Renewables Work

Job Growth from Renewable Energy Development in the Mid-Atlantic

MaryPIRG Foundation
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Executive Summary

By meeting future electricity demand with wind and solar power, the Mid-Atlantic region can develop a strong renewable technology industry and position itself as a major supplier to growing international clean energy markets. The area's natural resources, high-tech business experience, and access to trade routes uniquely situate the region to meet both local and global demand for renewable technology components, creating a powerful engine for economic growth.

Renewable energy can provide much of the power needed to meet future electricity demand in the Mid-Atlantic states of Maryland, Delaware, New Jersey, and Pennsylvania.

Electricity use in the Mid-Atlantic region is projected to grow by almost 20% over the next decade. In addition to energy efficiency programs, new generating capacity will be necessary to meet additional demand and to replace older power plants as they go offline. Much of these needs can be satisfied by wind and solar energy:

- According to estimates prepared by the National Renewable Energy Laboratory (NREL), the Mid-Atlantic region has enough natural wind resources to generate over 52 million MWh per year, over 17% of current demand. This does not include significant potential from offshore wind power.

- Additionally, NREL predicts that at least 10% of U.S. power-generation capacity will be solar photovoltaic cells by 2030.

Developing economically accessible wind energy resources in the Mid-Atlantic would create tens of thousands of well-paying jobs.

Wind industry experts place the economically developable wind potential of the Mid-Atlantic states at around 10,000 MW. Developing this amount of energy by 2015 could satisfy just over half of new electricity demand, generate over 9% of regional electricity needs, and power over 3 million homes. Through 2014, the benefits of this scenario for the Mid-Atlantic region include:

- 11,100 year-long jobs in wind turbine manufacturing and installation, with a total payroll of $334 million.
- 740 permanent jobs in wind farm operation and maintenance, with a yearly payroll of $30 million.
- 12,700 year-long jobs and 850 permanent jobs indirectly supported by wind turbine manufacturing, installation, and service, and induced by increased spending in the regional economy.
- At least $23 million in royalties paid to rural landowners who lease land for wind generation. Landowners with favorable wind resources can supplement their yearly income by more than $2,000 per turbine, with a majority of the land still free for farming, grazing, or other use.

The economic development potential of wind power will increase as offshore wind development becomes more feasible in the next decade.

Placing solar panels on one out of ten homes in the Mid-Atlantic would create thousands of high quality jobs and reduce overall electricity prices by reducing demand.

Using photovoltaic technology, every home, business and office building can generate a significant portion of the electricity it uses. Installing a 2 kW photovoltaic system on just one out of ten homes in the Mid-Atlantic would:

- Create 5,710 year-long local jobs in installation, operation and maintenance and 8,080 year-long manufacturing jobs, many of them in the Mid-Atlantic.
- Reduce electricity rates paid by all electricity consumers, especially during summertime peaks in demand when solar panel output is highest.
- Help to hedge against future blackouts like the one that struck the northeast in August 2003.

Wind and solar power create more economic growth than fossil fuels.

Renewable energy technologies have greater economic impact than traditional fossil fuels. Because the fuel is free, wind and solar expenditures support more local jobs than natural gas with its ongoing fuel expenses.

- Choosing wind power over a comparable amount of natural gas-fired generation would create more than twice as many jobs.
- Installation, operation, and maintenance jobs for wind farms are likely to be located in rural, mountainous counties where coal mining jobs have been on the wane. Pennsylvania coal mining employment, for example, is now less than half what it was in 1990. Some of these lost jobs may be replaced by wind development.

By positioning itself to supply growing worldwide demand for renewable energy technologies, the Mid-Atlantic region can create significant economic growth.

Strong local demand can help the Mid-Atlantic renewables industry to develop the technical expertise and manufacturing capacity that will enable it to become a global leader in this economic sector. Combined with access to world-class ports for shipping, a tech-savvy workforce, and a robust infrastructure for manufacturing, the Mid-Atlantic could become a major supplier to a rapidly growing international market:

- Worldwide wind capacity is predicted to reach 130,000 MW by 2010—more than a threefold increase over current capacity. The wind generation market, worth $4 billion in 2000, is expected to grow to $43.5 billion by 2010.
- The global market for photovoltaic cells is expected to reach $23.5 billion in 2010, as economies of scale push costs down. Solar is expected to account for 10% of U.S. power-generation capacity by 2030.

State policies can effectively promote the development of economical wind and solar energy.

The Mid-Atlantic states can adopt specific policies to jumpstart renewable energy development and attract high-tech, renewable manufacturing companies here. These policies include:

- **Renewable Portfolio Standards (RPS).** Such standards would require that a significant portion of electricity provided to consumers come from clean, renewable sources, thus creating a guaranteed market for generators of wind and solar electricity. New Jersey already has RPS, but its requirements should be made stronger—and the other Mid-Atlantic states should enact strong RPS—in order to ensure more generation from renewables.
- **State purchasing obligation.** Government agencies form a potentially large market for renewable electricity. Mandates that a certain amount of the electricity used in government facilities come from renewables would guarantee a sizable long-term market.
- **More generous net-metering limits.** Net-metering lets owners of small renewable systems (such as rooftop PV) sell their unused electricity onto the grid, to be used by other consumers. The Mid-Atlantic states all allow net-metering, but the policies are inconsistent and too restrictive in the size of qualifying systems. By raising current limits on the size of net-metered systems, states can encourage more small-scale renewable generation, which will also create more distributed generation.

Introduction

Clean, renewable energy is poised to become a major power source around the globe. Wind power generation has been transformed—from quaint wooden mills to towering steel structures topped with multi-megawatt turbines. The same solar technology that was once used simply to power calculators now powers buildings. Advances in technology over the past decade have made wind power cost-competitive with dirtier forms of generation, and advances in the coming decade will place solar power in the same position.

The potential benefits of these relatively new technologies can hardly be overstated. They already dispel much of the conventional wisdom about electricity generation.

The conventional thinking is that power plant pollution is a necessary evil. Our society's historic reliance on fossil fuels and nuclear energy have left us with the expectation that our energy needs leave us with no recourse but to attempt to minimize and mitigate pollution and its accompanying health impacts. But wind and solar power create no pollution and have negligible environmental impacts.

We have also learned to believe that we have no choice but to tolerate price spikes. The National Petroleum Council predicts that, due to the uncertainty of natural gas supplies, the current situation of high energy costs and price spikes "will likely persist and could deteriorate."[1] But there's nothing uncertain about energy from the wind and sun; these resources are endlessly renewable, and they're free.

As the benefits of clean renewable power over conventional power become increasingly evident, both at home and worldwide, demand for the technologies with which we harness wind and sun is increasing, creating an enormous market opportunity. The Mid-Atlantic region already has experience with these technologies: from Pennsylvania's AdvanTek wind engineering facility, to residential installers like New Jersey's Ecological Systems, to the Maryland headquarters of BP Solar, one of the world's largest manufacturers of photovoltaic products and systems.

Our region's renewables industry is poised to become a major player on an international scale. This burgeoning economic sector has the potential to create high quality jobs—in design, engineering, manufacturing, and installation—at a time when job growth is sorely needed in the Mid-Atlantic states. By guaranteeing a market for renewable power here in the Mid-Atlantic, state governments can lead the way to a cleaner future with more and better employment opportunities in the energy industry.

Meeting Energy Growth with Renewables

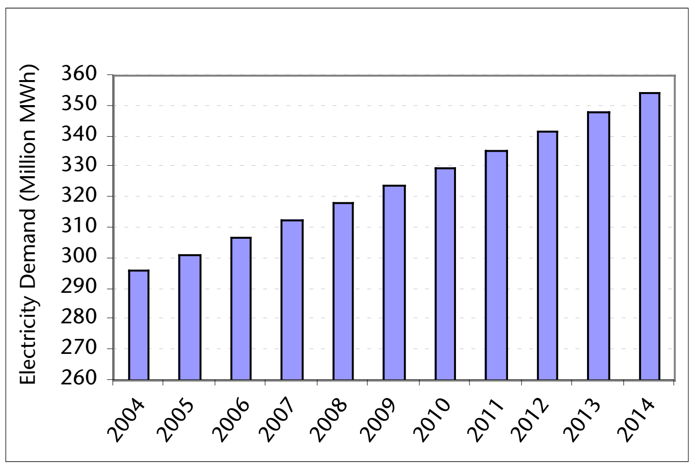
Renewable energy can provide much of the power needed to meet future electricity demand in the Mid-Atlantic states of Maryland, Delaware, New Jersey, and Pennsylvania.

If past growth patterns continue, electricity demand in the Mid-Atlantic region will grow almost 20% in the coming decade. Electricity use has grown an average of 1.80% annually for the past ten years. At this rate, the four states' combined 2001 electricity demand of 281 million MWh will reach 354 million MWh by 2014 (Figure 1).[2]

To meet electricity demand growth, the region can go two directions. One possibility is to stay on the same dirty path of nuclear power, coal and other fossil fuels. The other route, already being followed by a few pioneers, is cleaner, healthier, and more reliable electricity generation from renewables.

The Mid-Atlantic region has renewable resources capable of supplying a significant fraction of regional energy needs. Wind generation is especially promising because rapid advances in the technology over the past decade have made it cost-competitive with dirtier sources of energy. Solar generation offers an immense source of electricity nearly anywhere that energy demand exists, and its compact form provides a useful electricity source in the densely populated sections of the region where large-scale generation is impossible.

