June 2003

ENERGY FOR WASHINGTON'S ECONOMY

Economic Development from Energy Efficiency and Wind Power in Washington

WashPIRG Foundation

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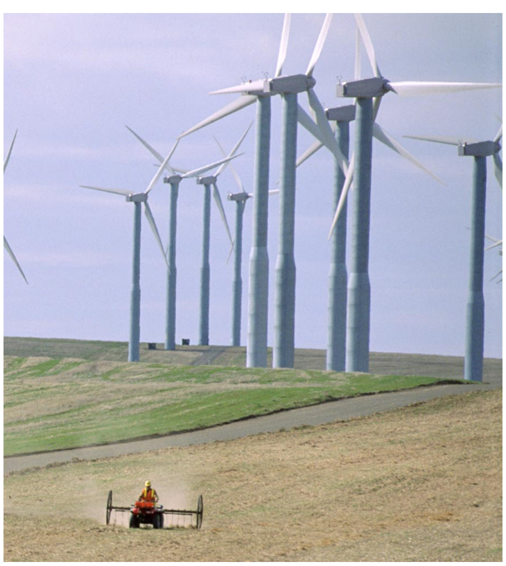
Executive Summary

Energy efficiency and wind power can provide major economic development benefits for Washington state and help ensure a reliable and affordable electricity supply. Tapping our efficiency and wind potential will create jobs, generate revenue for landowners, increase local tax revenues, and save water.

Energy Potential

Washington has substantial wind resources and a wealth of untapped potential for energy efficiency improvements.

- The state could commit to a reduction in electricity consumption of at least 12% by 2020. Annual demand reduction would reach 1,700 average megawatts (aMW) by 2020, enough to power 1.1 million homes. This is only half the potential identified in a recent survey of cost-effective energy efficiency opportunities.
- Washington could install enough wind turbines to generate 1,700 aMW of power by 2020. This would meet 14% of our power needs. With this amount of growth, Washington will have developed 89% of its total wind potential according to the most pessimistic resource estimate and 24% of total potential according to the most optimistic published estimate.
- The alternative plan for Washington is to meet growing electricity demand with 3,400 aMW of new natural gas power plants, which would decrease reliability, increase pollution, and leave consumers vulnerable to periodic price spikes.



Economic Benefits

Developing energy efficiency and wind power would have much greater economic benefits than continuing on the path of building more natural gas power plants.

Efficiency and wind would create more jobs than natural gas.

- Implementing 1,700 aMW of energy efficiency would create the equivalent of 11,400 year-long jobs.
- Developing 1,700 aMW of wind power would create 8,700 year-long jobs and 590 permanent jobs.
- Building 3,400 aMW of natural gas power plants would create 5,700 year-long jobs and 330 permanent jobs.
- Total employment from wind and efficiency equipment and facilities built through 2020 would be 2.5 times as high as from natural gas – 37,940 person-years for wind and efficiency compared with 15,460 person-years for natural gas.

Wind power would generate revenue for landowners.

- Farmers, ranchers, and other rural landowners can benefit financially from leasing land to wind farm developers. Ninety percent of the land can still be used for other purposes.

- Developing 1,700 aMW of wind power would result in approximately $103 million in lease payments to landowners through 2020 and $11 million per year thereafter.

Wind power would create a stronger tax base than natural gas power plants.

- A wind farm has higher capital costs than a natural gas power plant of equivalent capacity, for which ongoing fuel payments comprise much of the cost but are not taxed. Therefore, wind developers pay more property tax than owners of gas plants.
- Wind power would generate twice as much tax revenue as natural gas for half the capacity – $372 million in annual property taxes for 1,700 aMW of wind power compared with $192 million for 3,400 aMW of natural gas.

Natural gas would use large quantities of precious water resources, while wind power would not.

- Fossil fuel-based energy generation requires enormous amounts of water for steam and cooling. The amount of water used by wind and efficiency is negligible.
- Developing 3,400 aMW of natural gas power plants would require 3.5 billion gallons of water per year by 2020.
- Judging by the cost of recent water transfers, the rights to this water would cost $16 million.

Washington's Energy Industry

The energy efficiency and renewable energy industries in Washington are ready to take advantage of growing opportunities.

- At least 274 firms identified their primary business activity as energy efficiency or renewable energy in a recent survey by the Washington Department of Community, Trade, and Economic Development.
- These industries generated nearly $1 billion dollars in annual revenue, employing nearly 4,000 people and delivering $160 million in wages to Washington citizens.
- Including the additional energy efficiency work done by the many companies that design, build, and install energy efficient equipment and buildings but do not count it as their primary business activity, the energy efficiency industry employs 10,000-15,000 people in the state.

Policy Findings

Specific policies that would best help Washington realize its efficiency and wind potential include:

- An energy conservation standard requiring all retail electricity suppliers to meet a minimum percentage of future power needs with energy conservation.
- A renewable energy standard requiring all retail electricity suppliers to obtain a minimum percentage of their electricity from new renewable sources.
- No new permits for fossil fuel-based power plants beyond the 21 permits that have recently been granted.
- Tax incentives such as a sales tax exemption for equipment used in wind farm construction or reduced property tax rates for wind energy facilities.

Introduction

Washington's rural economy has not benefited from the last decade of growth and prosperity like the rest of the state. With waning opportunities in logging, farming, and ranching, Washington farmers have held their ground only with the help of $1.5 billion in subsidies from the federal government since 1996.[1]

Near urban centers, many farmers have given up fighting to keep the farm and have sold their land to developers. The amount of land in agriculture in Snohomish County dropped 18% from 1992 to 1997. In Pierce County the drop was 13%. In King County there are only 41,000 acres of farmland left, less than the size of Seattle.[2]

Fortunately, many Washington farmers have a new crop they can look to for income—wind power.

This new income source could be a boon for Washington's farmers and ranchers. $2,000-$4,000 a year for every wind turbine taking up a small fraction of crop or range land could mean the difference between abandoning agriculture and maintaining a way of life. With extra money also flowing into the school system and government services, wind farms could make a big difference in rural areas of the state.

Royal Raymond was one of the first farmers in the Northwest to reap the benefits of wind farms. In 1998, 28 wind turbines were installed on his wheat farm just over the Oregon border near Helix. Since then, he's been receiving monthly royalties that are far greater than what he'd been making from growing wheat on the 15 acres of displaced land. And the payments come through no matter how good the weather has been to his wheat crop, creating a stabilizing force to the ups and downs of farming.

When the turbines first went up, Raymond's neighbors were upset about all the construction activity. But now that they've seen the benefits, his neighbors are in line to get wind turbines on their land. Raymond has also signed up for more.[3]

The City of Helix and surrounding Umatilla County aren't complaining either. They are now benefiting from tax revenue based on the value of the wind turbines. For a town the size of Helix, with a population of 180, that makes a big difference.

Many Midwestern towns are turning to wind energy as a cash crop as well. The town of Montezuma, a small farming community in Kansas, is a good example. FPL Energy recently installed a 110 MW wind farm in this area. Around the same time, Debbie Wehkamp's farm equipment supply business was closing its doors for good. The wind farm could not have come at a better time for her. Now she works as the administrative assistant for Gray County Wind Energy alongside a newly employed operation and maintenance staff, and local farmers are getting royalty payments. With all the new activity, she said, "I don't think there is anyone in town who is not completely thrilled to have the wind farm here."[4]

Washington should learn from these experiences and follow suit by encouraging wind power development throughout the state.

A smart energy policy would benefit consumers and businesses as well. Nobody wants to see another energy crisis like what happened in 2000-2001. Because Washington utilities were too dependent on hydropower and natural gas, a season of low rainfall and tight gas supplies sent energy prices through the roof. Diversifying the energy mix to include lots of wind power would insulate against those shortages that are sure to come again in future years.

Energy efficiency presents a similar economic opportunity for Washington. Energy efficiency improvements are consistently found to be the cheapest, fastest, easiest way to satisfy energy demand and are good for the economy as a whole. Whenever anyone reduces power use, more money becomes available to spend elsewhere in the economy. Since much of the money spent on utility bills goes out of state for ongoing fuel purchases, redirecting those dollars provides a net boost to the state economy.

The state has an important responsibility and opportunity to encourage the development of electricity sources that can ensure an adequate supply of energy at stable prices with positive impacts on the state's economy and environment. Policy decisions will have an impact on what gets built. Washington utilities will definitely be able to meet new demand for power. The question is, *how* will they meet it?

One path leads deeper into fossil fuel dependence, with associated environmental and fuel costs, and the reality of limited fuel supplies and periodic price spikes. The other path leads toward efficient use of resources, tapping the energy blowing around us, cleaner air and water, reduced climate disruption, and a new source of revenue for rural economies searching for support. The efficiency and wind power course offers a unique opportunity to unite economic development, environmental concerns, and industrial interests around a common vision for the future of Washington.

Table 1. Energy Efficiency Measures Identified in Tellus Study

Measure	% of Total Savings in 2020
RESIDENTIAL	
Furnace & Duct Service	0.9%
Furnace & Heat Pump Fans	2.3%
Super-Efficient Windows	0.6%
Weatherization	0.4%
Beyond Code Performance	0.2%
Manufactured Home Insulation	0.8%
Compact Fluorescent (CFL) Torchieres	0.7%
Indoor CFL Fixtures	1.5%
Outdoor CFL Fixtures	0.6%
CFL Bulbs	0.6%
Add-On Heat Pump Water Heaters	2.0%
Integral Heat Pump Water Heaters	5.3%
Electronics Standby-Mode Losses	3.5%
Residential Subtotal	19.5%
COMMERCIAL	
Systems Analysis for New Bldgs	1.5%
Systems Analysis for Existing Bldgs	0.4%
Fluorescent Lighting	2.3%
Advanced Lighting Measures	6.7%
Low-Cost Refrigeration	0.9%
High-Cost Refrigeration	0.5%
General O&M	1.3%
Internet Data Centers	1.3%
Clothes Washers	0.2%
Commercial Subtotal	15.0%
INDUSTRIAL	
Premium Motors	2.4%
Motor Systems	6.7%
Aluminum Production Process	3.3%
Other Industry-Specific Processes	8.2%
General O&M	0.6%
High-Efficiency Transformers	0.1%
Industrial Subtotal	21.2%
OTHER	
LED Traffic Signals	0.2%
Irrigation	0.5%
Solar Direct Hot Water	1.2%
Condensing Gas Water Heaters	5.1%
Commercial Combined Heat & Power	20.9%
Industrial Combined Heat & Power	16.4%

Energy Efficiency

Despite a reasonable track record of improving energy efficiency in Washington, there are still many opportunities for further improvement. The state has not exhausted the "low-hanging fruit" of efficiency measures, and innovative new measures have become possible as technologies and systems advance.

