would have to overcome at least four major challenges to become a global center for the wind industry.

Lack of an Existing Concentration

Perhaps the single greatest factor in cluster success is the existence of one or more successful pioneers that can serve as the "anchor tenant." We have virtually no representation in any of the big money portions of the industry. None of the world's top 10 manufacturers has any significant presence in the region. None of the world's top wind farm developers are headquartered here.

Neither State Has a Renewable Portfolio Standard

Despite the region's environmental consciousness, neither Washington nor Oregon has passed a renewable portfolio standard. States that have adopted an aggressive RPS have discovered that it provides a powerful incentive for wind farming, since wind is almost always the least-cost renewable. In Texas and, more recently, in California, the adoption of an RPS has been followed by significant growth in wind farming.

Poor Market Access

As a result of our modest wind resources and our lack of RPS programs, the Northwest is not a major market in and of itself. Nor does it have a strong export relationship with those parts of Europe that are building most of the wind farms -- Germany, Spain, Scandinavia and the U.K. In 2002, Europe accounted for at least three-fourths of all wind installations according to BTM Consult. European companies performed virtually all of those installations using European-manufactured turbines.

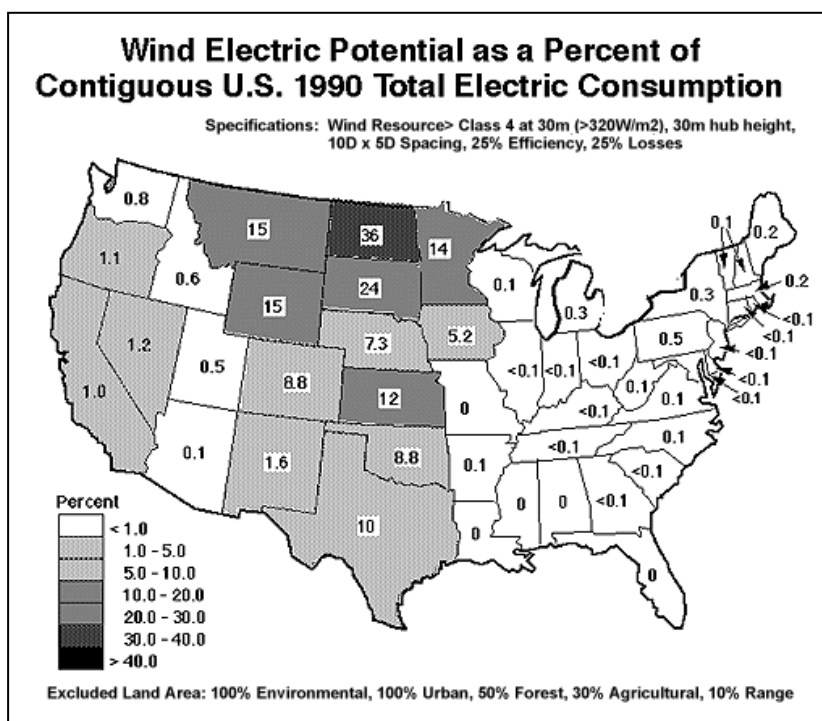
Few Synergies with Existing Industry Base

Wind exhibits few crossovers with the region's traditional high-tech strengths in software, semi-conductor manufacture and aerospace. In theory, our aerospace industry could provide relevant expertise in aerodynamics, manufacturing and advanced composites. In theory, grid connectivity and controls could be an area of Northwest expertise. In practice, these crossovers have not occurred.

Modest Wind Resources

According to the Tellus Institute's October, 2002 report *Clean Electricity Options for the Pacific Northwest*, "many of the region's best wind resources are located in areas far from major electricity demands and limited in existing transmission capacity." Combine these long distances with congestion and under-investment in transmission, and some of the area's best sites may not be usable -- it may cost too much to get the power where it's needed. Combine these factors with a growing Not in My Backyard movement, and the roster of viable sites shrinks even further.

The Northwest has more than enough good wind sites to make a meaningful contribution to the region's power needs. The region does not, however, contain enough good sites to make it a likely candidate to export power. Our potential pales compared to areas such as Montana, Wyoming, Texas, and the Dakotas. A 1991 PNNL assessment of U.S. wind energy potential found that Washington, Oregon and Idaho do not even rank in the top 20. (See Figure 7.)



Higher Costs, Lower Incentives

Both Washington and Oregon are perceived as high-cost states. Washington in particular suffers from a B&O tax that punishes startups. At the same time, neither state has the aggressive recruitment and incentives we see from states such as Colorado, Michigan, Massachusetts, Texas, Illinois, Missouri, Tennessee and New Mexico. These factors make it less likely that the region will attract a significant manufacturing operation that could anchor a cluster.