Figure 1: Projected Mid-Atlantic Energy Demand Through 2014



According to estimates prepared by the National Renewable Energy Laboratory (NREL), the Mid-Atlantic region has enough natural wind resources to generate over 52 million MWh per year from wind turbines (Table 1).[3] Fully developed, this potential would supply over 17% of 2002 electricity demand (294 million MWh).[4] Assuming that wind turbines produce an average of 33% of their peak output as wind speeds vary over time, this figure equates to 18,000 MW of capacity. Experts in the wind energy field expect roughly 10,000 MW of this energy will be economically developable.[5] Currently, energy companies are utilizing just over one percent of regional wind resources. Additionally, the potential estimates prepared by NREL do not include significant offshore wind resources that may become feasible to develop in the near future.[6]

As solar energy technology develops, it is likely to grow in importance as a regional energy source. NREL predicts that at least 10% of U.S. power-generation capacity will be solar photovoltaic cells by 2030.[7]

A Plan for Mid-Atlantic Wind Energy Generation

Extrapolating the pace of wind power growth over the past five years (Figure 2), we examined a scenario in which wind energy satisfies an increasing fraction of new electricity demand through 2014 (Figure 3). Under this scenario, wind-generated electricity will meet over 9% of total electricity demand by 2015—enough to power over 3 million homes (Table 2).[8]

Because of reduced system reliability caused by large inter-grid transfers of energy, much of the wind power to meet regional demand will likely be produced somewhere within the PJM grid region, as opposed to in the Midwest. The North American Electric Reliability Council (NERC) has repeatedly warned that growing bulk transfers of power threaten the capacity of an electric grid that was largely built to handle the more local, regulated markets of the past.[9] For this reason, it makes sense to look at satisfying the electricity demands of these four states in terms of the wind potential throughout the grid region.

At the end of 2003, the PJM grid region had nearly 200 MW of installed wind capacity. Projects that are already planned and underway (Table 3) could add another 562.3 MW in 2004; however, the uncertain status of the federal Production Tax Credit has stalled many of these projects. Supposing that half of

Table 1. NREL Estimated Potential Wind Generation vs. Actual Wind Generation

	NREL estimated wind potential (MWh)	Utilized potential at the end of 2004 (MWh)	% of total NREL estimated potential utilized
Maryland	2,240,000	54,300	2.4%
New Jersey	8,700,000	10,200	0.1%
Pennsylvania	39,340,000	506,300	1.3%
Delaware	2,240,000	0	0%
Mid-Atlantic Total	**52,520,000**	**570,800**	**1.1%**
West Virgina	4,860,000	722,300	14.9%
PJM Grid Total	**57,390,000**	**1,293,100**	**2.3%**

this capacity is actually installed by the end of the year, total PJM wind capacity would more than double during 2004 (Figure 2), yet the grid region would still only be utilizing 2.3% of its total wind potential projected by NREL (Figure 4).[10] A large portion of this is due to the two large wind farms (150 WM and 250 MW) planned for construction in West Virginia during 2004.

Table 2. Projected Wind Capacity to Meet Future Electricity Demand In the Mid-Atlantic

Year	Installed Mid-Atlantic Wind Capacity (MW)	Mid-Atlantic Wind Capacity Installed During This Year (MW)	% of Mid-Atlantic Electricity Demand Met With Wind
2004	129	80	0.2%
2005	210	180	0.4%
2006	390	360	0.6%
2007	750	550	0.9%
2008	1,310	730	1.5%
2009	2,030	920	2.1%
2010	2,950	1,100	3.0%
2011	4,050	1,300	4.0%
2012	5,350	1,470	5.2%
2013	6,820	1,690	6.5%
2014	8,510	1,850	8.0%
2015	10,400	N/A	9.6%

PJM Grid

Pennsylvania, New Jersey, Maryland, and Delaware are all on the same electricity grid, known as the PJM. A large portion of West Virginia is also served by this grid, as are parts of Virginia and Ohio. The grid is operated by PJM Interconnection, a regional transmission organization which plans generation and transmission expansion, and coordinates the largest competitive wholesale electricity market in the world. This means that electricity demand in one part of the grid can be satisfied by generation in other parts.

For simplicity, references to the "Mid-Atlantic region" in this report should be taken to mean Pennsylvania, New Jersey, Maryland, and Delaware. The "PJM grid region" or the "PJM" is the Mid-Atlantic region, plus the state of West Virginia.

A Note on Units

Megawatts (MW) are the standard measure of a power plant's generating capacity—how much power it could produce if operating at full speed. Utilities also measure their ability to supply demand on the grid at any one time in terms of MW. One MW equals 1,000 kilowatts (KW). One thousand MW equals one gigawatt (GW).

Power plant output and electricity consumption over a fixed length of time are measured in terms of megawatt-hours (MWh), the total amount of electricity generated or consumed during one hour. For example, a 50 MW power plant operating at full capacity for one hour produces 50 MWh of electricity. If that plant operates for a year at full capacity, it generates 438,000 MWh of electricity (50 MW capacity x 8,760 hours/year). To give a sense of scale, an average household uses about 10 MWh of electricity each year.

Most plants do not operate at full capacity all the time: either they are shut down for maintenance, because their power source is not available (the wind is not blowing), because their power is not needed, or because they are operating at only part of their maximum generating potential. The portion of the plant's full capacity that is in use, on average, given projected time off line, is called its capacity factor. Thus a 50 MW plant with a 33 percent capacity factor would produce 144,540 MWh of electricity in a year (50 MW x 8,760 hours/year x 33% capacity factor).

A facility's generating potential sometimes is measured in average MW (aMW), the amount of generation averaged over all the hours of the year. A 50 MW plant with a 33 percent capacity factor will have a potential of 16.5 aMW (50 MW x 33% capacity factor).

Figure 2: Wind Power Capacity on the PJM Grid is Rapidly Increasing

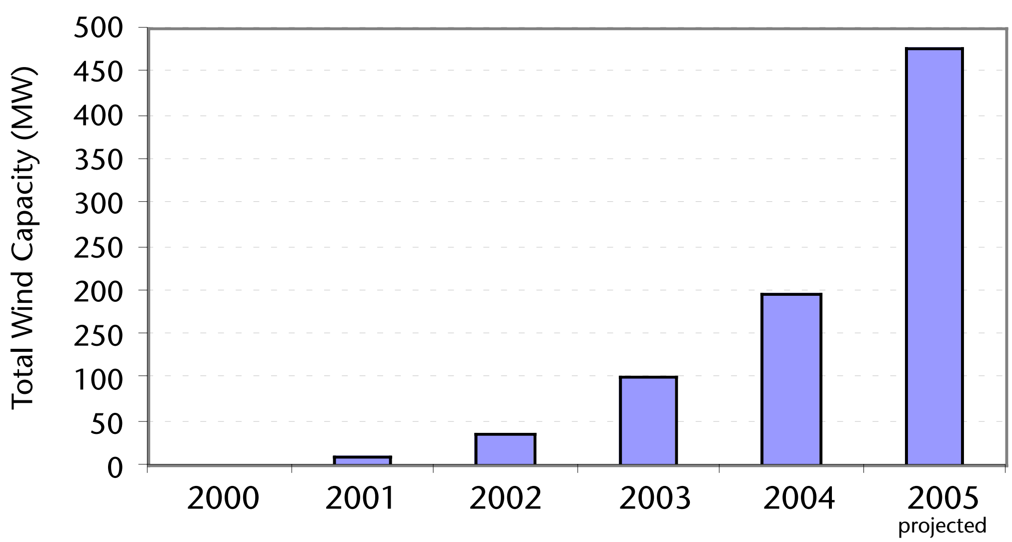


Figure 3: Projected Increase in Wind Generation

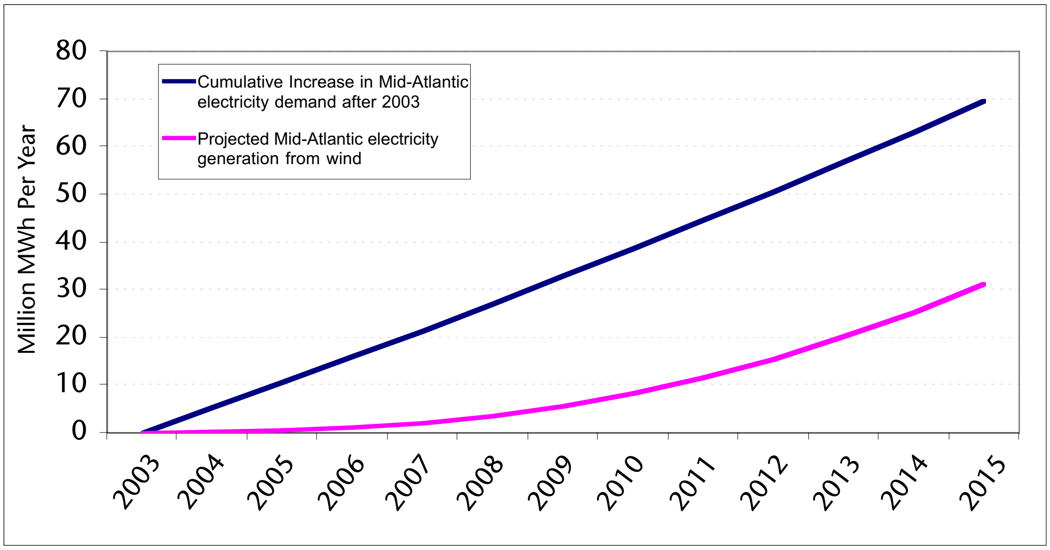


Figure 4: Expected Wind Generation at the Beginning of 2005 as a Percentage of Natural Resource Potential