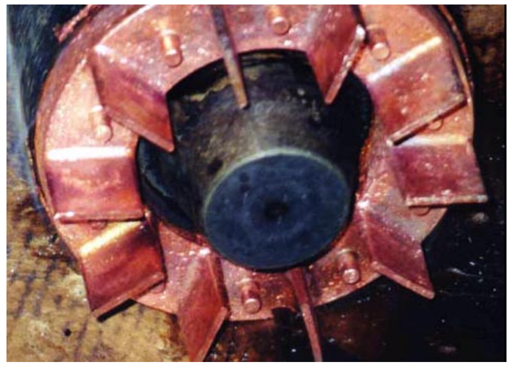
Washington was extremely successful in energy efficiency efforts in the 1990s. Due to its diligent support in the preceding two decades, Washington was ranked first among all the states for its electricity savings rate in an analysis by the American Council for an Energy-Efficient Economy for both 1993 and 1998. Washington utilities' electricity savings averaged 6.8% of electricity sales in 1993 and 9.2% — 990 aMW — in 1998. However, funding for energy efficiency programs dropped considerably in the late 1990s, the effects of which have since been felt. In 1998, Washington utilities spent 1.7% of revenues, $66 million, on energy efficiency programs, down from 7.1% in 1993.[5]

In an October 2002 study commissioned by the Northwest Energy Coalition, the Tellus Institute measured potential savings from cost-effective energy efficiency improvements and fuel switching in all sectors throughout the Northwest. (See Table 1.) In the residential sector, the study found potential savings through more efficient heating, cooling, lighting, water heating, and refrigeration. In the commercial sector, most savings were in better HVAC systems, lighting, refrigeration, and water heating. In the industrial sector, the study identified motor efficiency and improvements to the aluminum production process as the areas with highest potential energy savings. Further possible reductions were measured in streetlighting and irrigation, and the study also explored improved efficiency in electricity production through combined heat and power systems.

With all of these measures combined, the Tellus Institute determined that the Northwest could achieve a 12% overall reduction in electricity use by 2010 and 24% by 2020.

Experience shows that conservation rates even higher than this are possible. In 2001, when energy supplies were tight statewide, Seattle City Light set a goal of achieving a 10% reduction in electricity demand in a single year. Through a combination of public education, distribution of efficient light bulbs, and incentives for business customers, the utility surpassed its ambitious goal — reducing demand by 12% for the year. The utility's Energy Management Services Division acquired 11.7 aMW in 2001 from strategies that use less energy to receive the same level of productivity. This is enough energy to power 11,000 Seattle homes for a year. These savings allowed Seattle City Light to avoid the purchase of $80 million of electricity on the regional market.[6]

Similarly, in California, energy conservation was a highly visible priority throughout the energy crisis of 2001. State efforts to promote energy savings paid off, with a total annual reduction of 6.7% in statewide generation in a single year. Monthly peak load reductions from the previous year reached a high of 14% in June.[7]



Motors with copper rotors can reduce energy loss by 15-20%.

Table 2. Projected Energy Conservation (aMW)

Year	Projected Demand w/o Efficiency	% Savings from Efficiency	Total Efficiency Savings	Projected Demand with Efficiency
2003	11,000	0.8%	80	10,920
2004	11,200	1.5%	170	11,030
2005	11,400	2.3%	260	11,140
2006	11,500	3.0%	350	11,150
2007	11,700	3.8%	440	11,260
2008	11,900	4.5%	540	11,360
2009	12,000	5.3%	630	11,370
2010	12,200	6.0%	730	11,470
2011	12,400	6.6%	820	11,580
2012	12,600	7.2%	910	11,690
2013	12,800	7.8%	1,000	11,800
2014	13,000	8.4%	1,090	11,910
2015	13,200	9.0%	1,190	12,010
2016	13,400	9.6%	1,290	12,110
2017	13,600	10.2%	1,390	12,210
2018	13,800	10.8%	1,490	12,310
2019	14,000	11.4%	1,600	12,400
2020	14,200	12.0%	1,700	12,500

Although the energy savings outlined in the Tellus Institute study represent real, cost-effective opportunities specifically identified by their survey, to be more conservative the economic analysis in this report estimates the results of achieving only half of those savings. If Washington reaches 6% cumulative savings by 2010 and 12% by 2020, the state will be reducing electricity demand by 730 aMW in 2010 and 1,700 aMW in 2020. (See Table 2.)

Note on Units:

The size of a power plant is expressed in terms of megawatts (MW). This unit indicates how much electricity a plant can generate at one time. Utilities also measure their ability to supply demand on the grid at any one time in terms of MW. Megawatts are like the horsepower of a car engine – the maximum potential when operated at full speed.

Power plant output and electricity consumption are measured in terms of megawatt-hours (MWh) or average megawatts (aMW). These units indicate the total and average amount of electricity generated during a period of time. A 100 MW power plant operating for 100 hours at 90% capacity would produce 9,000 MWh, or 9 gigawatt-hours (GWh), of electricity. The plant would have an average output of 90 aMW. Megawatt-hours are like the number of miles a car travels, and average megawatts is like the average speed.

Wind Power

Washington has enormous wind potential by all estimates.

- The Pacific Northwest Laboratory in Richland estimated in 1994 that the state could generate 3,700 aMW of electricity from wind — more than one-third the total amount of electricity the state generated in 1998.[8]
- The National Renewable Energy Laboratory (NREL) made more conservative estimates, measuring wind potential only in areas that met stricter wind classifications and that were located within ten miles of existing transmission lines. Under these criteria, NREL estimated Washington could generate 3,400 aMW of electricity from wind.[9]
- More recently, four research organizations published a survey of renewable resources in eleven Western states called the Renewable Energy Atlas of the West. This study found 7,000 aMW of wind potential in Washington. The study used higher resolution data and considered taller and more advanced turbines than those used for the earlier analyses.[10]
- The Tellus Institute, in a recent report contracted by the Northwest Energy Coalition, identified 1,900 aMW of wind energy potential in Washington looking only at the windiest and most developable locations. Including medium-wind locations, many of which are cost-effectively developable, the study found 76,000 aMW of wind potential in four northwestern states.[11]

Projected Growth in Wind Power Generation

Currently, Washington has three wind farms with a combined capacity of 228 MW, but the technology is ready and the price is competitive to build more now. Seven additional wind projects with a combined capacity of 820 MW are currently in development and two others totaling 230 MW are being considered.[12] (See Table 3.) When the Bonneville Power Administration sought bids for 1,000 MW of new wind power for the Northwest, it was "blown away with 25 proposals that could provide 4,000 MW of wind capacity."[13]

We project that Washington wind developers could complete nearly half of the 820 MW of wind projects currently in development over the next two years to reach a peak capacity of 600 MW by the end of 2004, then add wind power capacity at the rate of 250 MW per year. In this scenario, the state would be generating 700 aMW of electricity from wind by 2010 and 1,700 aMW by 2020. (See Table 4.) With this amount of growth, Washington will have developed 89% of its total wind potential according to the most pessimistic resource estimate mentioned above and 24% of total potential according to the most optimistic published estimate.

Table 3. Wind Projects in Washington[14]

Project	Peak Capacity (MW)	Status
Mariah	0.2	online
Nine Canyon	48	online
Stateline, phase I	180	online
Klickitat Wind	15	permitted
Stateline, phase II	40	permitted
Zintel Canyon	50	permitted
Desert Claim	180	permits pending
Kittitas Valley	181	permits pending
Maiden Wind Project	150	permits pending
Stateline, phase III	204	permits pending
Columbia Wind Ranch	80	in study
Roosevelt	150	in study
Total online	228	
Total in development	820	
Total in study	230	
Total	**1,278**	

Table 4. Projected Wind Power Growth[15]

Year	Capacity (MW)	Production (aMW)	% of Total Generation
2003	228	80	0.7%
2004	600	200	1.8%
2005	850	280	2.5%
2006	1,100	360	3.2%
2007	1,350	450	4.0%
2008	1,600	530	4.7%
2009	1,850	610	5.3%
2010	2,100	690	6.0%
2011	2,350	820	7.1%
2012	2,600	910	7.8%
2013	2,850	1,000	8.5%
2014	3,100	1,090	9.1%
2015	3,350	1,170	9.8%
2016	3,600	1,330	11.0%
2017	3,850	1,420	11.7%
2018	4,100	1,520	12.3%
2019	4,350	1,610	13.0%
2020	4,600	1,700	13.6%

Natural Gas

Because Washington has such a large base of hydropower, the state has not relied on natural gas power plants or other fossil fuel plants for electricity as much as many other states. However, with recent and continuing growth in electricity demand, this is rapidly changing.

Twelve natural gas power plants, with a combined capacity rating of 860 MW, have gone online in the past two years. In addition, three plants totaling

Figure 1. Price of Natural Gas Sold to Electric Utilities in the U.S.[16]