Sidebar 5 -- Bellevue's Wind Turbine Company Faces the Commercialization Gap



Bellevue, WA's Wind Turbine Company illustrates a challenge common to the entire New Energy sector -- moving from concept to commercial product.

WTC's innovative design puts the blades downwind.
(Standard designs face into

the wind.) The company has also developed ways to continuously adjust blade angles for changing wind speeds. The company has received numerous awards, not to mention contracts from the DOE and the California Energy Commission to develop large-scale demonstration projects.

In theory, WTC's downwind design would be at least 25% cheaper to construct. Despite these advantages, the company has struggled to move from proof-of-concept to mainstream production. Government programs typically end once a concept has been demonstrated. Yet most wind developers won't take a chance on a product that doesn't have a multi-year track record in commercial production. It's a classic Catch-22.

If WTC can cross the chasm, it could provide the centerpiece to a turbine manufacturing concentration. In discussions with company management, however, it seems quite possible WTC will relocate to a region that is both closer to customers and provides relocation incentives.

REGIONAL OPPORTUNITIES

Our research failed to uncover any “naturally occurring” cluster opportunities in wind.

The Pacific Northwest has several important wind farms. Several more are in the pipeline. If they go forward, these wind farms will provide short-term construction jobs plus long-term operations jobs and lease payments. They will also add beneficial clean, renewable energy to our power mix.

However, scattered wind farms in remote regions will not produce a cluster. This does not mean the Northwest should shy away from wind farms. It simply means that, in the absence of some kind of intervention, we cannot rely on wind farming as long-term industry of significance such as software or aerospace.

Several factors could improve the prospects for more jobs from wind:

A Breakthrough by a Regional Company

The Northwest has few players in the wind sector. It is conceivable, however, that a firm such as the Wind Turbine Company could break through to significant growth. (See Sidebar 5, page 24.) If WTC succeeds in its plan to become both a manufacturer and a wind farm operator, it could become the epicenter of a regional cluster.

We are aware of at least one other regional company that is attempting to get financing for a revolutionary turbine design. (The company is not yet public with its plans.) If it successfully commercializes this technology, it could cause a “shift” in the industry with resulting opportunities for the Northwest. Since the design depends on advanced composite materials, it could also tap into synergies with the region’s aerospace sector.

Relocation of a Major Manufacturer

Approximately two years ago, Vestas (the world’s leading wind turbine manufacturer) considered moving its U.S. headquarters to the Portland area. For a variety of factors, it decided not to make the move. Such a relocation would change the equation and raised the prospects for a meaningful cluster.

Renewable Portfolio Standards

If both Washington and Oregon were to pass aggressive RPS policies, regional wind farming would grow well beyond current plans. A sizable regional market for wind farms might attract developers and manufacturers (or at least significant branch operations).

Regional Cooperation to Create a “Wind Park”

Montana, Wyoming and (to a lesser extent) Idaho have enormous wind reserves. A regional plan to create a wind park to export power could have significant benefits to Washington and Oregon. For instance, it is likely that regional organizations such as the Bonneville Power Administration would play a large role in the transmission and export of this power.

Such a scheme would require significant incentives. Northwest power prices are currently below national averages, making wind too expensive unless it is subsidized. Implementing this strategy would also require enormous investment in transmission lines. Even today, power gets “trapped” in Alberta and Montana because of overloaded grid interconnections. A multi-gigawatt wind facility would exacerbate the problem. It would require high-voltage lines from the site to the grid, and major reinforcement of grid interconnections.

Such a park also presupposes an open market for power. Although the federal government is attempting to establish a standard market design, it is unclear when or even whether open markets will appear.

A Major Policy Shift

Regional officials could greatly enhance the economic development potential of wind if they were to adopt a comprehensive plan in its favor.

Such a shift would begin with an aggressive RPS, as discussed above. Through the RPS, the wind park concept, and other policies, it would need to pledge the construction of at least 1,500 MW of new wind power. And it would need to demand a strong local component for all wind projects. Such requirements would bring a higher percentage of wind farming’s economic benefits to the region.

Such policies have been successful in Europe. When Denmark’s Vestas developed wind farms in the Navarra region of Spain, it partnered with a Spanish company and sited several subsystem plants in the area. Spain’s Castilla-La Mancha region is looking to install 2,000 MW and Portugal’s Galicia area is talking about a 5,000 MW long-term plan. Both regions are insisting on some local assembly as part of the package.

That’s the theory. In practice, current regional policies work against such a scenario. The Pacific Northwest congressional delegation is staunchly against open markets. The Washington State legislature recently rejected an energy bill with a modest RPS. And it is currently considering a new budget that eliminates the state energy office. (To the best of our knowledge, such an action would make Washington the only state without an energy office.)