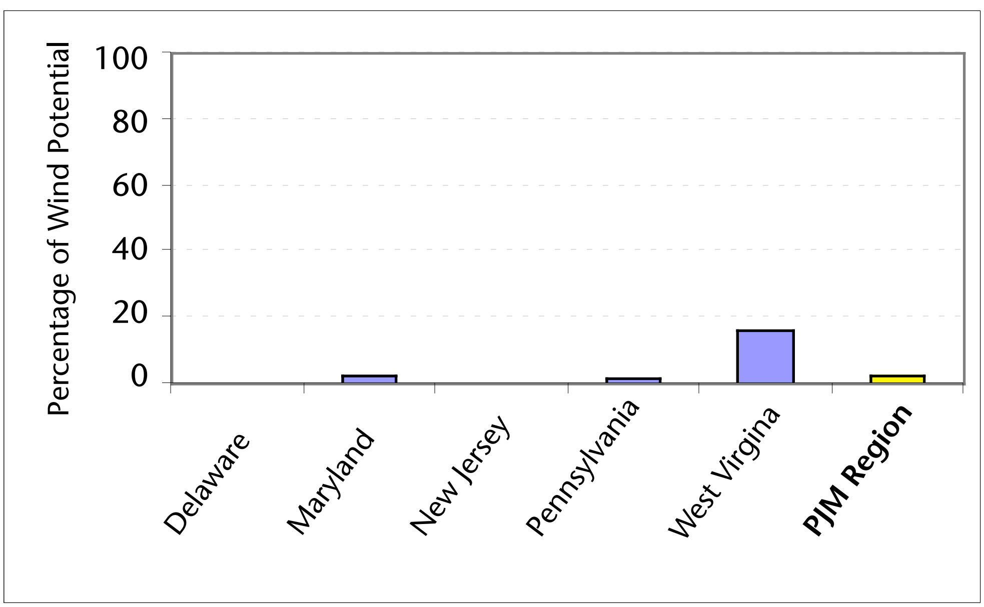


Table 3. Current and Expected Wind Farms On the PJM Grid[11]

State	Project name	Location	Year	Capacity (MW)
Wind farms currently online				
PA	Humboldt Industrial Park[12]	Hazelton	1999	0.13
PA	Somerset Wind Power Project[13]	Somerset	2001	9.0
PA	GreenMountain Wind Farm[14]	Garrett	2000	10.4
PA	Mill Run Wind Power[15]	Fayette	2001	15.0
PA	Meyersdale Wind Power Project[16]	Meyersdale	2003	30.0
PA	Waymart Wind Farm[17]	Wayne County	2003	64.5
WV	Mountaineer Wind Energy Center[18]	Backbone Mtn	2002	66.0
Wind farms planned for construction in 2004				
MD	Savage Mountain[19]	Garrett County	2004	45.0
MD	Criterion Project[20]	Garrett County	2004	100.0
NJ	Atlantic City Wind Farm[21]	Atlantic City	2004	7.5
PA	Bear Creek Wind Project[22]	Pocono Mountains	2004	20.0
PA	Forward WindPower[23]	Somerset	2004	30.0
PA	Stoneycreek WindPower[24]	Somerset	2004	64.8
WV	Ned Power Mount Storm[25]	Grant County	2004	150.0
WV	Mount Storm Wind Force[26]	Grant County	2004	250.0

The Future of Mid-Atlantic Solar Power

Photovoltaic cells (the primary technology for generating electricity from solar energy) are clean and renewable, and have immense potential to generate large amounts of electricity in close proximity to the point of use. For years, the U.S. Department of Energy has predicted that photovoltaic cells (PV) will play a significant role in future energy production: "It is easy to foresee PV's 21st century preeminence."[27]

PV technology can greatly reduce demand on the grid—the wires, substations and transformers that are required to transport electricity from the power plants to the users—because the rooftop of almost every house, store, and office building can become a source of electricity. Even if it does not provide all of the building's electricity, a rooftop PV system can save the consumer money and even pay for itself over the 20-30 year lifetime of the system (the savings equal the market price of the power they are no longer drawing from the grid).

Moreover, demand reductions in the Mid-Atlantic—through distributed generation, such as PV, as well as through energy efficiency measures—will ultimately save *everyone* money. A study by JBS Energy, Inc., showed that owners of

Offshore Wind

20 turbines, rated at 2 MW each, in Denmark's Middelgrunden Offshore Wind Farm. Photo © BONUS Energy A/S.

All estimates for future wind generating capacity in this report are restricted to onshore wind generation, and for that reason should be considered conservative. The waters off the coasts of New Jersey, Delaware, and Maryland undoubtedly have enormous potential for wind generation, but in the near future wind farms will likely be onshore. Studies that have been performed as part of the Long Island Offshore Wind Initiative have shown the nearby waters to have the potential to generate 77% of Long Island's electricity needs.[28]

Offshore generation has many potential advantages over onshore wind farms. It is not uncommon to find wind speeds about 20% higher only a short distance offshore, and this translates to about 73% more energy. More stable winds, the generally smooth surface of water, and less wind turbulence all translate into higher electricity yields, longer turbine lifetime, and cheaper turbines.[29]

There are technical issues for offshore wind that currently prevent it from being as economical as onshore wind, and the states in the region have yet to establish siting guidelines to minimize impacts on local ecology and wildlife. These challenges include the design of tower foundations, nature of the grid connection, and optimization of turbines for offshore generation. Also, because the operation and maintenance costs tend to be higher for offshore wind farms, the electricity from them tends to cost more. Some European countries have already begun to tap offshore generating potential, including the construction of two 160 MW offshore wind farms by Denmark. Advances made by European companies for these pioneering projects are expected to make offshore generation cost competitive in the next few years.[30]

PV systems help lower rates for all electricity consumers by reducing the overall demand on the grid.[31]

The study found that the benefits to Mid-Atlantic ratepayers are twice the market price of the electricity saved during most hours of the year, and can be as much eight times as valuable during peaks in demand, when the price per kWh of electricity from the grid is at its highest.[32] These peaks generally occur on hot summer days, when homeowners and businesses turn up their air conditioners; by a lucky coincidence, these sunny summer days are exactly when PV generates the most electricity.

Table 4. Generation From Rooftop PV Systems on 10% of Homes in Mid-Atlantic States

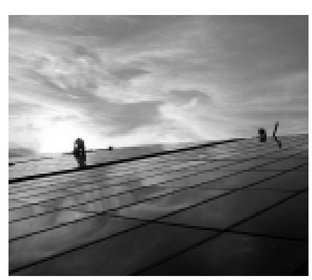
State	Potential solar capacity from 10% of homes (MW)	MWh generated each year	% of 2004 demand met
DE	40	38,000	0.33%
MD	270	235,000	0.37%
NJ	400	352,000	0.47%
PA	680	597,000	0.41%
Mid-Atlantic total	**1,390**	**1,222,000**	**0.41%**

Solar energy is an especially useful source in the densely populated areas of the Mid-Atlantic, like the central corridor of New Jersey and the greater Baltimore area, where a lack of space prohibits the construction of wind farms. The thin modules can be placed on any rooftop facing south, situated along highways to generate electricity for lighting, or located on brownfields that cannot otherwise be used for homes or parks. This distributed generation can also hedge against blackouts like the one that occurred in the North East in August 2003.

These benefits of PV systems, however, are often undervalued and rarely accrue to the system owners, so homeowners with PV systems are paying for the costs while not reaping all the benefits. Even though the systems can largely pay for themselves over their lifetime, implementation of the technology will be slower than necessary as long as individual consumers are expected to shoulder the burden of the initial investment hurdle and are unable to reap all of the financial benefits.

R&D and economies of scale will bring down the cost of the technology, but serious efforts must be made to address the obstacles to financing. Homeowners are often unable to roll the cost of solar panels into a mortgage, and commercial loan rates are much less favorable. However, incentives that bring down the cost of solar installations—such as rebates offered through New Jersey's Clean Energy Program—have helped in this regard, and have brought greater business to solar manufacturers and installers.

Table 4 presents a scenario in which just 10% of households in the Mid-Atlantic region are equipped with a typical 2 kW residential PV system, generating a total of 1.2 million MWh each year.[33] This is enough electricity to power 122,000 homes. House roofs are only a fraction of the possible locations for PV generation; many retailers, restaurants, and office buildings have installed solar systems as well. Furthermore, new houses offer a great opportunity for solar installations, because the cost of a rooftop system is reduced by 33% when built during construction of the home.



Solar panels on the Cambria Office Building of the Pennsylvania Department of Environmental Protection. Picture courtesy of NREL/DOE.

Biomass

The category of "biomass" encompasses many types of "waste-to-energy" technologies and energy crops used to generate electricity. The PJM grid region could generate 21,200 GWh per year from biomass, enough to satisfy almost 6% of the Mid-Atlantic's projected 2014 electricity demand, according to the U.S. Department of Energy.[34] However, while some forms of biomass can provide a net benefit to the environment, others are unacceptably harmful. This analysis does not examine biomass's economic benefits, though a commitment to renewable electricity will no doubt involve a certain amount of biomass generation.

Any material that releases air pollutants or toxins into the air upon combustion at a greater rate than the fossil fuel it is replacing will not solve all the problems that truly clean renewables can. Included in this group are municipal solid waste and construction debris, which can release dangerous toxins from the combustion of plastics and chemicals.

Timber wastes and agricultural wastes also have high emissions of dangerous pollutants, but can provide a net benefit over current practices. Burning organic waste in closed systems to generate electricity can result in lower emission than disposing of it in open-air burn piles. Emissions can be further reduced with biogas digesters, although this option is not currently cost-effective. Biogas digesters utilize bacteria to transform livestock manure into fertilizer and biogas, which consists mainly of methane (the main component in natural gas). Some forms of digesters are currently employed for sewage treatment and fertilizer production, with biogas-generated electricity as a secondary benefit.

In most cases, landfill gas used as a renewable fuel has a net benefit for the environment. When large amounts of methane are emitted from landfills, operators are required to flare it; when emissions fall below limits requiring flaring, methane and other toxins escape into the atmosphere. Therefore, burning methane to generate electricity is more desirable.

Various types of energy crops (i.e. willow, sweetgum, sycamore, switchgrass, woody crops) hold the potential for cleaner electricity production compared to traditional fossil fuels, especially coal, but their life-cycle impacts on the environment deserve further study.