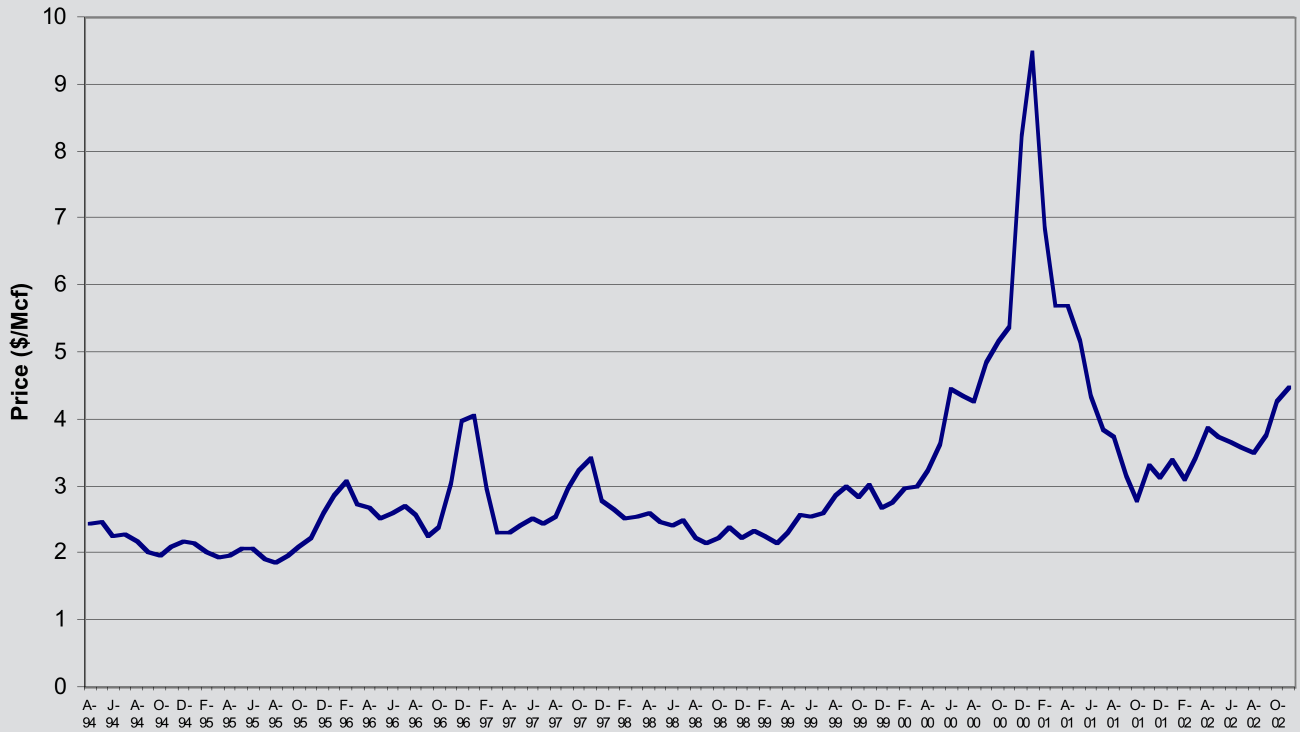


Table 5. Washington Natural Gas Development (MW)

2001-2002 Additions	860
Current	2,550
Under Construction & Permitted	2,818
Total Current & Permitted	5,368
Proposed	3,862

787 MW are under construction and the state has granted initial approval to six plants totaling 2,031 MW.

This amount of natural gas power plant development has more than achieved its purpose of boosting energy reliability in Washington. At this point, the state faces considerable risk from over-dependence on natural gas, which has considerable price and supply uncertainty and volatility.

Most power projects currently proposed but not yet permitted are also fueled by natural gas. Plants totaling 3,862 MW are under consideration, 76% of all proposed new capacity.[17]

This is part of a national trend. With new pipelines, Washington is now part of the national natural gas market and subject to its vagaries. When cold weather in the Northeast or Midwest increases demand for gas for heating, Washington will experience the price pressure. Across the nation there are 80,000 MW of natural gas plants under consideration. Such demand could overwhelm our supply and delivery capabilities.

Coal

Coal-fired plants are the electricity generating industry's old-guard technology. Washington's coal plants were built in the 1970s. The environmental and socioeconomic costs of coal-fired power plants make them an unlikely choice for meeting new capacity needs in Washington.

The health, visibility, and local air quality costs of coal plants are borne by society at large, and are external to the apparent cost included in electricity rates. Traditional accounting sets these costs at zero, which clearly underestimates the true price of coal use. While there is no universally agreed upon method for putting a price tag on these costs, accounting for them would significantly raise the price of coal-fired power. For example, a recent European Union study found that if the health and environmental costs of coal use were considered, the price of coal-fired power would double, even without considering the economic impacts of climate change or carbon sequestration.[18]

Coal mining is also problematic. It contaminates waterways and damages land. The most economical coal mines, based on open pit techniques, produce coal through removing the material that covers coal seams, removing the coal, and replacing the soil, followed by reclamation of the surface. This practice can disrupt local ecosystems.

Burning coal creates unacceptable levels of air pollution. Coal combustion produces chemicals like sulfur dioxide, nitrogen oxides, soot, and mercury. Sulfur dioxide and nitrogen oxides form smog and soot, impacting respiratory health. Mercury contaminates the food chain through fish in polluted waterways, exposing people to the threat of neurological or developmental damage. Burning coal also produces large amounts of carbon dioxide, a gas that causes climate change.

The coal industry hopes for "clean coal" technology to solve these problems. They claim that energy can be harnessed from coal without causing extensive environmental and health risks or costs. However, the actual pollution reduction from these technologies to date has been marginal and expensive. Ultimately, these technologies redirect toxins to the land and water instead of the air. The General Accounting Office recently concluded that federal spending on "clean coal" has been a waste of taxpayer money.[19]

On the economic side, Washington's only coal plant in Centralia is able to produce cheap electricity because the initial investment has been extensively depreciated. Although coal supplies and prices are more stable and less costly than natural gas, increasing environmental requirements and public scrutiny, the potential for a carbon tax or the need for carbon sequestration technology, and Clean Air Act enforcement actions all could make electricity generated from coal more expensive.

Finally, the construction of a new coal plant is a lengthy and costly endeavor. The five-year construction times facing coal plants is a challenge to the development of any new coal plant.

Based on these reasons, this analysis compares baseload natural gas with wind and efficiency as the most likely electricity supply options for the state.

Economic Benefits of Energy Technologies

Investing in wind power and energy conservation will do more than supply electricity to Washington citizens. It will benefit the economy as well, providing an estimated 2.5 times as much employment, nearly double the tax base, $100 million for landowners, and less demand for water. (See Table 6.)

Employment Impact

Energy Efficiency

Energy efficiency improvements cost less than traditional power sources, yet they still create significant job growth throughout the economy.

History has proven that energy efficiency measures are the most cost-effective way to address power needs. Nationally, utilities have saved 25,000 to 30,000 MW annually, the equivalent of 100 large power plants, over the past five years through energy efficiency programs. These programs averaged 2.8¢/kWh, a cost that is less than that of most new power plants.[20]

As mentioned previously, a 2002 Tellus Institute study found that the Northwest could achieve a 12% overall reduction in electricity use by 2010 and 24% by 2020. It also found that such a reduction would roughly break even economi-

cally through 2010, as the cost of new equipment is offset by energy savings, and create a savings of $482 million through 2020, as the previous equipment investments continue to provide energy savings.[21]

The Tellus Institute study identified 6,283 aMW of cost-effective energy savings potential by 2020 throughout the Northwest from 35 categories of efficiency measures. Looking only at Washington and measuring the benefits from only half of the Tellus projections, the state can be expected to achieve at least 1,700 aMW of energy savings through 2020. Assigning the activities needed for each category of efficiency measure to sectors of the economy, we can calculate the total energy savings created by each sector, as shown in Table 7.

The University of Washington Office of Financial Management published a

Table 6. Summary of Projected Economic Impacts of Electricity Generation Options

Benefit	Wind	Efficiency	Wind Plus Efficiency	Natural Gas
Energy Production/Savings (aMW)	1,700	1,700	3,400	3,400
One-Year Jobs	8,700	11,440	20,140	5,700
Permanent Jobs	590		590	330
Total Employment (person-years)	26,400	11,440	37,840	15,600
Landowner Revenue	$103,584,000		$103,584,000	$0
Property Taxes	$371,516,000		$371,516,000	$192,145,000

study in 1993 that calculated the economic benefits of investments in different sectors of the economy. The division determined the job creation and labor income for investments in each of 60 sectors.[22] Using these estimates and the total investment by sector in Table 7, we can calculate the economic benefits of the investments, as shown in Tables 8. Table 9 summarizes these same benefits for 2010, 2015, and 2020.

Wind Power

Developing Washington's wind energy potential would create jobs in component manufacturing, turbine installation, facility operation and maintenance, and in a variety of areas which indirectly support these activities.

Manufacturing requires skilled laborers who design and build the towers, rotor blades, generators, hubs, and as-

Table 7. Projected Energy Savings Attributable to Work in Six Sectors

Sector	Savings in 2020 (aMW)	% of Total	Cost (cents/kWh)	Investment
Business Services	72	4.2	2.20	$50,878,000
Industrial Machinery	1,110	65.2	3.08	$1,104,189,000
Computer & Office Equipment	21	1.3	3.70	$25,605,000
Electrical Equipment	446	26.2	2.02	$291,401,000
Glass Products	12	0.7	2.92	$11,248,000
Construction	43	2.5	3.64	$50,125,000

Table 8. Economic Benefits by Sector through 2020

Sector	Jobs	Payroll Value
Business Services	710	$12,177,000
Industrial Machinery	7,880	$166,100,000
Computer and Office Equipment	200	$4,171,000
Electrical Equipment	2,150	$44,466,000
Glass Products	90	$1,829,000
Construction	410	$8,342,000
Total	11,440	$237,085,000

Table 9. Statewide Benefits of Energy Efficiency Investments

	2010	2015	2020
Energy Savings (aMW)	730	1,190	1,700
Jobs (person-years)	4,930	7,970	11,440
Payroll value	$102,144,000	$165,057,000	$237,085,000

sorted electronic controls that make up a wind turbine. Installation typically involves local construction firms, boosting local economies. The operation and maintenance needs of a wind plant create permanent, high-quality local jobs ranging from servicing the turbines to accounting.

Manufacturing

Much of the work involved in creating a wind farm goes into manufacturing the components, which include rotor blades, structural towers, hubs, gearboxes, generators, and electronic controls. The Electric Power Research Institute (EPRI), an energy research consortium founded and funded by electric utilities, estimates that every megawatt of wind energy capacity installed creates 2.06 year-long manufacturing jobs.[23]

Most manufacturing of specialized components will happen out-of-state, at least in the near term. Many of the world's major turbine manufacturers are based in Europe, and the U.S.-based industry is in California and elsewhere. As noted in the following section, Washington does have one integrated turbine manufacturer and many component manufacturers. In addition, Vestas, the world's leading wind turbine manufacturer, may build a major manufacturing facility in Portland, which they announced last April but have since put on hold. If this facility is built, it could benefit Washington by employing residents of Vancouver.

In addition, growth in the wind energy market could bring more manufacturing capability to the state. In Montana, for example, some current contracts for wind energy include offers to open in-state wind-turbine manufacturing facilities.[24] In making its siting decision, Vestas mentioned proximity to the large wind energy projects that are currently being planned and built in the Pacific Northwest as a reason for wanting to be in the area.

Based on these facts, this analysis assumes 20% of manufacturing for Washington wind farm components will happen in-state. Following the capacity growth projections stated above, in-state manufacturing of wind energy components could create 1,800 person-years of direct manufacturing employment through 2020. According to the U.S. Bureau of Labor Statistics, the average wage for manufacturing workers is approximately $35,000 per year.[25] At this rate, the payroll value of these jobs would be $63 million.