To make such a shift, policy makers would also have to ignore other, more promising candidates for their support. As noted in a separate report, Smart Energy creates similar environmental benefits while promising more economic development opportunities.

ABOUT THE PROJECT

ABOUT THE METHODOLOGY

Athena analysts are experts in the growth of emerging markets. They combine this expertise with a systematic research methodology:

- Extensive review of secondary data and industry reports
- Multiple interviews, discussions and research roundtables with regional and national players: energy companies, utilities, investors and policy/program leaders
- In-house technical sessions to map information, generate market scenarios, and establish key findings
- Review of draft reports to a committee of advisors and industry experts

This document is part of the Preliminary Analysis of Near-Term Opportunities. It reports on the wind segment. Other documents in this same research module cover prospects in solar, fuel cells and Smart Energy.

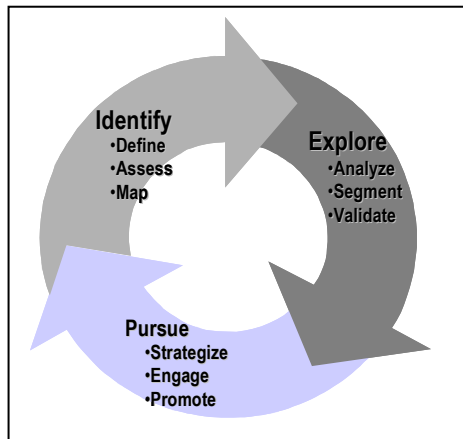
The Role of This Report

This report is *not* intended to represent a final decision. It is not for use to promote our region externally. It is an internal tool to help the Steering Committee decide where to focus the next stages of the research. The role of this preliminary analysis is to identify appropriate niches to investigate in more detail. Follow-on research can then examine those niches in more detail. (See Figure 6.)

Figure 6
Role of This Report

Preliminary reports identify market niches worthy of further effort. The Steering Committee decides which ones to explore in more depth

Source: The Athena Institute.



ABOUT CLIMATE SOLUTIONS

Climate Solutions is a public interest group that works to make the Pacific Northwest a global warming solutions leader. Since 1998, the group has targeted development of a Northwest clean energy technology industry cluster as a globally significant contribution the Northwest can make to reduce greenhouse emissions

into the atmosphere. Climate Solutions generates leading-edge information and knowledge on clean energy technology and economic opportunities it presents. The organization issues reports, organizes conferences and builds cross-cutting alliances to further the goal of rapid energy transition.

ABOUT THE ATHENA INSTITUTE

The Athena Institute is a research organization that helps executives and organizations find success in emerging markets such as Smart Energy. Its Market Power program helps governments, regions and corporations understand and take advantage of new opportunities. Its Partner Assets program assists regions and corporations looking to partnerships as a source of competitive advantage. Its Strategic Leadership program strengthens corporations and helps individual leaders position their companies to win . Athena's methodologies and insights have been implemented by many organizations, ranging from Fortune 1000 corporations to public policy agencies.

ABOUT THE ANALYSTS

PS Reilly is a noted expert, researcher, and advisor on commercial success in emerging markets. Her insights and predictions are regularly featured in articles, columns, and keynotes. Most recently she was Vice President of Emerging Markets for Ziff Davis Media, where she provided strategic advice to leading technology companies, including IBM, Peoplesoft, and many others. She has designed and led numerous large-scale research projects, from analysis of a single market, to investigating the economic impact of regional policy and infrastructure changes.

Jeff Canin brings 20 years of experience in the financial services sector. As a stock analyst with Hambrecht & Quist, Montgomery Securities and Salomon Brothers in San Francisco, he provided in-depth high tech research coverage to institutional investors in North America and Europe. Since 1995, he has worked as a venture capitalist and consultant to emerging growth companies in the information technology and distributed energy fields.

Jesse Berst is an internationally known technology and business analyst. He has authored or co-authored more than a dozen books on technology topics, written hundreds of articles for leading publications and keynoted dozens of business events in the U.S. and abroad. He combines two decades of professional experience in emerging markets with a personal interest in environmental and energy issues.

David Amdal has a 25-year career heading international market research firms. He was formerly head of market research for BIS Strategic Decisions for the Asia-

Pacific region, a \$30M operation with ten offices in seven countries. (BIS has since become Giga Information Group.) He has conducted 300+ market entry evaluations, identifying the sectors, customers and communication with the strongest potential for success. Clients have included Apple, IBM, Canon, S.C. Johnson, Foremost, R. J. Reynolds, Heineken, Guinness, Bayer, BIC, Coca-Cola and Gillette, as well as regional development authorities.