Creating Economic Growth with Renewable Energy

Developing wind and solar generation in the Mid-Atlantic will do more than just provide clean and pollution-free electricity. It will also give our economy a needed boost by creating thousands of good jobs.

In fact, meeting future electricity demand with wind and solar power will create more than twice as many jobs as meeting it with new natural gas plants (Table 5). Clean, renewable generation is cost competitive—especially in the case of wind power—because the fuel itself is free. Wind power will also result in millions of dollars of new income for farmers and other rural landowners who lease their land to wind farm developers.

Table 5: Projected Economic Benefits of Wind Power in the Mid-Atlantic Region through 2014, Wind Compared to Natural Gas

	Wind	Natural Gas
Electricity Generation	30,700 GWh	30,700 GWh
New Capacity	10,200 MW	6,670 MW
One Year Jobs		
Manufacturing	5,910	2,500
Installation	5,160	3,260
Supporting Areas	12,700	6,630
Long-Term Jobs		
Operation and Maintenance	740	270
Supporting Areas	850	310
Royalties Paid to Landowners	$23 million	N/A

Wind

Developing the region's wind energy potential will create jobs in component manufacturing, turbine installation, facility operation and maintenance, and a variety of areas that indirectly support these activities.

Manufacturing requires skilled laborers who design and build the components of the wind turbines and towers. Installation typically involves local construction firms and general contractors, boosting local economies. The operation and maintenance needs of a wind farm create permanent, high-quality local jobs ranging from servicing the turbines to accounting.

Under the wind energy development scenario outlined in the previous section, the region could add 10,200 MW of wind capacity over the next decade, to bring the Mid-Atlantic region's total capacity to approximately 10,400 MW (Table 2). Table 5 summarizes the economic development impact of wind power deployment at this scale.

Workers assemble rotor blades. Photo courtesy of NEG Micon.

Manufacturing Jobs

Much of the work involved in creating a wind farm goes into manufacturing the components, which include rotor blades, structural towers, hubs, transmissions, generators and assorted electronic controls. Based on a national survey of companies involved in the manufacture of wind turbines, the Renewable Energy Policy Project (REPP) found that every megawatt of wind energy capacity installed creates 3.19 year-long manufacturing jobs.[35]

A percentage of these manufacturing jobs will likely be located in the Mid-Atlantic region. Local companies will likely be able to supply raw materials and components for manufacturing. Mid-Atlantic companies already produce easily transported components ranging from fuses to electrical enclosures to power conversion systems. Local companies that could supply components for wind systems include Siba Fuses of Wayne, NJ; Motors and Controls International of Hazelton, PA; and Fibox, Inc. of Glen Burnie, MD.[36]

Although most of the world's major turbine manufacturers are currently based in Europe or other parts of the United States, additional growth in the local wind energy market could also bring turbine manufacturers and additional component suppliers to the region. For example, the Spanish turbine manufacturing company Gamesa, among the top five turbine manufacturers in the world, is considering locating a new manufacturing plant that would create close to 400 jobs somewhere on the East Coast of the U.S. or Canada. According to the *Tribune-Democrat* of Johnstown, Gamesa is considering locations in Johnston, Leigh

Valley, Scranton, Philadelphia, and Pittsburgh, among others. Johnston has vacant mills that could offer the large space necessary to build wind-farm components.[37] According to the *Tribune-Democrat*, "the effort, if successful, would help replace some of the thousands of Cambria-Somerset manufacturing jobs lost through the years with the downturn of the steel industry."[38]

Some components of wind turbines, such as structural steel towers and blades, are large and expensive to transport, and also relatively uncomplicated to manufacture. These components are most likely to be made locally, in Mid-Atlantic states. For example, as Texas's wind energy industry took off in response to the passage of a renewable portfolio standard (RPS), Texas companies Bergen Southwest Steel and Trinity Structural Towers began supplying towers for wind turbines in 1999. [39] Mid-Atlantic companies like International Steel Group, Inc., with facilities near Harrisburg, Pennsylvania and on the Chesapeake Bay in Maryland, could play a similar role for a growing regional wind market in the Mid-Atlantic.[40] According to an analysis of wind turbine manufacturing labor requirements by the Renewable Energy Policy Project, towers account for 12.6% of wind turbine manufacturing requirements.[41]

Based on these facts, this analysis assumes that the equivalent of 100% of structural tower manufacturing, or 12.6% of manufacturing jobs, will happen within the region through 2007, with the remainder in other locations. After 2007, this analysis projects that increasing wind turbine installations will promote additional manufacturing jobs within the region and that the share of local labor will increase to a third by 2015. We also assume that the jobs/MW created by wind power will decrease over time as the industry continues to take advantage of economies of scale.[42] Following capacity growth predictions, manufacturing of wind energy components for the Mid-Atlantic could create 5,910 person-years of manufacturing employment in the next decade (Table 6). At an average salary of $29,448, the payroll value of these jobs would be $174 million.[43]

Construction Jobs

Large wind farms can need up to 300 workers on site during construction. 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.[44]

According to a national survey of wind energy companies conducted in 2001, the Renewable Energy Policy Project estimates that every megawatt of wind

Table 6. Projected Direct Employment Benefits of Wind Power Through 2009 and 2014

Through Year	Wind Energy Installed After 2004 (MW)	Construction		Manufacturing		Operation and Maintenance	
		One-Year Jobs	Payroll Value	One-Year Jobs	Payroll Value	Permanent Jobs	Yearly Payroll
2009	2,820	1,580	$48.8 million	1,130	$33.3 million	220	$9.09 million
2014	10,200	5,160	$160 million	5,910	$174 million	740	$30.0 million

capacity creates 0.68 year-long installation jobs.[45] Data from proposed and actual wind projects from around the U.S. collected by the Union of Concerned Scientists shows that this figure ranges between 0.4 and 1.7 jobs per megawatt.[46] For instance, data obtained from Florida Power and Light Energy on the total hours worked during the 2000-2001 installation of the 278 MW wind farm in King Mountain, Texas, show an average of 1.2 full time jobs (49 weeks at 40 hours a week) for every MW installed.[47]

Using the more conservative estimate from the Renewable Energy Policy Project, and taking account for the fact that the number of construction jobs per megawatt will decrease over time in accordance with projected cost declines for wind power (see methodology), installing 10,200 MW of capacity would create approximately 5,160 year-long construction jobs (Table 6). At the average construction worker salary of $30,943 per year, these jobs would have a payroll value of $160 million.[48]

Turbine construction. Photo © BONUS Energy A/S.

Operation and Maintenance Jobs

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.[49] According to the Union of Concerned Scientists, operation and maintenance employment needs range between 0.06 jobs/MW for large projects and 3.6 jobs/MW for small projects, with most projects around 0.1-0.2 jobs/MW.[50] According to a national survey of wind energy companies, the Renewable Energy Policy Project estimates 0.10 jobs/MW.[51]

Assuming that every ten megawatts of capacity requires 1 full time employee, and taking account for the fact that the number of operation and maintenance jobs per megawatt will decrease as turbine sizes increase over time, by 2015 the operation and maintenance needs of projected wind farms in Mid-Atlantic states could employ 740 people (Table 6). The region's average salary for electrical and electronics repairers of commercial and industrial equipment is $40,623, so these workers could be expected to earn $30.0 million per year.[52]

Indirect Jobs

The economic impact of building wind farms extends beyond the direct jobs created in building and installing the equipment. Each dollar invested creates impacts that ripple outwards through the local economy.

Table 7. Indirect Employment and Landowner Revenue From Wind Development

Indirect jobs through 2014		Landowner revenue	
Year-long	Permanent	Through 2014	In 2015 alone
12,700	850	$23 million	$4.4 million

For example, workers at a manufacturing plant need raw materials and equipment. Their work in assembling turbines supports jobs in equipment manufacturing and component supply. Contractors at a construction site need concrete and heavy equipment, and their work supports additional jobs supplying these needs. In addition to these indirect jobs, workers spend some of their wages in the local economy, purchasing goods and services like groceries and housing.

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 last few years.[53] Using this estimate, wind farm manufacturing and construction in the Mid-Atlantic will create 12,700 year-long jobs in supporting areas, and operating and maintenance needs will support 850 ongoing indirect jobs by the year 2015 (Table 7).

Landowner Revenue

Farmers, ranchers, and other rural landowners with good wind resources can take advantage of the income resulting from leasing a portion of their land to a wind farm developer. Unlike wheat or corn, 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. The Union of Concerned Scientists estimates a typical farmer or rancher with good wind resources could increase the economic yield of their land by 30%-100%.[54]

Although wind farms occupy large areas, the actual physical footprint of each wind turbine is small. A landowner could lease up to 10% of their land area for the construction of wind turbines, while continuing to use the rest for other purposes. Lease terms vary, but they typically represent 2.5% of gross revenue from electricity sales.[55] Assuming a contract price for electricity generated from wind power of 3 ¢/kWh,[56] a single 1.5 MW turbine would bring the landowner $3,285 each year.[57]

At this price, projected electricity generated by Mid-Atlantic wind power through 2014 would sell for $920 million, and the lease payments associated with this electricity would supplement the income of landowners by a total of $23 million (Table 7). In the year 2015 alone, 10,200 MW of wind farms would produce nearly $175 million worth of electricity, and landowners would earn $4.4 million.