Installation

A wind farm as large as the Stateline Project needs as many as 300 workers on-site during the height of construction.[26] These workers assemble turbines, erect towers, build roads, and lay cable. Unlike traditional power plants, wind farms are built quickly, usually in a year or less.

EPRI estimates that every megawatt of wind energy capacity installed creates 0.5 year-long local installation jobs.[27] Using this estimate, installing 4,600 MW of capacity by 2020 would create 2,250 year-long jobs over 17 years. At the average Washington construction worker salary of $36,050 per year, these jobs

Table 10. Projected Employment Benefits of Wind Power by 2020[33]

	MANUFACTURING		INSTALLATION		OPERATION & MAINTENANCE	
Job Type	*One-Year Jobs*	*Payroll Value*	*One-Year Jobs*	*Payroll Value*	*Permanent Jobs*	*Payroll Value*
Direct	1,800	$63,000,000	2,250	$81,112,500	280	$12,367,600
Indirect	2,070	$72,450,000	2,580	$93,009,000	320	$14,134,400
Total	3,870	$135,450,000	4,830	$174,121,500	600	$26,502,000

would have a payroll value of $81 million.[28]

Operation and Maintenance

Wind farms need staff to operate and regularly service the turbines throughout their roughly 30-year lifetimes. These needs create long-term, full-time employment close to the wind farm. A recent survey of wind farms in Texas found that every 16.7 MW of capacity requires one full-time employee to operate, monitor, and service it — a rate of 0.06 jobs/MW.[29] This is the same rate as that projected by the developers of the proposed Kittitas County wind farm.[30]

According to growth projections, in 2020 the operation and maintenance needs of Washington's wind farms could employ 280 people. At the average Washington salary for industrial and electrical equipment repairers of $44,170, these workers would earn $12 million per year.[31]

Indirect Employment

The economic impact of building power plants extends beyond the direct jobs created in building and installing the equipment. Each dollar invested creates impacts that ripple outward throughout the local economy.

For example, workers at a manufacturing plant buy raw materials and replacement parts from local suppliers. Contractors at a construction site need concrete and heavy equipment, and their work supports additional jobs supplying these needs.

The Texas Comptroller's office estimates that 1.15 indirect jobs are created for every direct wind energy job, based on the new wind farms that have gone up over the past few years.[32] Using this estimate, wind farm manufacturing and installation in Washington will create 4,650 year-long jobs in supporting areas, and operating and maintenance needs will support 320 ongoing indirect jobs by the year 2020.

Natural Gas

If Washington were to meet its electricity demand growth with natural gas power plants instead of wind energy, fewer jobs would be created.

Installation

To produce the same amount of energy as wind power and energy efficiency under the development scenario used in this analysis, Washington would have to install 3,800 peak MW of gas-fired power plants, enough to generate 3,400 aMW of electricity at the 90% capacity factors typical of Washington gas plants.

Although Washington utilities do not make employment figures public, power plant developers in California are required to estimate the number of jobs to be created by proposed power plants as part of the permit application process. A review of the applications for the 19 plants that were built or approved in 2001 and 2002 reveals that these plants were projected to create a total of 6,337 person-years of work directly within the construction projects, including new gas transmission lines, for 12,853 MW of capacity.[34] The construction of these plants thus created an average of 0.49 person years of work per MW. Assuming the same value for power plants in Washington, building 3,800 MW of new natural gas plants would create 1,850 year-long jobs in plant construction.

Manufacturing

The high energy concentration in fossil fuels require much smaller power conversion systems per MW rating, yielding a lower employment intensity for fossil fuels. Also, Washington has no manufacturing capability for gas turbines, which are the most expensive part of the power plant.

About 30% of the costs of a natural gas plant go toward construction, while 70% go toward manufacturing of turbines, electrical systems, boiler islands, instrumentation, and controls.[35] Since installation creates 0.49 jobs/MW, as established above, the 70/30 ratio yields an employment intensity of 1.14 jobs/MW for the manufacturing of natural gas power plants, compared to 2.06 jobs per MW for wind.

Assuming that 20% of natural gas plant component manufacturing activity will happen in Washington, building 3,800 MW of new plant capacity would create enough activity to support 870 one-year jobs through 2020.

Table 11. Cumulative Impacts of Energy Efficiency and Wind Power Development

Benefits	2010	2015	2020
Energy Efficiency (aMW)	730	1,190	1,700
Reduction from Current Demand Projections	6%	9%	12%
Wind Energy Generation (aMW)	690	1,170	1,700
Percent of Total Electricity Generation	6%	10%	14%
Employment Impacts			
One-Year Energy Efficiency Jobs	4,930	7,970	11,440
One-Year Wind Jobs			
Wind Turbine Manufacturing	770	1,280	1,800
Wind Turbine Installation	960	1,600	2,250
Wind Energy Indirect Jobs	1,990	3,320	4,650
TOTAL	3,720	6,200	8,700
Long-Term Wind Jobs			
Wind Turbine Operation and Maintenance	130	200	280
Wind Energy Indirect Jobs	140	230	320
TOTAL	270	430	600
Property Taxes	$82,278,000	$206,343,000	$371,516,000
Royalties Paid to Landowners	$20,983,000	$53,256,000	$103,584,000
Conserved Water (million gallons)	7,200	18,100	31,000
Value of Rights to Conserved Water	$6,155,000	$10,938,000	$16,226,000

Operation and Maintenance

New natural gas plants are highly automated and relatively easy to maintain, even more so than wind farms. The plans for 19 new plants in California mentioned above include an average of only 25 jobs per plant, yielding a rate of only 0.04 direct jobs per MW of capacity. At this rate, the natural gas route would create only 150 permanent jobs by 2020.[36]

Indirect Employment

Since natural gas plants create fewer direct jobs, the indirect employment they support is also less. Estimates of indirect employment from several California natural gas plant developers yield a similar multiplier effect as wind, in the range of 1.1 indirect jobs for every direct job.[37] Assuming that the employment multiplier effect is the same as the multiplier of 1.15 for wind energy, natural gas plants would support 2,980 indirect one-year jobs and 170 indirect permanent jobs.

Natural gas plants also support ongoing jobs in the extraction and delivery of natural gas. However, no natural gas is produced in Washington, so these jobs would all be located out of state. The construction of gas pipeline extensions to serve new plants is included in the employment estimates for new natural gas plant installation in California used in this analysis.

Overall, natural gas plants would create 14,440 fewer one-year jobs through 2020 and 260 fewer permanent jobs than wind power and energy efficiency. In percentage terms, wind power and energy efficiency would create 3.5 times as many temporary jobs and 1.8 times as many permanent jobs as natural gas power plants over the next two decades.

Table 12. Economic Benefits of Natural Gas Power Plant Development

Benefit	2010	2015	2020
New Generation (aMW)	1,430	2,360	3,400
Percent of Total Electricity Generation	12%	18%	24%
Employment Impacts			
One-Year Jobs			
Manufacturing	360	600	870
Installation	780	1,280	1,850
Indirect Jobs	1,360	2,070	2,980
TOTAL	2,500	3,950	5,700
Long-Term Jobs			
Operation and Maintenance	60	100	150
Indirect Jobs	70	120	170
TOTAL	130	220	320
Property Taxes	$44,242,000	$105,531,000	$192,145,000

Table 13. Landowner Income and Property Taxes From Wind and Natural Gas

Benefit	Wind	Natural Gas
Landowner Income	$103,584,000	$0
Property Taxes	$371,516,000	$192,145,000

Wind and efficiency would provide 2.5 times as much total employment through 2020 as natural gas — 38,000 person-years for wind and 15,600 person-years for natural gas. (See Table 12.)

Landowner Revenue

Farmers, ranchers, and other rural landowners can take advantage of the income resulting from leasing a portion of their land to a wind farm developer. Unlike crops, payments from wind energy are steady and year-round. If the land is owned by a government entity, the income can be funneled into local government, schools, and services.

Although wind farms occupy large areas, the actual physical footprint of each wind turbine is small. A landowner can lease 10% of a farm's land area for the construction of wind turbines while continuing to grow crops or graze animals on the rest of the land around the turbines.

Lease terms vary, but they are usually tied to electricity sales and typically represent 2.5% of gross revenue from the electricity produced at a wind farm.[38] The Union of Concerned Scientists estimates a typical farmer or rancher with good wind resources could increase the economic yield of his or her land by 30%-100%.[39]

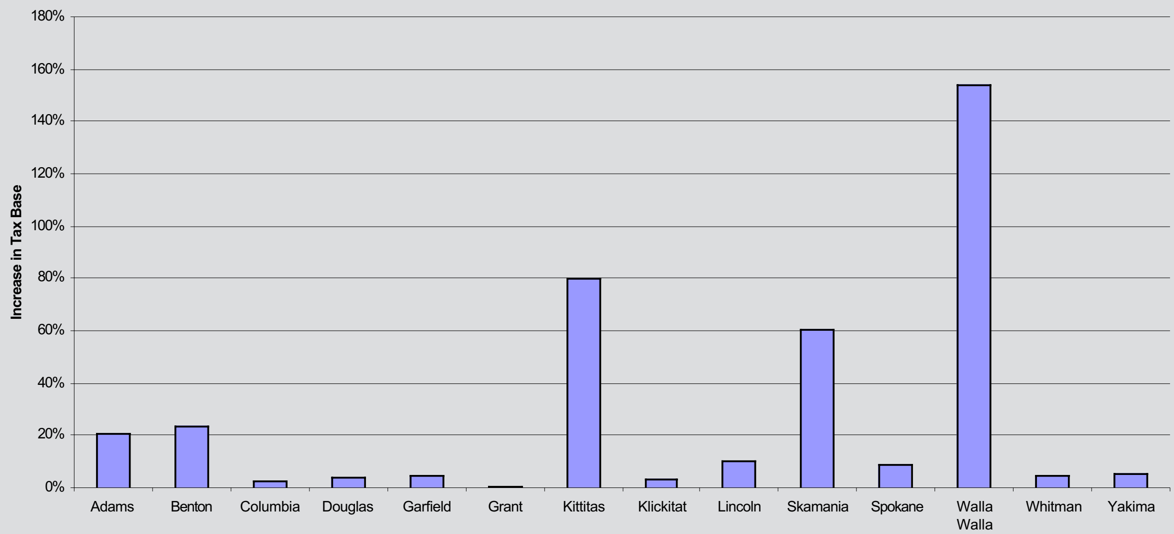
Assuming a contract price for electricity generated from wind power of 3¢/kWh, the projected electricity generated by wind power through 2020 would sell for $4.1 billion.[40] At lease terms of 2.5% of gross revenue, the lease payments associated with generating this electricity would supplement the income of farmers, ranchers, and other landowners by a total of $103 million between now and 2020. By 2020, 1,700 aMW of wind farms would produce $447 million worth of electricity, and landowners would earn an additional $11 million per year on top of their normal crop yield.

Natural gas plants cannot be located on land actively used for growing crops or grazing animals. Generating capability at natural gas plants is much more concentrated, and occupies much less land than a comparable wind farm. The land for these plants would most likely be purchased outright at the cheapest price available, in areas relatively close to metropolitan areas. Accordingly, they would not provide lease payments to rural landowners.

Local Tax Income

Wind turbines will raise the property tax base of a county, creating a new revenue source for education and other local government services. According to EPRI, wind energy plants cost approxi-

Figure 2. Tax Base Increase from a 200 MW Wind Farm in Washington's Windiest Counties



mately $900,000 per installed MW, a total of $4.3 billion for all projected capacity additions.[41] A typical plant will operate for a 30-year lifetime, and the assessed value of the facility will depreciate slowly over this period.

Fossil fuel-based plants have lower capital costs, since less equipment is needed and much of the total expense is for ongoing fuel payments. The average new natural gas plant costs about $540,000 for every installed MW — about 40% less than a comparable wind turbine.[42] As a result, wind farms often shoulder a higher property tax burden than conventional power plants.

Using wind development projections, the depreciating values of wind facilities, and the average Washington property tax rate of 1.25%, wind power would generate $371 million in government revenue through 2020.[43]

Increases in the tax base from installing new wind farms will be largest in rural counties where the wind resources are greatest. Although the direct impact to the statewide tax base will be relatively modest, just as with new fossil-fueled plants, new wind farms can make a big difference to small communities. Tax base increases in Washington's windiest counties are shown in Figure 2.

New natural gas plants installed on the same schedule would increase the property tax base less than wind plants. With an assumed lifetime of 30 years, 3,400 aMW of new natural gas plants would provide $192 million in property taxes through 2020, about half that of 1,700 aMW of wind energy.

To encourage wind power development, this tax rate disparity should be eliminated. Taxes could be calculated on a power output basis rather than a capital cost basis, or wind power projects could be granted discounted rates, as suggested in the policy recommendations of this report. The economics of wind power would be much more favorable if it was competing on a level playing field. However, as property taxes for power plants are currently based only on capital costs, we calculate the tax disparity as an economic benefit to local communities in this report.

Avoided Water Use from Displaced Conventional Energy Generation

Especially in times of drought, water is a valuable commodity in Washington, with all water rights spoken for and not enough left for healthy fish habitat or agriculture. Wind energy could conserve billions of gallons of water that would otherwise be used for electricity generation by conventional power plants.

Fossil fuel-based energy generation requires large amounts of water for steam and cooling. For every MWh generated, natural gas power plants use about 230 gallons of water, three-quarters of which is not returned to the water body for subsequent reuse.[44] Growing water demand will make even less water available for use at new thermoelectric power plants.

In contrast, generating electricity through wind uses very little water, no more than that required for an occasional washing of the turbine blades and for the mixing of concrete. At projected development rates, wind power and energy efficiency would save 31 billion gallons of water compared to the use of natural gas through 2020. In 2020 alone, wind and efficiency would reduce water use by 3.5 billion gallons — 11,000 acre-feet per year, enough to supply 5,500 families.

Unlike many states, in which water rights are regularly traded, water rights rarely change hands in Washington. Despite our rainy climate, there already isn't enough water for all needs. But with a growing population, more municipalities are going to need to acquire new drinking water supplies. Based on an appraisal of recent sales of municipal water rights in the Walla Walla area, the going rate for water rights in Washington appears to be $1,500 per acre-foot.[45]

At that price, the right to withdraw 3.5 billion gallons of water, the amount wind and efficiency would save in 2020, would be worth $16 million.[46]

Electricity Pricing Impacts

Wind energy and energy efficiency could also have large macroeconomic benefits for the state due to impacts on the cost of electricity. First, energy efficiency has consistently proven to be the most cost-effective means of addressing power needs. Second, wind energy can insulate consumers from secondary price spikes due to unpredictable fluctuations in natural gas costs by diversifying the state's energy generation portfolio. Third, natural gas prices overall will continue to rise while wind energy prices continue to fall. As a result, consumers will likely save money that they can then spend in other sectors of the economy.

Natural gas prices are projected to increase, sometimes unpredictably. With their low up-front capital costs, natural gas power plants make attractive investments. However, the unpredictable price of natural gas leaves ratepayers vulner-

Table 14. Projected Water Use and Value of Water Rights for Wind and Natural Gas

	Wind & Efficiency	Natural Gas
Water Use in 2020	negligible	3.5 billion gallons
Total Water Use, 2003-2020	negligible	31 billion gallons
Value of Water Rights	$0	$16 million

able to dramatically increased prices. Over-reliance on natural gas also exposes customers who use natural gas for heating to price spikes caused by increased demand and decreased supply.

Since natural gas power plants are dependent on unstable supplies of natural gas and fluctuating prices, electricity generating costs from gas plants can rise dramatically during gas price spikes. In late 2000, natural gas costs more than tripled to nearly $10 per thousand cubic feet.[47] One of the biggest reasons for this price spike was natural market fluctuation. Fifteen years of low gas prices and the resulting disincentive for resource development followed by a cold winter led to depleted stocks and unprecedented wholesale prices.

In 2001, the convergence of a booming economy, a failed California deregulation plan, market manipulation, and a Northwest drought skyrocketed prices for natural gas and electricity.

With rapidly increasing natural gas demand in the Western market and a supply that is far from guaranteed, such price spikes are almost certain to be a periodic occurrence in the future.[48] As the state found out in 2000-2001, Washington natural gas prices are tied to the rest of the Western market. Supply problems in other Western states can drive up natural gas prices across the board.

Over the past two years, natural gas consumers have had to pay a premium of roughly 0.5 ¢/kWh over expected spot prices to lock in natural gas prices for the next ten years.[49] Because wind power has no fuel costs, it can serve as a hedge against volatile natural gas prices, reducing the need to speculate on future fuel expenditures. Diversifying Washington's generation portfolio, just like diversifying investments in the stock market, can insulate consumers from unpredictable price fluctuations.

Limited domestic reserves of natural gas and uncertain foreign supplies make it nearly certain that gas costs overall will gradually rise over time. Proven domestic reserves will be spent by 2008, according to demand projections by the U.S. Department of Energy. The U.S Geological Survey estimates that future domestic finds will total 1,049 trillion cubic feet of gas, which Department of Energy growth predictions suggest will only get us to 2040.[50] As we begin to import more of our natural gas supply, prices will rise due to increased delivery costs.[51]

Wind energy prices, in contrast, are projected to decline as the industry matures, takes advantage of economies of scale, and deploys more advanced technologies. And the fuel for wind is free. Shortages are not a concern. Over the past several decades, the cost of wind power has dropped by 80%.[52] As the industry develops, the cost of wind energy will continue to decline.

Similarly, costs of energy efficiency are stable. Ceiling insulation does not go out of service, and the price of insulation is not volatile. Any improvement in energy efficiency leads to dependable long-term savings from reduced need for electricity.

Consumers will experience these savings directly in their wallets, increasing the amount of money they have available to spend in other sectors of the economy. The effects will be felt throughout the state. Due to uncertainties in energy prices, however, this benefit is not included in the numerical analysis in this report.

Washington's Energy Efficiency & Renewable Energy Industry

The energy efficiency and renewable energy industries in Washington are ready to take up the challenge of reducing overall demand for electricity and developing the state's renewable energy potential. Washington has a wealth of assets, including: experienced consulting firms, engineering companies, and manufacturers; a growing wind power industry; strong trade relationships that could lead to the export of clean energy technologies to other states and countries; extensive government and university research and development support; and a highly trained and skilled work force.

Industry Breadth

The Washington Department of Community, Trade, and Economic Development commissioned a survey of the advanced energy industry in 1997, finding that it contributed as much to the state as the wholesale apple industry.[53] According to the survey:

- At least 274 firms directly identified their primary business activity as efficiency or renewable energy.
- These industries generated nearly $1 billion in annual revenue, employing nearly 4,000 people and delivering $160 million in wages to Washington citizens.
- Three-quarters of this activity came from the efficiency sector, with the remainder from solar, biomass, small-scale hydroelectric, and wind energy companies.
- Including the additional energy efficiency work done by the many companies that design, build, and install energy efficient equipment and buildings but do not count it as their primary business activity, the energy efficiency industry employs 10,000-15,000 people in the state.[54]

Energy efficiency companies in Washington provide a wide variety of services. Architecture and design firms help plan energy efficient structures. Consulting firms help businesses meet building codes and reduce energy use. Energy service companies provide a wide range of energy related services, from conservation to facilities management. Engineering firms create technical solutions. Manufacturers make energy efficient lighting, appliances, windows, motors, electronics that control energy use, and countless other efficient products. Other companies provide installation and service for heating, ventilation, air conditioning, and refrigeration systems.

Although the renewable energy industry in Washington is not as mature as the efficiency industry, it is playing an increasingly large role in the state's economy. In 1997, the renewable energy industry consisted of 134 companies with 900 employees and $147 million in revenue. Most of this activity stemmed from solar energy and related electrical companies. However, the wind power industry has grown rapidly since then to serve the Stateline Project and other wind projects currently in development.[55]

Washington companies can also export energy-related goods and services to other states and countries. Increasing use of clean energy sources spurred by state renewable energy standards and incentives in states like California, Texas, Minnesota, Iowa, and Nevada should open new markets for Washington's advanced energy industry. Worldwide, demand is growing quickly for efficiency and renewables, driven by increased need for electricity, government policies, and international agreements to reduce greenhouse gas emissions. Global installations for wind power are increasing at about 28% per year.[56] Washington can take advantage of its strategic location and trade links with the international community to open up new markets for clean energy technologies abroad.

New and growing businesses in Washington have access to support services from groups like the Pacific Northwest National Laboratory in Richmond (PNL) and Washington State University's Energy Extension Program.[57] PNL helps companies overcome organizational, environmental, and technical obstacles by making federally funded innovations available to businesses in the region. The Energy Extension Program at WSU provides a link between businesses and experts in energy use and technology, promoting energy efficiency at all levels of the economy.

Finally, Washington is home to a highly trained work force. The state ranks first in the country in the percentage of residents with a high school diploma. In Seattle, more than 93% of residents over 25 years of age have graduated from high school, and 36% have a university education.[58] This human resource can play a key role in providing the talent and experience necessary to make Washington a center of advanced energy development.