Cost-Competitiveness of Wind Generation

Wind generation has benefited greatly from advancements in the technology and economies of scale, especially in the past decade, and this has made it cost-competitive with dirtier forms of energy. Wind-generated electricity currently costs about 4-6 ¢/kWh. After 2010, wind power is expected to cost under 3 ¢/kWh without government incentives.[58]

In fact, in 2001, because of skyrocketing natural gas prices and the uncertainty of future prices, Colorado's Public Utility Commission ordered Xcel Energy to add a previously excluded wind farm project back into its resource plan for meeting future demand. The commission stated that its decision was "justified purely on economic grounds, without weighing other benefits of wind generation."[59] The PUC determined that wind would be the most competitive energy source if gas costs rose above $3.50 per thousand cubic feet. In the first half of 2003, the average amount paid by utilities nationwide for gas ranged between $5.00 and $7.73 per thousand cubic feet.[60] This wind project, in Lamar, Colorado, came online in December 2003 with a rated capacity of 162.0 MW, the largest in the state.[61]

Solar

Like wind power, renewable generation from solar photovoltaic cells (PV) has the benefit of creating high-quality jobs, many of them local to the generation. The International Brotherhood of Electrical Workers has taken a public position in support of solar power development because of the job opportunities that will become available as the industry grows. In fact, the IBEW Local 269 in Trenton, New Jersey, installed a 90 kW photovoltaic system on their roof in 2002, to demonstrate their support for solar energy and also to provide a training ground for New Jersey electrical workers.

The Renewable Energy Policy Project estimates that every megawatt of PV capacity installed creates 32.6 year-long jobs, most of them in manufacturing.[62] However, because future economies of scale and R&D will continue to bring down the cost of solar PV, and because PV is still becoming more and more cost competitive, employment calculations can quickly become dated.

A 2002 analysis by UC-Berkeley Professor Daniel Kammen takes future changes into account. Dr. Kammen derived the analysis from a combination of historical experiences related to him by renewable energy companies and median values of economic models produced by others.[63]

The analysis splits the jobs created into jobs that could be located anywhere (manufacturing) and those that are necessarily local (installation, operation, and maintenance jobs). Dr. Kammen found that increased production activity would initially result in 31.26 manufacturing jobs/MW and 6.52 installation and O&M jobs/MW, declining to 5.79 manufacturing jobs/MW and 4.09 installation and O&M jobs/MW ten years later.

Installing a 2 kW rooftop PV system on one in ten homes in Mid-Atlantic states (Table 4) would yield 1,400 MW of rooftop solar electricity capacity. Using Dr. Kammen's estimates for how many jobs would be created per MW of solar after ten years, this scenario would create 5,710 installation, operation and maintenance jobs, and 8,080 manufacturing jobs.

Comparison to Fossil Fuel Generation

Renewable energy technologies create more economic development per energy output than comparable fossil fuel technologies. For example, choosing wind power over a comparable amount of natural gas-fired generation would create more than twice as many jobs (Table 5). In addition, wind power creates jobs in rural and mountainous regions where employment in the coal mining industry has continued on a steady decline, despite increases in coal-fired generation.

Natural Gas Jobs

If the Mid-Atlantic were to meet electricity demand growth with natural gas power plants instead of wind energy, fewer jobs would be created.

To produce the same amount of energy as wind under the development scenario used in this analysis, the region would have to install approximately 6,670 MW of gas-fired power plants.[64] 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 19 plants that were built or approved between July 2001 and June 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.[65] In other words, the construction of these plants created 0.49 person-years of work per MW. Assuming the same value for power plants in the Mid-Atlantic, building new natural gas plants would create 3,270 year-long jobs in plant construction.

Assuming that one-third of manufacturing employment will be within the region, natural gas-fired plants would still create less than half as many manufacturing jobs as wind. 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.[66] Assuming that 70% of the jobs created by gas plants go toward manufacturing of these components, manufacturing needs would create about 1.14 jobs per MW, compared to 3.1 jobs per MW for wind. This is most likely because the high energy concentration in fossil fuels require much smaller power conversion systems per MW rating, yielding a lower employment intensity for fossil fuels. We are unaware of any natural gas turbine manufacturing facilities in the Mid-Atlantic. However, General Electric manufactures large gas-fired turbines in Schenectady, NY, and Greenville, SC, and it appears unlikely that future demand in the Mid-Atlantic will affect the location of jobs for this established technology. Therefore, this analysis assumes that one-third of natural gas manufacturing jobs would be in the Mid-Atlantic region, yielding 2,500 year-long manufacturing jobs.

Building more natural gas power plants would result in many fewer permanent jobs than wind energy as well. New natural gas plants are highly automated, even more so than wind farms, and are relatively easy to maintain. The plans for the 19 plants in California include an average of only 25 jobs per plant, yielding a rate of only 0.04 direct jobs per MW of capacity.[67] At this rate, the natural gas route would create only 270 permanent jobs by 2014.

In terms of overall direct employment, the natural gas option would produce 5,330 fewer one-year jobs and 470 fewer permanent jobs than wind power (Table 5).

Declining Coal Mining Jobs

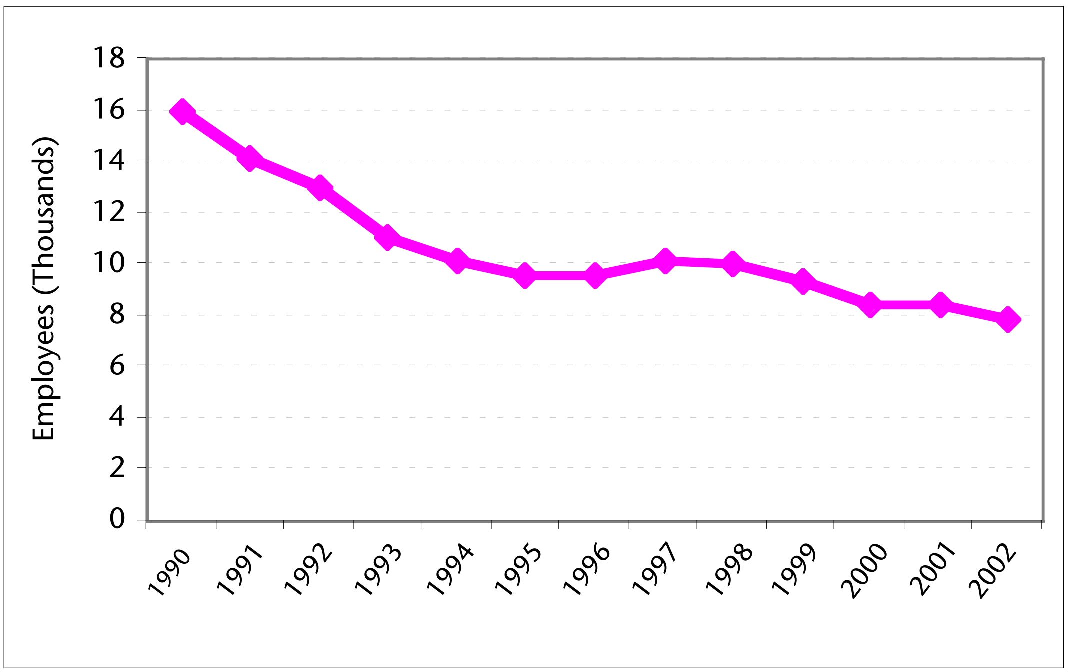
Coal mining employment, mainly in rural areas of several Mid-Atlantic states, has declined dramatically in recent years, while coal-fired generation has remained basically steady. The Bureau of Labor Statistics provides data for Pennsylvania coal mining employment as far back as 1990, when the industry provided 15,900 jobs. In 2002, there were less than half as many coal jobs (Figure 5).[68] According to EIA statistics, Pennsylvania's generation of electricity from coal has changed little since 1992, rising an average of 0.3% per year.[69]

For a region that is suffering from jobs lost due to a waning coal industry, recommitting itself to waste coal or "clean" coal generation, as some observers recommend,[70] is not the right path. Wind generation can provide new jobs in the same rural regions where the coal industry now employs half as many as it once did, and without the negative environmental effects.

Landowner Revenue

Unlike wind farms, natural gas and coal plants are not located on land actively used for growing crops, grazing animals, or other uses. Generating capability at fossil fuel 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. Accordingly, they would not provide lease payments to rural landowners.

Figure 5: Decline in Pennsylvania Coal Mining Employment



From the Mid-Atlantic to a Global Market

The Mid-Atlantic has the potential to become a major player in the growing international market for renewable energy technologies. The region's renewables companies stand poised at the synergy of market opportunity and resource availability, and a guaranteed local demand can give them the experience needed to become a driving force in this sector.

Over 50 renewable energy companies already call the Mid-Atlantic region home, and many companies from other parts of the United States and other countries do business in the region. By providing guaranteed markets in the Mid-Atlantic, the region will develop its wind energy infrastructure, increase the use of photovoltaic cells, and build the requisite supporting industries. It will then be able to compete effectively in both national and international markets, further strengthening the economic base in the region.

A certain amount of demand already exists for renewable energy in the region, as shown by the success of green power marketers like Pennsylvania's Community Energy. They have tapped into what is frequently called a "niche" market for wind-generated electricity: selling to environmentally-conscious consumers who are willing to pay a green premium. In fact, this voluntary market has proven robust, with several large consumers recently signing long-term wind power purchase agreements. A 10-year deal with the University of Pennsylvania has cleared the way for a 20 MW wind farm in Pennsylvania's Pocono Mountain region, known as the Bear Creek Project, and a 20-year contract with the Atlantic County (NJ) Utility Authority will lead to a wind farm being built to power a water treatment facility.[71]

However, this voluntary market can only go so far. Due to the deregulated nature of the region's electricity market, utility companies are cautious about signing long-term power purchase agreements with wind farms. This forces developers to "front-load" the costs, rather than spread them out over a longer timescale. Because wind power has high up-front costs, this drives up the price of the wind-generated electricity.[72]

A guaranteed demand for renewable energy—especially in the form of a renewable portfolio standard—would change this: utilities would have more incentive to sign long-term power purchase agreements if there were assurance that there would be a market for the green electricity down the line. This, in turn, would make it easier for developers to get financing for wind farms.

Creating these wind farms would provide the region's companies with invaluable experience, leading to greater technical expertise, improved project coordination, and economies of scale. State policies can help to create this demand, especially through renewable portfolio standards, or green-power buying requirements for government agencies.