Companies Active in Washington

Many Washington companies involved in energy efficiency and renewable energy are worth profiling. Here are a few. A more complete list of relevant businesses is in Appendix A.

Energy Efficiency Companies

MagnaDrive Corporation

MagnaDrive of Seattle builds a new type of industrial motor that operates with little friction and greatly improved efficiency over conventional motors. The potential for this technology to reduce energy demand in the industrial sector is great: about 23% of the electricity generated in the U.S. is inefficiently used by single-speed industrial motors to run pumps, blowers, and large pieces of equipment.[59]

Two MagnaDrive motors helped the maintenance staff at the Washington Mutual Tower in Seattle improve the efficiency of the building's heating and cooling system. The new motors reduced energy use in the system by 30% to 66%, saving 36,000 kWh of electricity every year and reducing maintenance costs.[60]

The motors also helped a concrete and gravel company near Sacramento cut the power demand of a pumping system by 24%, saving 233,000 kWh and $17,000 per year. With a total cost of only $34,000, the project paid for itself within two years.[61]

In 2000, the company employed 14 staff and had $800,000 in revenues, with rapid growth expected to push sales as high as $20 million.[62]

Johnson Controls

Johnson Controls is one of the largest energy efficiency companies in the U.S., with Washington facilities in Bellevue, Richland, and Spokane. The company provides a wide variety of products and services, including:

- Manufacturing and installation of heating, ventilation, air conditioning, and lighting systems.
- Design and production of electronics and software to monitor and control energy use in buildings.

- Consulting on energy use and facility management contracting.
- Design and construction of facilities with overall efficiency in mind.

A study of Johnson Controls estimates that between 1990 and 2010 the firm's activities will conserve 270 million MWh of electricity, save customers $18 billion in energy costs, and create 9,000 jobs nationally.[63]

Siemens Building Technologies

Siemens Building Technologies is the North American affiliate of one of the world's largest electrical and electronic engineering firms. The company produces products used in building automation, ventilation, and temperature control. In Washington, the company has a facility in Bellevue, complementing the Siemens Solar Industries manufacturing plant in Vancouver.

Products made by this company help the Boeing Defense and Space Group in Seattle save nearly 7 million kWh of electricity worth $1 million each year.[64]

Perfection Glass

Perfection Glass provides weatherization and energy efficient window installation services in the tri-city area. The company employs 40 staff in its offices in Kennewick and Chelan.

The Lighting Design Lab

The Lighting Design Lab in Seattle promotes energy efficient lighting technologies. It is a non-profit organization funded by utilities and the Northwest Energy Efficiency Alliance. The lab provides education, training, consulting, technical assistance, and demonstrations for lighting consumers.

Philips Lighting Company

Philips Lighting Company is one of the world's largest lighting manufacturers. In Washington, the company has facilities in Shoreline, Somerset, and Bothell. Philips lighting employs more than 4,800 people across the U.S. and makes 625 million lamps per year. They manufacture a variety of products, including energy efficient compact fluorescent lights that reduce energy use by 75% compared to incandescent bulbs.

In June 2001, Phillips Lighting replaced the lights in an entire city block in Berkeley, CA with energy efficient compact and linear fluorescent light bulbs. The experiment resulted in a 45% energy savings, or roughly 62,700 kWh per year.[65]

Ecotope, Inc.

Ecotope is a small consulting firm with 25 years of experience providing energy efficiency and sustainability services in the Seattle area. The company works to make buildings more energy efficient through design, engineering, and sustainable building techniques.

Renewable Energy Companies

CH2M Hill

CH2M Hill is an environmental engineering firm that employs over 10,000 people at over 300 offices and project sites around the world.[66] Among many other activities, the company assists with wind project development. From locations in Bellevue, Lynnwood, Richland, and Spokane, the firm provides wind energy services including resource assessment, siting, permitting, licensing, transmission analysis, construction management, production forecasting, and operation and maintenance.

CH2M Hill is participating in some of Washington's new large wind projects, including:

- The Stateline Wind Project between Oregon and Washington.
- The planned Maiden Wind Project in Washington's Rattlesnake Hills.
- The planned Kittitas Valley Wind Project near Ellensburg.

The Wind Turbine Company

The Wind Turbine Company is a wind turbine manufacturer located in Bellevue. The company has been working on a new type of wind turbine technology since 1989. The blades of the turbine are oriented downwind, the opposite of conventional turbines. As a result, the blades and the structural tower can be made of more flexible materials with lower costs. The company expects the turbines to cost 30% less than conventional designs and reduce the unsubsidized price of wind energy to 3.5 cents per kWh.

The firm's proof of concept turbine was installed at the National Renewable Energy Lab in Colorado in 2000, with the first commercial wind farm expected within two years.[67]

Chinook Wind

Chinook Wind in Redmond provides a range of wind energy consulting services. The company tests wind energy sites and equipment, designs wind turbines, develops wind energy projects, supports operation and maintenance staff with monitoring and spare parts, installs structural towers for wind projects in the Pacific Northwest, and provides business and patent support services.

Toray Composites America

Toray Composites manufactures carbon fiber components for aircraft, as well as for wind energy systems. The company employs 150 people in Tacoma.

Energy Northwest

Energy Northwest is a joint operating agency run by 17 public utilities that owns the Nine Canyon Wind Project near Richland. The company also provides the operation and maintenance service to keep the turbines turning, in addition to operation and maintenance services for several other conventional power plants. They are planning to expand the Nine Canyon Project.

Global Energy Concepts

Global Energy Concepts in Kirkland is a leading wind energy engineering and technology consulting firm. The firm specializes in the analysis, design, testing, and management of wind energy systems and projects. Among many local, national, and international projects, the firm provided technical support to the Wind Turbine Company, including testing, tower design, aerodynamic analysis, and certification support. The firm also supports the City of Seattle in wind energy proposal evaluation and power purchase contract negotiation. Other clients include the world's leading wind turbine manufacturers, major utilities, foreign governments, and a variety of engineering and insurance companies. The firm employs 14 staff.

Harris Group

The Harris Group is an engineering company based in Seattle. The company works on a variety of energy projects, from biomass to cogeneration systems, as well as structural towers for wind

farms. The company's services include design, engineering, consulting, project planning, and feasibility studies.

Pacific Northwest National Laboratory

The Pacific Northwest National Laboratory (PNL) in Richland, operated for the U.S. Department of Energy, conducts research on environmental, energy, health, and national security issues. On the energy front, the lab works to produce scientific and technical breakthroughs in energy efficiency, stability of energy supply, and clean energy technologies. In addition, PNL runs an economic development program which helps to make federally funded technology advancements available to local businesses. In 2002, the lab employed 3,824 people and had a business volume of $550 million.

State policy is crucial to realizing the benefits of renewable energy. Historically, there has never been a new energy technology commercialized without help from government. Existing fossil fuel technologies benefit from large tax and public expenditure subsidies and from free use of the air, land, and water for waste disposal. Mature technologies have the advantage of occupying large and proven markets. Policy makes it possible for new energy technologies to compete with conventional energy sources. These policies act like a ladder, easing passage over an initial hurdle and helping technologies compete based on their inherent strengths and weaknesses, rather than on market share alone.

Other states prove how crucial policy is. From state contracts for renewable power to renewable purchase obligations to tax incentives, many states are finding ways to balance the playing field for renewable energy with well-established fossil fuel technologies like coal and natural gas. The lasting market for renewable power thus created is helping states realize the long-term advantages of renewable energy and promote outcomes they find beneficial for society. For example, these types of policies are helping Texas, Minnesota, Iowa, and California develop wind energy, protecting consumers from price spikes, reducing air pollution, and strengthening rural economies.

Texas

A renewables portfolio standard, requiring that utilities purchase a small amount of their electricity from renewable energy providers, is driving rapid growth in the Texas wind energy market, helping to reduce air pollution, ease demand for natural gas, revitalize struggling rural areas, and provide inexpensive electricity.

The renewables standard was signed into law by then-Governor George W. Bush in 1999. The standard requires 2,800 MW of renewable energy to be in place by 2009, or approximately 3% of the state's generating needs. An enforcement surcharge for missing renewable energy credits backs up the requirement.[68] The market created by this standard supported the construction of 912 MW of wind energy capacity in 2001 alone, putting Texas firmly into the leading ranks of sustainable electricity generation.

Most of this requirement will be met with wind energy, currently the least expensive renewable resource available. Wind speeds in the range of 18 mph and turbines producing an average of 40% of their peak capacity allow wind energy facilities in West Texas to produce cheap electricity. With the federal Production Tax Credit of 1.7 ¢/kWh, these facilities produce energy for less than 3¢/kWh, competitive with Texas' natural gas plants even at low natural gas prices.[69] Some of the largest wind energy facilities in the world are being built in West Texas. Most recently, FPL Wind Energy built a 278 MW project there, north of McCamey.

In response to Texas' renewable energy requirement and uncertainty about the duration of the Production Tax Credit, utilities and wind companies invested $1 billion in 2001 to build new wind energy projects.[70] These projects created 2,500 direct jobs with a payroll of $75 million, and will create $13.3 million in tax revenue and $2.5 million for landowners in 2002 alone.[71]

The renewables standard is driving utilities to gain experience with new technologies. As written, the renewables standard applies only to investor owned utilities. Although all utilities in Texas have access to federal incentives for wind power and to a renewable energy credit trading program in Texas, only investor owned utilities made significant acquisitions of wind power. Three of these companies bought 610 MW of wind energy in 2001, while six other utilities without a purchasing requirement bought only 1 MW. These three investor owned utilities alone exceeded the entire state requirement for 2001 by more than 200 MW. They seem to have found renewables to be less expensive and more reliable than predicted, and they bought more than strictly necessary.[72]

This policy provided dramatic benefits to the people of Pecos County, Texas. This county is one of the top ten oil producing counties in the state, but now it is attracting new types of prospectors — ones that search for landowners with excellent wind resources.[73] With over 400 MW of installed wind farms, the county added 14% to its total tax base in just one year.[74] The county will receive $4.6 million in additional property tax revenue in 2002.

Iowa

Motivated by a desire to "conserve … finite and expensive energy resources and to provide for their most efficient use," Iowa policy encourages the development of renewable energy facilities.[75] The 1983 Alternative Energy Production Law and its 1991 amendments require electric utilities to enter into long-term contracts for renewable energy.