Increasing Global Demand for Clean Energy

Wind

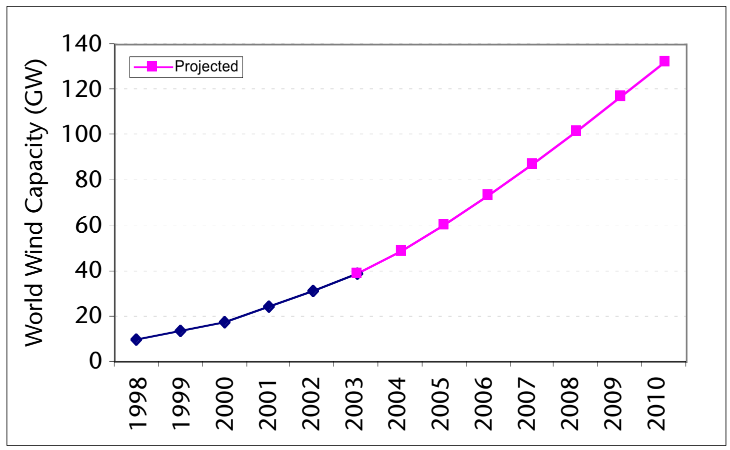
Wind has become the fastest-growing energy sector, and this trend will continue. Most of the growth in renewable energy in the next decade, measured by energy output, will come from wind.

The cost of wind generation has dropped from 12 ¢/kWh in 1990 to 4-6 ¢/kWh in 2002, making many projects cost-competitive with natural gas power plants. These costs are expected to continue to drop, and after 2010 wind power is expected to cost under 3 ¢/kWh, even without government incentives.[73]

Wind capacity is forecast to continue expanding rapidly. In 2002, installed wind capacity worldwide went from 24,390 MW to 31,128 MW.[74] Developers installed even more wind turbines in 2003, raising world wind capacity by 8,200 MW and maintaining an overall growth rate of 26% per year.[75] Many nations have set targets that will guarantee further expansion of wind power worldwide.

The International Energy Agency (IEA), a forum for 26 member countries, predicts that world wind capacity will reach 130,000 MW by 2010.[76] Growth in the wind market must actually slow by 2% per year through 2010 to reach this benchmark (Figure 6).

Figure 6. Projected Worldwide Growth in Wind Power Capacity



In dollar terms, the wind power market was worth $4 billion in 2000 and will grow to $13 billion by 2005 and $43.5 billion in 2010, according to the clean energy advocacy group Clean Edge.[77] Climate Solutions, another clean energy group, predicts that the market will grow to approximately $60 billion by 2020.[78]

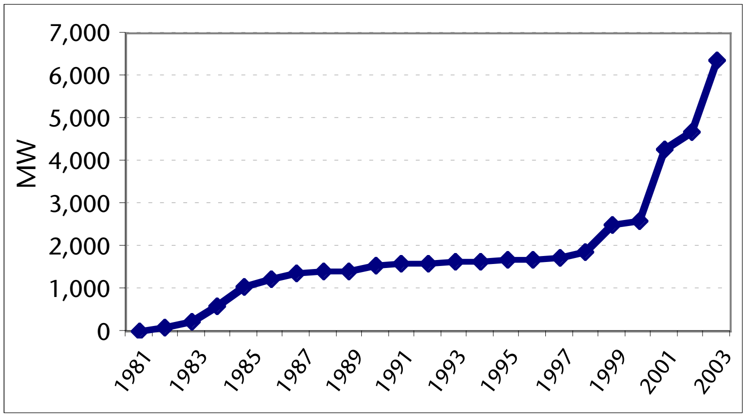
Solar Photovoltaic Cells

The worldwide solar PV industry is still small. However, it is growing quickly and stands to benefit greatly from economies of scale as demand grows. In percentage terms, PV is the second fastest growing power source worldwide, right behind wind power.[79]

U.S. Renewables Market

A primary driving force for the growth in the U.S. market has been, and will continue to be, the establishment of policies known as renewable portfolio standards (RPS). These policies require that a certain amount of the electricity generated or sold in a state come from renewable sources. To date, over a dozen states have an RPS or some similar restrictions: Arizona, California, Connecticut, Iowa, Maine, Massachusetts, Minnesota, Nevada, New Jersey, New Mexico, Pennsylvania, Texas, and Wisconsin.[80]

Figure 7: U.S. Total Wind Capacity



In large part because of these policies, the U.S. wind market has taken off in the past few years, and there is now over 6,300 MW online (Figure 7).[81] The National Renewable Energy Laboratory projects that 80,000 MW of wind power will be online in the U.S. by 2020—5% of total energy production.[82] This would require installing an average of 4,600 MW of new capacity each year.

U.S. Solar Market

By 2020, the photovoltaic cells industry is expected to reach $15 billion in the U.S.[83] The U.S. plans to achieve more than 2,000 MW of PV peak capacity by 2010 and 3,000 MW of capacity by 2020.[84] NREL predicts that at least 10% of U.S. power-generation capacity will be PV by 2030.[85]

However, the Energy Information Administration predicts that, under business as usual, the U.S. will only have 1,110 MW of PV capacity by 2020, and 1,540 MW by 2025.[86] The U.S. Department of Energy is working to support rooftop PV use through its Million Solar Roofs Initiative. The program works to build partnerships between industry, government agencies at all levels, financial institutions, and non-governmental organizations in order to improve markets for solar energy technologies.[87] However, because the program offers no direct financial assistance, it has not been as successful as national efforts in other countries. This underscores the fact that state policy makers must continue to take proactive steps for solar generation to develop.

The factory price of PV modules has fallen from $61/peak watt (Wp) in 1976 to $7.50/Wp in 1990 to $3.85/Wp in 2000,[88] and they are expected to reach $1.16/Wp by 2005.[89] Increases in manufacturing capacity lead to significantly lower prices, which further expands the market and leads to more production and price reductions. Because the potential market is so large, this cycle can continue to reap benefits well into the future.

PV is already cost-competitive with traditional energy sources for many buildings with moderate power needs that are not already connected to a power grid, for example in developing countries. Solar panels are becoming widespread for remote applications. World shipments of photovoltaic modules expanded more than 30% between 1998 and 2000.[90]

An Allied Business Intelligence report in 2000 predicted that global PV production will exceed 800 MW by 2005. The report found that worldwide demand for PV could be as high as 900 MW by 2005 and 5,000 MW by 2010.[91] The International Energy Agency estimates that installed PV capacity will be 11,000 MW by 2010.[92]

In dollar terms, the GAO has reported that world sales of photovoltaic technology increased by 16% every year between 1985 and 1997 to exceed $1 billion in 1997.[93] According to the National Renewable Energy Laboratory, the PV industry worldwide will be worth $30-$40 billion by 2025.[94] Clean Edge sees the photovoltaic cells market growing from $2.5 billion in 2000 to $7.5 billion in 2005 and $23.5 billion in 2010.[95]

The American solar industry is already an exporter of PV cells and modules, with 2002 exports of 66.8 MW, up from 61.3 MW in 2001 (2003 data is not yet available).[96] Of these shipments, 58.0% went to Europe, and 23.5% went to countries in Asia and the Middle East.

The Mid-Atlantic's Potential to be a Global Leader

The region has all of the elements necessary to take global leadership in the renewables industry. It has manufacturing and exporting experience, a tech savvy workforce, and the history of business entrepreneurship necessary to bring those elements together.

Research and Development

Being a leader in these emerging technologies will mean pioneering the newest developments, a task that the Mid-Atlantic has already begun. At Johns Hopkins University in Maryland, the Meyer Group studies inorganic photochemistry "with an eye toward practical device fabrication."[97] Their research will lead to a better understanding of how to efficiently harvest solar energy.

In Pennsylvania, Carnegie Mellon's Electricity Industry Center uses an interdisciplinary approach in several program areas, including advanced generation, transmission and environmental issues. Pennsylvania also recently became home to AdvanTek International, a wind engineering facility (see box, page 33).

At New Jersey's Rutgers University, the Center for Advanced Energy Studies merges engineering, operations research, and public policy to create, develop, and promote new technologies and practices in energy systems. New Jersey is also home to Energy Photovoltaics (see box, page 33).

The states in the region also boast impressive statistics with regard to general R&D and academics. Among U.S. states, Pennsylvania is 5th in the number of doctoral scientists and 8th in the number of doctoral engineers. It also has 4 of the top 15 undergraduate engineering programs, and ranks 6th in the number of science and engineering graduate students.

"As the PV market continues to grow, IBEW members will have expanded opportunities to utilize their skills in manufacturing, installing and servicing these photovoltaic systems."

Ed Hill, President
International Brotherhood of Electrical Workers

Maryland has the second highest concentration of doctoral scientists and engineers of any state. With 220 federal and academic research centers, it ranks second in total federal funding for R&D, with emerging technologies—such as alternative power—as a focus area. In New Jersey, the U.S. Route 1 corridor from Rutgers University down to Princeton University creates the state's own high-tech valley.

Business and Labor

The region has always had a strong manufacturing base, and the components for solar cells, wind towers and turbines require skilled labor.

Maryland has a higher percentage of professional and technical workers than any other U.S. state, and the highest percentage of the population with at least a bachelor's degree. Pennsylvania is already the 4th-leading state for industrial electronics manufacturing, and has been named 4th best place for new manufacturing plants by *Site Selection* magazine. Three of the state's cities (Pittsburgh, Allentown-Bethlehem-Easton, and Harrisburg-Lebanon-Carlisle) are among *Expansion Management* magazine's "50 Hottest Cities for Manufacturing Expansions and Relocation." These accolades are no doubt at least in part because the state provides more than $35 million a year in grant funds for skills training, both for new jobs and to upgrade skills for new technologies. The state also offers a 10% tax credit for new R&D investments.

Location

Perhaps the greatest strength of the Mid-Atlantic is its world-class shipping ports in Baltimore, Philadelphia, and Newark. These give the region access to the growing global markets, and make it an ideal location for manufacturing facilities for turbines and other renewable technology components.

The region is also naturally situated to reach markets in the New England states and Eastern Canadian provinces—whose governors and premiers are formulating plans to reduce regional greenhouse gas emissions, a strong commitment that will no doubt require cleaner electricity generation—as well as the American South and Midwest. The South has a great solar generating potential, while the Midwest is known for having a huge wind potential. Perhaps because of these considerations, the Spanish wind turbine manufacturer Gamesa is exploring the possibility of locating a manufacturing plant in Pennsylvania.[98]

All of these elements—a highly-skilled workforce, natural resources, strong manufacturing base, and experience with high technology business—give the Mid-Atlantic the potential to step up to the plate and meet the growing national and global market for renewable energy technologies.

Wind Engineering and Development Companies

AdvanTek International (Harrisburg, PA) is a wind energy engineering facility that is developing a new rotor blade and control system that will increase turbine output by 25%. Their Instantaneous Power Control™ technology enables a farm to capture more power at lower speeds, and could more than double the land available for wind development in Pennsylvania.[104]

Community Energy (Wayne, PA), along with its NewWind Energy brand, is one of the most active developers and marketers of wind energy in the Mid-Atlantic. They are also involved in wind energy in the Midwest and Western regions of the U.S.[105] Recently signed long-term power purchase agreements will allow them to go forward with the development of new wind farms in Atlantic City, New Jersey, and the Pocono Mountain Region of Pennsylvania, both of which are expected to be completed by the end of 2004.[106]

Clipper Wind Power (Carpenteria, CA) is a wind farm developer that recently started east coast operations. Their planned 100 MW Criterion Project, in Garrett County, MD, will be the state's first major wind farm, and larger than any current farm in the region. They are also planning a farm in Warren County, New Jersey, and are involved in turbine design.[107]

Mid-Atlantic Companies Involved in Solar Power

BP Solar (Linthicum, MD) is a vertically integrated firm that "manufactures, designs, markets and installs a wide range of photovoltaic solar electric products and systems."[99] The 1999 merger of BP and Amoco brought BP Solar together with Amoco's Solarex, making BP Solar one of the world's largest manufacturers of photovoltaic products and systems.

Energy Photovoltaics (Princeton, NJ) specializes in an integrated manufacturing system for the production of thin-film PV modules, which are less-energy efficient but more cost-effective than other types.[100] The company also recently received a research grant from the state to extend the commercial uses of PV and building integrated PV (BIPV), in order to both lower the costs and increase the use of PV in New Jersey.[101]

McConnell Energy Solutions (Greenville, DE) set out to create a simple, easy-to-install rooftop PV mounting system. The result was the SolarDock, designed specifically for flat-roofed buildings or ground-mounted PV, and adaptable to different solar modules.[102] McConnell Energy Solutions is an offshoot of McConnell Johnson Real Estate, and was created when the company decided that installing solar energy systems on its own construction projects would be less expensive and less time-consuming if it could be done in-house.[103]

Conclusions & Policy Recommendations

High system construction costs followed by extremely cheap produc tion makes renewable energy unique in the world of electricity generation. But, electricity itself is 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. Given a foothold in the market, renewable energy technologies will then be able to gain a larger market share with less assistance.

The single biggest impediment to developing renewable energy projects is that nearly all of the costs are incurred upfront, in the component manufacturing and construction. In effect, renewable energy producers are financing 30 years worth of power all at once. Coal and natural gas generation, on the other hand, spread the costs of fuel over the lifetime of the plant, with the expectation that price fluctuations will be absorbed by the consumer.

Combined with the recent deregulation of electricity markets, these high upfront costs create a disincentive for utilities to sign long-term power purchase agreements with wind farm developers. This fact makes it much more difficult for wind developers to get financing from investors and build their projects in the first place.

The absence of a guaranteed long-term market for renewable electricity in the U.S. also lessens the likelihood that renewable energy companies would establish production here. In contrast, European nations like Germany, Denmark, and Spain have promoted wind energy development by guaranteeing long-term contracts to renewable energy developers, guaranteeing consumer demand. The Mid-Atlantic region can reap great economic benefits from the emerging renewable technologies industry, but strong local demand is needed for the industry to reach its full potential.

A variety of policy options can enable the Mid-Atlantic to successfully develop its wind and solar energy resources, realize the economic benefits that renewable energy can provide, and establish a strong

Examples of Successful Policies

Policies adopted in Europe and elsewhere are instructive. In recent years, Germany, Denmark, Spain, and Japan have put successful national policies in place, increasing the use of renewable energy and expanding the domestic renewable energy industry.

- In 1990, Germany enacted a law requiring utilities to purchase renewable energy at a guaranteed minimum price. Since then, the country's wind capacity has grown from 56 MW to 12,000 MW in 2002, more than a third of wind capacity worldwide. The German wind industry now employs 40,000 people.[108]
- Germany started the 1,000 Roofs program in 1991 and expanded it to 100,000 Roofs in 1998. The program offers 10-year, low-interest loans for individuals and businesses to install PV panels. Largely as a result of these programs, Germany is expected to have 440 MW of solar power in operation by the end of 2003, more than twice as much as the entire U.S. German PV manufacturers are greatly expanding their capacity in response to this demand. In one decade, Germany has built an industry with billions of dollars in revenue.[109]
- Spain passed a law in 1994 guaranteeing access to the electric grid and establishing purchase requirements for renewable energy, and is now adding wind turbines at the third highest rate in the world. Spain's Gamesa Eolica has become the world's second-largest wind turbine manufacturer.[110]
- Denmark has long had a policy of guaranteeing a market for producers of wind energy, stimulating manufacturing activity that has made the country the world's largest producer of turbines.[111]
- The Japanese government invests $200 million per year in a program that provides a rebate on solar panels in exchange for the right to collect performance data. The program has resulted in 41% annual growth in total installed PV capacity since 1992, and manufacturers have expanded their operations to keep pace with this growth. Japan is now the world leader in both the use and production of solar panels.[112] Solar capacity is expected to increase in Japan nearly ten fold by 2010, so that it will account for 30% of renewable energy supply. The national target is 5,000 Megawatts of installed PV Systems by FY 2010, up dramatically from the approximate 200 MW installed at the beginning of 2000.

industry for renewable technologies. 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.

Renewable Portfolio Standards (RPS): Creating a Guaranteed Market for Renewable Electricity

The primary policy tool for states to guarantee a market for green electricity is the RPS, a requirement that a certain amount of the electricity generated or sold in a state come from renewable sources. An effective RPS includes a clear way to track utility compliance and a system of incentives and penalties to encourage utilities to follow through with procuring renewable energy. While it places certain restrictions on the market, an RPS still allows market forces to determine how the requirement can be best satisfied.

New Jersey has recently bumped up its RPS to require 4% by 2008, with a requirement that 120,000 MWh come from solar energy. Pennsylvania does not have a state-wide RPS, but has requirements that vary by utility region in the 2-5% range. For comparison, California's RPS, the strongest in the nation, requires that 20% of electricity come from renewables by 2017.[113]

There are several key components to an ideal RPS:

- There should be a high expectation for the percentage of electricity coming from renewables. As this analysis has shown, the Mid-Atlantic states could meet over 9% of their electricity demand with onshore wind power alone.
- There should be a system of incentives/penalties to ensure that electric service providers comply.
- The standard should be restricted to truly clean and renewable technologies, excluding false solutions such as the burning of waste coal or municipal solid waste.

Some forms of RPS also include "carve-outs" for specific technologies; requiring, for example, that a certain percentage of the renewable electricity come from solar energy. This could ensure that certain parts of the renewables industry get the boost they need to become competitive with other sources.

Several wind development companies interviewed for this report cited a strong RPS as the best policy for encouraging renewable generation in the Mid-Atlantic. A writer for *Renewable Energy World*, a renewable technology professional magazine, found the same recommendation made by industry analysts.[114] Because the electricity market in the Mid-Atlantic stretches across several states, a better outcome will be achieved by more states adopting a strong RPS, thus ensuring a larger market for the renewable-generated electricity.

State Purchasing Obligation

Another option for guaranteeing demand is green power buying requirements for the state and local government agencies, usually requiring that a certain percentage of the electricity bought by the state government be produced from renewable sources. State agencies can potentially be a large market for wind and solar power.

Maryland, Pennsylvania and New Jersey have all engaged in government purchasing of green power to some degree. In March 2001, Maryland's Governor issued an executive order calling for 6% of electricity consumed at state-owned facilities to come from "green" sources. However, the order allowed for using municipal solid waste to fulfill part of this

Renewable Portfolio Standards and the Texas Wind Energy Boom

A renewable 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.[115] The market created by this standard supported the construction of 915.22 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. The now-expired federal Production Tax Credit of 1.7 ¢/kWh allowed these facilities to sell electricity for less than 3 ¢/kWh, competitive with Texas's natural gas plants even at low natural gas prices.[116] Some of the largest wind energy facilities in the world were built in West Texas. Most recently, FPL Wind Energy built a 278 MW project there, north of McCamey.

In response to Texas's renewable energy requirement and uncertainty about the duration of the Federal Production Tax Credit, utilities and wind companies invested $1 billion in 2001 to build new wind energy projects.[117] 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.[118]

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. It appears that these companies have found renewables to be less expensive and more reliable than predicted, and they bought more than strictly necessary.[119]

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.[120] With over 400 MW of installed wind farms, the county added 14% to its total tax base in just one year.[121] The County received $4.6 million in additional property tax revenue in 2002.

obligation and also created no incentives or penalties to ensure that agencies comply.[122] The Montgomery County (MD) Council, on the other hand, voted unanimously in March 2003 to buy 5% of its electricity from renewables.[123]

Pennsylvania Governor Rendell recently ordered state agencies to double their efforts to purchase green energy, so that 20% of the government's electricity needs come from renewables.[124] Furthermore, state agencies in Pennsylvania and New Jersey have actually signed power purchase agreements with renewable energy producers, though the terms have generally ranged from only 1 to 3 years. Recent long-term deals with the University of Pennsylvania and the Atlantic County Utility Authority (see page 28) have thus far been the exceptions rather than the rule.