This law required that investor-owned utilities in the state acquire 105 average megawatts of renewable energy.[76] For over 10 years, the utilities resisted the requirement, balking at any type of forced terms coming from the state utility board.

Windustries, Inc. and Midwest Wind Developers filed petitions with the Iowa Utilities Board in 1995, urging the Iowa Utilities Board to enforce the law. The board found that the utilities were not meeting their purchase requirements, and that willing renewable energy providers were ready to supply power.

In 1996, the Board set the standard contract price at 6 ¢/kWh over 33 years, guaranteeing a long-term market for some of the first renewable energy facilities in the Midwest.[77] The price was set to reflect the economic and environmental benefits of renewable power, which the state wanted to encourage.[78] The Board felt that this price balanced the need to encourage renewable energy development with reasonable rates for consumers.

They noted, "While the immediate impact of the 6¢ rate may be negative … if viewed from a rate impact standpoint only, ratepayers gain from diversity of fuel supply, lock-in of a 6¢ rate for the long-term, and environmental and economic benefits" resulting from the development of renewables.[79]

Two economic incentives back up this requirement. The federal Production Tax Credit reduces the price of wind-generated electricity by 1.7 ¢/kWh over the first 10 years of electricity production. This credit is available to facilities commissioned in any state through 2003. Iowa also has a sales tax exemption for manufacturing or purchasing wind energy equipment. This statute exempts from the state sales tax the total cost of wind energy equipment and all materials used to manufacture, install, or construct wind energy systems.[80]

The collective impact of these policies has made Iowa one of the leading wind energy markets in the Midwest. At the end of 2001, Iowa had 324 MW of wind power capacity installed. Another 200 MW is in various stages of planning.

The utilities have already met their requirement, but are installing additional facilities because they make economic sense, and utilities are willing to enter into power purchase agreements.

Renewable energy development in Iowa has not begun to approach its potential, however. Iowa is ranked 10th in the country in wind energy potential. A recent study by the Iowa Policy Project, looking at several scenarios the state was considering to increase renewable energy generation, found that alternative energy provides an excellent opportunity to generate and retain dollars in Iowa and reduce the demand for coal.[81] Another study projects that increasing renewable electricity generation could save the state's ratepayers over $300 million over the next 30 years.[82]

A Few Wind Farms Created by Iowa Policy

Iowa's wind farms at Storm Lake (196 MW) and Clear Lake (42 MW) directly result from state policy. These wind farms pay royalties to 115 different landowners, totaling roughly $640,000 per year. They pay $2 million in property taxes to counties. They employed 200 people for 6 months in construction, and support 40 permanent operations and maintenance workers.[83]

Minnesota

Faced with growing pollution problems, especially the lack of safe storage space for nuclear waste, the Minnesota Legislature established a preference for renewable energy. The Legislature determined that renewable power was the best way to reduce the harmful impact of conventional electricity generation. They put several policies in place to shift electricity production in a more sustainable direction.

First, the Legislature established a clear preference for renewable energy and conservation in their resource planning process. In 1994, it ordered Xcel Energy to purchase wind energy in exchange for allowing the company to store nuclear waste at one of its plants. In 1999, the Minnesota Public Utilities Commission identified wind as a least-cost resource, competitive with traditional technologies. Finally, in 2002, the Legislature helped to level the playing field between wind power and traditional technologies by linking property tax payments to output instead of assets for wind facilities.

Minnesota's electrical resource planning process has a clear preference for renewables and conservation. The rules are designed to ensure that utilities give adequate consideration to socioeconomic and environmental impacts of different resource mixes. Every two years, a utility must prepare and submit least-cost estimates for meeting 50% and 75% of its new energy needs through conservation and renewable energy. It also must evaluate the environmental costs of the generation technologies it selects.[84] The Public Utility Commission also approves nonrenewable energy facilities only if their renewable equivalents can be shown to be against the public interest. [85]

The Legislature ordered Xcel Energy to buy renewable power as part of a nuclear waste storage deal eight years ago. Xcel operates a nuclear power plant at Prairie Island, Minnesota. In 1994, Xcel ran out of viable places to store the extremely radioactive waste, and asked the Legislature for permission to store it in dry casks on site. As a part of this deal, the Legislature prodded Xcel to get out of the nuclear business by ordering Xcel to purchase 425 MW of wind and 125 MW of biomass facilities by 2002.[86] This law spurred the construction of the Lake Benton wind farms (211 MW), creating 240 year-long construction jobs, $1.5

million in contracts to Minneapolis engineering firms, and 61 ongoing jobs in operation, maintenance, administration, and sales in rural Minnesota.

A second part of this deal stipulated that an additional 400 MW of wind must be added if the Public Utilities Commission found that wind was competitive as a part of its least-cost resource planning process. In 1999, the commission ordered Xcel to bring the additional capacity online by 2012, finding that wind was at least as attractive as natural gas.[87]

In 2002, the Minnesota Legislature enacted a change in the way that wind farms are taxed, helping to level the playing field between wind energy and traditional technologies.[88] Since the assets of renewable energy producers are worth more in terms of replacement value, they paid higher taxes. The bill exempted wind energy projects from traditional property taxes, and created a direct payment program based on the actual electricity generation of the project. Basing tax payments on output rather than assets brings Minnesota one step closer to establishing tax equity between wind and conventional technologies.

Minnesota also has a renewable energy goal of generating 10% of its electricity from renewables by 2015, excluding the 825 MW Xcel was ordered to purchase. This goal requires "good-faith" efforts from utilities, and does not include any enforcement mechanism other than the resource planning process.[89] As a result, this goal is unlikely to drive the renewable energy market significantly.

At the end of 2001, Minnesota had 319 megawatts of wind energy capacity. Within the next decade, Minnesota will have at least 825 MW of wind energy capacity.[90] Minnesota ranks 9th in terms of wind energy potential. Given this potential, much more renewable energy development should happen in the state.

Landowners Take Advantage of Wind Energy

Roger and Richard Kas of Woodstock were part of the first group of landowners to lease land to wind developers in response to the Xcel order. They have 17 turbines taking up two percent of their 320 acres of crop-producing land. Their turbines began generating electricity in 1999. The project has been so successful that the brothers have purchased and put up their own turbines, financed by a local bank. The brothers see it as an opportunity to grow one more crop. In a recent newsletter for farmers looking to take advantage of the wind on their land, Roger said, "we're here everyday feeding the cattle and taking care of the farm, and we see the wind turbines as just a few more machines for us to take care of."[91]

California

In September 2002, Governor Gray Davis signed into law the strongest renewable energy bill in the country, ensuring that 20% of California's energy will come from clean energy sources in the next 15 years. The bill, the California Clean Energy Bill, established a renewables portfolio standard (RPS) requiring that 20% of California's energy be produced from clean technologies like wind, solar, and geothermal sources by 2017. The program will be implemented by the California Public Utilities Commission.

Currently, California obtains about 10 percent of its electricity from renewable energy. The new law requires all retail sellers of electricity to add between one and two percent of clean power every year until they reach 20%. They must reach that goal no later than 2017.

California utilities responded to the RPS even before it was fully implemented. San Diego Gas & Electric announced new contracts for wind and biomass power in November 2002 for 4% of its electricity needs in 2003 and 7% in 2004.[92] Southern California Edison signed a contract in March 2003 for 200 MW of geothermal power.[93] Other contracts for renewable energy have been hinted at but are unconfirmed and undisclosed.

In addition to the Clean Energy Bill, Gov. Davis signed two other energy bills in 2002 that remove barriers for increased investments in renewable energy. AB 58 extended California's Net Metering Program, allowing consumers who install their own solar or wind energy systems to credit excess clean power on their utility bills. AB 117 allows municipalities to negotiate with independent power providers, many of which offer cleaner energy than the current companies servicing the state.

Policy Findings

The single biggest impediment to developing renewable energy projects is that nearly all of the costs are incurred up-front, in the form of initial construction costs. In effect, renewable energy producers are financing 30 years worth of power all at once. In the absence of long-term contracts, building renewable energy plants involves more risk to investors due to uncertain future markets. Traditional power plants can be more attractive to investors because the technologies have been around longer, require less initial investment, and attract long-term purchase contracts from utilities; fuel costs are then incurred over time, and increases due to fuel cost changes can be passed on to consumers.

Due to the real and perceived risks associated with wind power, lenders have offered less favorable financing terms and demanded a higher return on investment than for traditional energy sources.[94] For capital-intensive technologies like wind, the price of electricity depends greatly on the interest rate at which the owners pay off debt. A 1996 study by the Lawrence Berkeley National Laboratory found that contract prices for wind-generated electricity could decrease by 25% with financial terms typical of natural gas projects.[95]

High plant construction costs followed by almost free production makes renewable energy unique in the world of electricity generation. Fortunately, electricity is also somewhat unique in that it is a commodity we all use which has a long history of regulation to ensure stable supplies at fair prices. To promote renewables, the state can provide a guaranteed market for renewable energy, without vast subsidies or regulation of specific investments. If renewable energy producers had a guaranteed price for much of the lifetime of their plants, the high construction costs would present less of a barrier and attract better financing terms. Given a foothold in the market, renewable energy technologies will then be able to gain a larger market share with less assistance.

Washington state recently took good steps forward with completion of the Action Plan for a Sustainable Washington.[96] This report has the right goals, but still lacks the policies and incentives to achieve those goals.

Washington has several policy options to realize the economic benefits that renewable energy and energy efficiency can provide. Based on the experience of other states, the most effective policies ensure a lasting, stable market for renewables upon which developers and investors can depend, and are guided by a cohesive state policy rather than varying policies adopted by different jurisdictions.

Renewable Energy Standard

Creating a guaranteed market for renewable energy with a purchasing requirement will ensure that wind developers do not overlook Washington. To ease the hurdle of high up-front costs and uncertain markets, the state can require utilities to get some of their power from renewable energy producers. Such agreements reduce the risk of investment and make it possible to produce cheaper electricity.

There are about a dozen states that have some kind of minimum renewables requirements now, including California, Nevada, Arizona, New Mexico, Texas, Wisconsin, New Jersey, Connecticut, and Massachusetts.

Effective purchase requirements include a clear way to track utility compliance and a system of incentives and penalties to encourage utilities to follow through with procuring renewable energy.

Energy Conservation Standard

Washington should require all utilities doing business in the state to meet a percentage of future power needs with energy conservation. Opportunities for energy savings are abundant, and the utilities are well positioned to administer the development of many of those opportunities. As part of their public interest responsibilities, utilities should be required to include energy conservation as part of their energy development plans.