Strong Net-Metering Policies

All of the Mid-Atlantic states have laws requiring that net metering be offered to certain customers, thus allowing renewable energy system owners to sell unused electricity back onto the grid. For example, when a residential solar system generates more electricity than the residents are using, the house's electric meter will actually run backwards as the excess power goes onto the grid to supply other users.

The standards, however, are currently inconsistent and put restrictive caps on the size of qualifying systems. Even within Pennsylvania, the maximum system size varies between 10 kW and 50 kW in different utilities' regions.

Raising the caps on net metering, so systems in the megawatt range would be included, would increase the financial return on investments in renewable energy systems. With less restriction on system size, municipalities and large commercial building owners would be better able to utilize their rooftops for PV systems, and farmers would be better situated to invest in their own wind systems. The result would not only be an increase in clean, renewable generation, but also the decrease in strain on the transmission grid that naturally results from distributed generation.

Federal Production Tax Credit

The expiration of the federal Production Tax Credit (PTC) threatens to slow the United States's recent rapid growth in wind farm construction. The PTC—worth 1.8 ¢/kWh—helped make wind power more competitive with dirtier forms of generation. It applied to all wind generation installed before December 31, 2003, and is good for 10 years.

The American Wind Energy Association warns that the expiration is leading to layoffs, stalled projects, and a negative near-term market outlook.[125] For example, the developer of the 64.8 MW Stoneycreek project in Somerset, Pennsylvania, recently secured a 20-year power purchase agreement that is contingent upon the extension of the PTC.[126]

Although there is a fairly good chance that the credit will be renewed, it is uncertain when this will happen. Until it is renewed, wind developers will have great difficulty financing projects. This means that state governments should still do what they can to promote generation from renewables.

Methodology

This study provides a sketch of the employment impacts of developing the most economically viable fraction of the wind energy resources of Maryland, Delaware, New Jersey, and Pennsylvania over the next decade, as well as the jobs created by installing 1,400 MW of solar PV in the same states. The intent is to give a relatively simple estimate of the economic value of various activities supported by the wind and solar industries. Future dollar values do not include inflation or discount estimates. Also, the projected growth in wind capacity is meant to give a sense of where the industry could go with a favorable policy environment, and what the effects will be. Capacity additions are unlikely to grow as smoothly as predicted, because market conditions will undoubtedly cause variation. Key assumptions and calculations are summarized below.

Geographic Factors

The Mid-Atlantic states are all served by the same electricity grid, the PJM, except for a small portion of western Pennsylvania. The PJM grid also serves a large part of West Virginia, and small parts of Virginia and Ohio. For simplicity, we assume that the grid region contains only the five states of Maryland, Delaware, New Jersey, Pennsylvania, and West Virginia.

Demand Growth Projections

Because of the nature of the PJM grid, and the deregulated electricity markets that frequently cross state borders, electricity demand numbers and growth predictions are not frequently available on a state-by-state basis. In October 2003, the DOE's Energy Information Administration published state electricity generation profiles. These profiles give total retail electricity sales in 1992, 1996, and 2001, as well as the annual growth rate from 1992-2001. We assume that each state's demand through 2014 has grown and will continue to grow by the same rate that it grew from 1992-2001. The effects of future energy efficiency measures, while certainly desirable, are ignored.

Wind Capacity Projections

The current wind generation in the region and the planned capacity additions for 2004 are based on a database maintained by the American Wind Energy Association (AWEA), websites of the wind farm development companies involved in the region, and personal communications with those companies. Our projection for 2004 is half of the sum of all planned capacity, under the expectation that not every planned project will actually be completed.

Wind capacity additions for 2005-2014 are based on a scenario in which wind energy is relied on in steadily increasing amounts to meet anticipated energy demand. To create the scenario, we projected that enough wind turbines would be installed in 2005 to meet 10% of the anticipated electricity demand increase in 2006. We project that the percentage of new demand met with wind will increase through the decade until all new demand anticipated in 2015 is met by new wind installations in 2014. Additionally, we assume that wind turbines will operate more efficiently over time as the technology matures, producing an average of 31% of peak capacity for turbines installed in 2004 increasing to 36% for turbines installed in 2014.

Growth rates that result from this scenario compare plausibly with the 26% rate of growth sustained by the global wind industry to date.[127] Under this scenario, the local wind industry would grow rapidly in the first few years, installing more than twice as much capacity as the previous year through 2006. As the industry matures, the annual growth rate in installed capacity slows down gradually. Under the scenario, in 2014 the industry would install 10% more capacity than in 2013. The scenario projects that

Table 9. Projected Wind Capacity to Meet Future Electricity Demand in the Mid-Atlantic

Year	Mid-Atlantic Electricity Demand (MWh/year)	PJM Wind Capacity At Year's Start (MW)	PJM Wind Production (MWh/year)	PJM Capacity Added This Year (MW)	Installed Mid-Atlantic Wind Capacity (MW)	This Year's Newly Installed Mid-Atlantic Wind Capacity (MW)	% of Mid-Atlantic Demand Met With Wind in the PJM
2004	296,120,000	195	512,539	281	129	81	0.2%
2005	301,450,000	476	1,276,030	200	210	183	0.4%
2006	306,877,000	676	1,818,714	394	393	361	0.6%
2007	312,403,000	1,070	2,923,904	602	754	551	0.9%
2008	318,029,000	1,672	4,611,975	793	1,305	726	1.5%
2009	323,759,000	2,465	6,903,866	1,009	2,031	924	2.1%
2010	329,594,000	3,474	9,821,094	1,197	2,954	1,095	3.0%
2011	335,535,000	4,671	13,385,771	1,422	4,050	1,301	4.0%
2012	341,585,000	6,093	17,620,617	1,607	5,351	1,471	5.2%
2013	347,745,000	7,701	22,548,978	1,841	6,823	1,685	6.5%
2014	354,018,000	9,542	28,194,837	2,026	8,508	1,854	8.0%
2015	360,406,000	11,568	34,582,832	N/A	10,362	N/A	9.6%

wind energy will meet just under 45% of new demand over the next decade, reaching the 10,000 MW threshold identified by wind energy experts as economically viable for development in the near term, excluding offshore wind resources.[128] Under this scenario, in 2015 wind energy production will supply 9.6% of regional energy demands. Table 9 shows the year-by-year capacity additions in this scenario both for the PJM grid region and the four Mid-Atlantic states, unrounded for transparency.

Because of the nature of the grid, it is difficult to predict where in the PJM region the capacity additions will occur. We assign a proportion of the installations to the four Mid-Atlantic states according to their natural resource potential as estimated by the National Renewable Energy Laboratory.[129] Mid-Atlantic states hold 91.5% of the regional potential, the fraction of wind energy installations assumed to occur within the region.

Wind Employment

Wind energy employment impacts derive primarily from applying employment estimates made by the Renewable Energy Policy Project (REPP) to the projected development of 10,233 MW of wind power as described above. REPP derived employment estimates from a survey of 19 wind energy companies in 2001.[130]

As the wind industry matures, experts predict declining manufacturing and installation costs. As a result, the employment intensity of the technology will also decrease. We assume that for every doubling of installed capacity worldwide, employment intensity will decrease by 15% through 2010, and afterwards decrease by 10% for every doubling of capacity. These assumptions are based on a worldwide economic analysis of wind energy made by the European Wind Energy Association and Greenpeace in *Wind Force 12*.[131]

Not all of the manufacturing employment will be in the Mid-Atlantic, but increased demand for wind generation in the region will lead to more manufacturing located here. In order project the fraction of manufacturing jobs located in the region, we assume that 12.6% of manufacturing jobs will be located in the Mid-Atlantic through 2007, or the equivalent of fully manufacturing steel towers locally. The percentage of manufacturing that takes place in the region is then gradually increased to a third by 2014 to reflect the increasingly large installations of wind power over time.

Indirect employment figures derive from an estimate of 1.15 indirect and induced jobs for every direct job by the Texas Comptroller's office.[132] We apply the same multiplier to natural gas direct employment figures to estimate indirect and induced labor supported by natural gas. IMPLAN multipliers for construction work in the region are similar.

Landowner Income

Royalties from land leases to wind farm owners are estimated at 2.5% of the yearly sale of electricity at 3 ¢/kWh.[133]

Comparison to Fossil Fuel Generation

Natural gas employment estimates derive from employment intensities at 19 proposed natural gas plants in California, and the capacity of natural gas generation necessary to produce the same amount of electricity as the Mid-Atlantic wind power projections outlined above. The capacity figure assumes that natural gas-fired plants have a capacity factor of 52.6%, based on the Mid-Atlantic's 2001 natural gas-fired electricity generation statistics (see EIA's *State Electricity Profiles 2001*, October 2003). 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 1.14 jobs per MW, assuming that employment for manufacturing follows the representative cost breakdown for a natural gas plant of 30% installation and 70% components. We also assume that one-third of these jobs would be in the Mid-Atlantic and that this percentage will not change over time because of the relatively mature market for the technology.

Solar Projections and Jobs

The estimates for possible solar development are intended to give an idea of scale. They result from hypothetically placing a 2 kW rooftop system, operating with a capacity factor of 10%, on 10% of all households owned by their occupants in the Mid-Atlantic states (using 2000 U.S. Census figures).

The estimates of resulting jobs are based on projections made by Daniel Kammen of UC-Berkeley, who concluded that solar PV would create 5.79 manufacturing jobs/MW and 4.09 installation and O&M jobs/MW ten years after an increase in production activity.[134]

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