Deny Permits to Pending Fossil Fuel Power Plant Proposals

Energy companies have built 860 MW in fossil fuel-based power plants in Washington in the past two years and are actively constructing 787 MW more. In addition, the state has granted initial approval to fossil fuel power plants with a combined capacity of 2,031 MW that are now under development. Nearly all of this capacity is fueled by natural gas.

This amount of natural gas power plant development has more than achieved its purpose of boosting energy reliability in Washington. At this point, the state risks decreased reliability due to over-dependence on volatile fossil fuels.

Most recently announced power projects are also fueled by natural gas. The state should reverse this trend and not grant approval to any more natural gas power plants. The wind projects currently being built are enough for the next stage of energy capacity development in Washington.

Tax Incentives for Renewable Energy Equipment

Tax incentives such as Iowa's sales tax exemption for equipment used in wind farm construction or manufacturing can help make wind energy more economical. These incentives reduce the initial capital investment required to develop a wind farm and produce a lower levelized cost for wind-generated electricity. However, it should be noted that tax incentives work best in conjunction with standards rather than in isolation.

Transmission Planning

Other potential obstacles to renewable energy development can happen when transmission capacities are inadequate. Because adding or upgrading transmission lines often takes longer than building a new wind plant, problems can occur in getting the wind-generated electricity to market.

In order to accommodate sustained new wind power development, Washington will need to make sure that necessary transmission upgrades are timely. By keeping a close eye on transmission planning with wind power in mind, the state can play an important role in helping to realize the benefits of wind energy.

Table 15. Proposed New Generating Projects (MW)[97]

Resource	Permitted	Planned	In Study	Total	Pct
Hydro	56	21	31	108	1%
Coal			349	349	5%
Natural gas	2,031	2,608	1,254	5,893	78%
Nuclear			150	150	2%
Biomass		6	24	30	0.4%
Wind	65	715	230	1,010	13%
Total	2,096	3,329	2,007	7,539	

Appendix A. Energy Efficiency and Renewable Energy Companies in Washington

Washington already has a wealth of business activity in the energy efficiency and renewable energy industries. An informal survey by the WashPIRG Foundation has identified 113 energy efficiency companies, 16 renewable energy companies, and 6 research organizations.

The following companies were identified in the course of developing this report. Many came from reports of the Washington Department of Community, Trade, and Economic Development. Others turned up in news searches and trade journals.[98] They represent about half of the companies counted in the Department's anonymous 1997 survey.

Energy Efficiency Companies

Consulting, Architecture, and Design

Advanced Energy Services	Mukilteo
Art Anderson Associates	Bremerton and Seattle
Ardary Consulting	Olympia
BRACO Resource Services	Seattle
DEI Electrical Consultants	Spokane
Dorough Resources	Bellingham
Ecotope	Seattle
Efficiency Development Services	Vancouver
Encompass	Seattle
Energard Technologies	Redmond
Interface Engineering	Kirkland
Interlocken Energy Services	Port Orchard
JA Energy Services	Seabeck
L&S Engineering Associates	Spokane
LineSoft Corporation	Spokane
Management Engineering Associates	Camas
MW Consulting Engineers	Spokane
Parker Messana and Associates	Federal Way
Path Engineers	Bothell
Power System Engineering	Covington
Price Consulting	Seattle
Putnam Resources	Seattle
Recovered Energy Resources	Seattle
Resource Efficiency Management	Bremerton
Resource Efficiency Services	Maple Valley
Rice Group	Lynnwood
Riley Engineering	Spokane
SBW Consulting	Bellevue
UCONS	Bellevue
Itron	Vancouver
Thomas Gerard and Associates	Spokane
Total Efficiency Network	Olympia
Unicade	Bellevue
Utility Bill Advisory Services	Puyallup
VECO Pacific	Bellingham

Energy Management Control Systems

Alerton Technologies	Redmond
Allen-Bradley	Spokane
Building Control Systems	Lynnwood
Control Contractors	Seattle
Energex	Blaine
Holaday-Parks	Seattle
Johnson Controls	Bellevue, Richland, and Spokane
LRS Electric Controls	Spokane
Powerit Solutions	Seattle
Programmable Control Services	Spokane
Electrical Service Products	Spokane
MicroPlanet	Edmonds
Energy Smart Products	Redmond
PLC Multipoint	Everett
Square D Company	Spokane
Thompson Sales	Vancouver

Energy Service Companies and Engineering Companies

Abacus Engineered Systems	Seattle
ACCO Engineered Systems	Kent
Casne Engineering	Spokane
CDi Engineers	Lynnwood
Cochran	Seattle
Coffman Engineers	Seattle and Spokane
Conley Engineering	Yakima
Control Contractors	Seattle
Demand Side Engineering	Redmond
EMCOR Facilities Services	Kent and Gig Harbor
EMP2	Richland and Kennewick
Engineering Economics	Seattle
Engineering Services Organization	Bremerton
ESSCO Electric	Pasco
Honeywell	Redmond
Global Energy Partners	Olympia
Jaco Electric	Pasco
Landis and Staefa	Bellevue
L.N. Storset and Associates	Gig Harbor
Matrix Northwest	Seattle
Madison Engineering	Seattle
MC Squared Efficient Energy Systems	Vaughn
Northwest Energy Services	Spokane
Professional Energy Management	White Salmon
Quantum Engineering and Development	Seattle
Siemens Building Technologies	Bellevue
Richmond / Archos Engineering	Olympia and Longview

Heating, Ventilation, Air Conditioning, Insulation, and Refrigeration

Apollo	Kennewick
Bob Rhodes Heating and Air Conditioning	Kennewick
Cork Insulation Division	Seattle
Dayco Heating and Air	Kennewick
Evergreen Refrigeration	Seattle
Flow Control Industries	Woodinville
Harold Electric	Walla Walla
In Control	Seattle
Intermountain West	Kennewick
JA Energy Services	Bremerton
MacDonald-Miller Company	Seattle
McKinstry Company	Seattle
Pacific Western Agencies	Vancouver
Perfection Glass	Kennewick
Performance Heating and Air Conditioning	Kent
Puget Sound Refrigeration	Seattle
Sturm Heating	Spokane
Town and Country Heating	Vancouver
Trane Company	Spokane
University Mechanical Contractors	Mukilteo
Vincent Construction	Pasco

Lighting Products and Services

The Lighting Design Lab	Seattle
Cascade Lighting and Design	Snohomish
Sparling Electrical Engineering and Candela Architectural Lighting	Seattle
Columbia Lighting	Spokane
Osram Sylvania	Seattle
Efficiency Works	Seattle
Graybar Electric	Spokane
G.E. Lighting	Issaquah
Holophane Lighting	Bainbridge Island
NEMCO Architectural Lighting	Seattle
PFO Lighting, Inc.	Vancouver
Phillips Lighting Co.	Shoreline, Somerset, and Bothell

Efficient Motor Manufacturing

Magna Drive Corporation	Seattle
Magna Force, Inc.	Port Angeles

University Research Facilities and Education/Training Organizations

WA State University's Comparative Extension Energy Program	Olympia
The Energy Project	Bellingham
Northwest Energy Coalition	Seattle
Energy Ideas Clearinghouse	Olympia
New Buildings Institute	White Salmon
Pacific Northwest National Laboratory	Richland, Seattle, and Sequim

Renewable Energy Companies

Wind Energy Companies

CH2M Hill	Bellevue, Richland, Lynnwood, and Spokane
Energy Northwest	Richland
Wind Turbine Company	Bellevue
Toray Composites America	Tacoma
Global Energy Concepts	Kirkland
Kelso Starrs and Associates	Bellevue
Harris Group	Seattle and Kennewick

Solar Power and Related Companies

Ample Technology	Seattle
Schott Applied Power Corporation	Turnwater Washington
JX Crystals	Issaquah
Shell Solar	Vancouver (formerly Siemens Solar)
Xantrex	Arlington (formerly Trace Engineering)
Wescorp	Seattle

Other

CWT Technologies	Richland
North American Energy Services	Issaquah
Power Resource Management	Co-owned by four PUDs.

Appendix B. Methodology

This study provides a sketch of the economic impacts of supplying a significant amount of Washington's electricity needs with wind energy and energy efficiency. The intent is to give a relatively simple estimate of the economic value of various activities supported by wind and efficiency, as if all of the activity happened in the present. Accordingly, future dollar values do not include inflation or discount estimates. Key assumptions and calculations are summarized below.

Demand Prediction and Wind Power Growth

The Northwest Power Planning Council assumes annual growth in electricity generating needs of 1.48% for Western Washington's and 1.52% for Eastern Washington. in the draft of the Fifth Northwest Power Plan.[99] We use 1.5% for a statewide average. Baseline utility generation of 92,300 GWh for 2000 in Washington is reported by the Energy Information Administration (EIA).

Wind energy figures assume the turbines will operate at 33% capacity through 2010, and that technological advances will then increase the capacity factor to 35% through 2015 and 37% thereafter. The analysis of the impacts of natural gas stem from the amount of new natural gas plants required to supply the same amount of electricity, based on the 90% capacity factor expected by NWPPC.[100]

Employment

Wind energy employment impacts derive from applying employment estimates from the Electric Power Research Institute (EPRI) to the projected development of 1,700 aMW of wind power as described above, assuming only 20% of manufacturing activity will happen in-state. EPRI predicts that the manufacturing and installation of 1 MW of wind power requires 2.57 people working for one year. They estimate that 20% of that will go towards local labor for installation, and 80% will go towards manufacturing. For operations and maintenance jobs, we use the 0.06 jobs/MW figure from a recent study by Public Citizen and Texas SEED because it is more conservative than the EPRI estimate of 0.145 local O&M jobs per MW.[101] It is also supported by a recent analysis for the Colorado Legislature by Gary Tassainer of TASCO Engineering, which estimated 0.06-0.08 O&M jobs/MW for wind energy. We leave the EPRI estimates for manufacturing and installation unaltered, as they are the most conservative we have found.

Natural gas employment estimates derive from employment intensities at 19 proposed natural gas plants in California and from Washington demand projections.[102] These plants require an average of 0.49 installation jobs and 0.04 operation and maintenance jobs per MW. The manufacturing estimate in this report projects employment of 0.34 jobs per MW, assuming a representative cost breakdown for a natural gas plant of 30% installation and 70% components — 2.3 times as many jobs for manufacturing than installation — and 20% in-state manufacturing.[103]

Landowner Income

Royalties from land leases to wind farm owners are estimated at 2.5% of the yearly sale of electricity at 3 ¢/kWh, escalating with projected growth in wind power use.

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