Middle States Geographer, 2004, 37:9-18

Utility-Scale Wind Power in the Northeastern United States: A Consideration of Present and Future Locations

Lawrence A. McGlinn
Department of Geography
SUNY-New Paltz
New Paltz, NY 12561

ABSTRACT: *As the fastest growing form of alternative energy in the United States, wind power is likely to become more obvious in the landscape of the Northeast over the next 20 years. Already several large wind projects have been built in the region, several more have been approved and are being built, and many more have been proposed. Because of their obvious impact on the visual landscape, siting wind turbine arrays has become an important and sometimes contested process. Wind projects are proposed and located for a combination of four reasons:1. Wind Patterns, 2. State Policies, 3. Economic Status and Local Attitudes, and 4. Population Concentrations. The most limiting of these factors is wind patterns because without a mean wind speed of 15.7 mph at 50 meters elevation, it is not currently economical to build a wind project, restricting most projects in the region to ridge tops or coastal waters. Within these constraints, favorable state policies, economic hardship, and nearby population concentrations promote the siting of wind projects. On the other hand, regions that depend on tourism and vacation home sales typically oppose the siting of wind projects. In the near future, the current pattern of siting wind projects is likely to continue. However, over the long term, even tourist/vacation regions may become more open to the siting of utility-scale wind developments.*

INTRODUCTION

Wind energy has the potential to become a major part of the landscape in the northeastern United States over the next two decades. The efficiency and reliability of wind turbine technology has improved dramatically since wind power's ignominious beginnings in the United States twenty years ago, and the demand for electric power continues to rise in the region. Currently, wind provides less than 1% of electricity nationally and in the Northeast. However, less than 1% of potential wind resources have been exploited in the region, leaving room for significant growth (UD DOE, 2004a). Now only 184.5 MW are operating in the region, most in Pennsylvania or New York. This is enough capacity to power approximately 57,000 average households (AWEA, 2004). Much more capacity is set to come on line soon (Figure 1). Over the next generation, wind energy could become part of a new era of power generation that, along with greater energy efficiency and other alternative sources, reduces impact on the atmosphere. Or it may simply be another minor form of energy for the ever-expanding needs of an energy-thirsty society.

In 2002, the region from Pennsylvania to Maine generated significantly more electricity than it consumed (Table 1). The excess production was in Pennsylvania where coal and nuclear generation dominate, and in Maine where natural gas is by far the top energy source. Growth in both total generation and total sales was modest over the 10-year data period. Renewable generation, including hydro power, wind, solar, etc, fell during the period due mostly to reduced production in hydro power in New York. In 2003, Governor Pataki of New York led the formation of a coalition of ten northeastern states to control carbon dioxide emissions within the region. By spring 2005, this coalition is to establish a "cap and trade" system in which overall carbon dioxide emissions for the region are limited, and more efficient industries can sell their emission permits to new or less efficient industries (Office of the Governor, 2003). Although this system is primarily meant to improve regional air quality, an indirect effect of it is to drive development of alternative, non-polluting sources of energy.

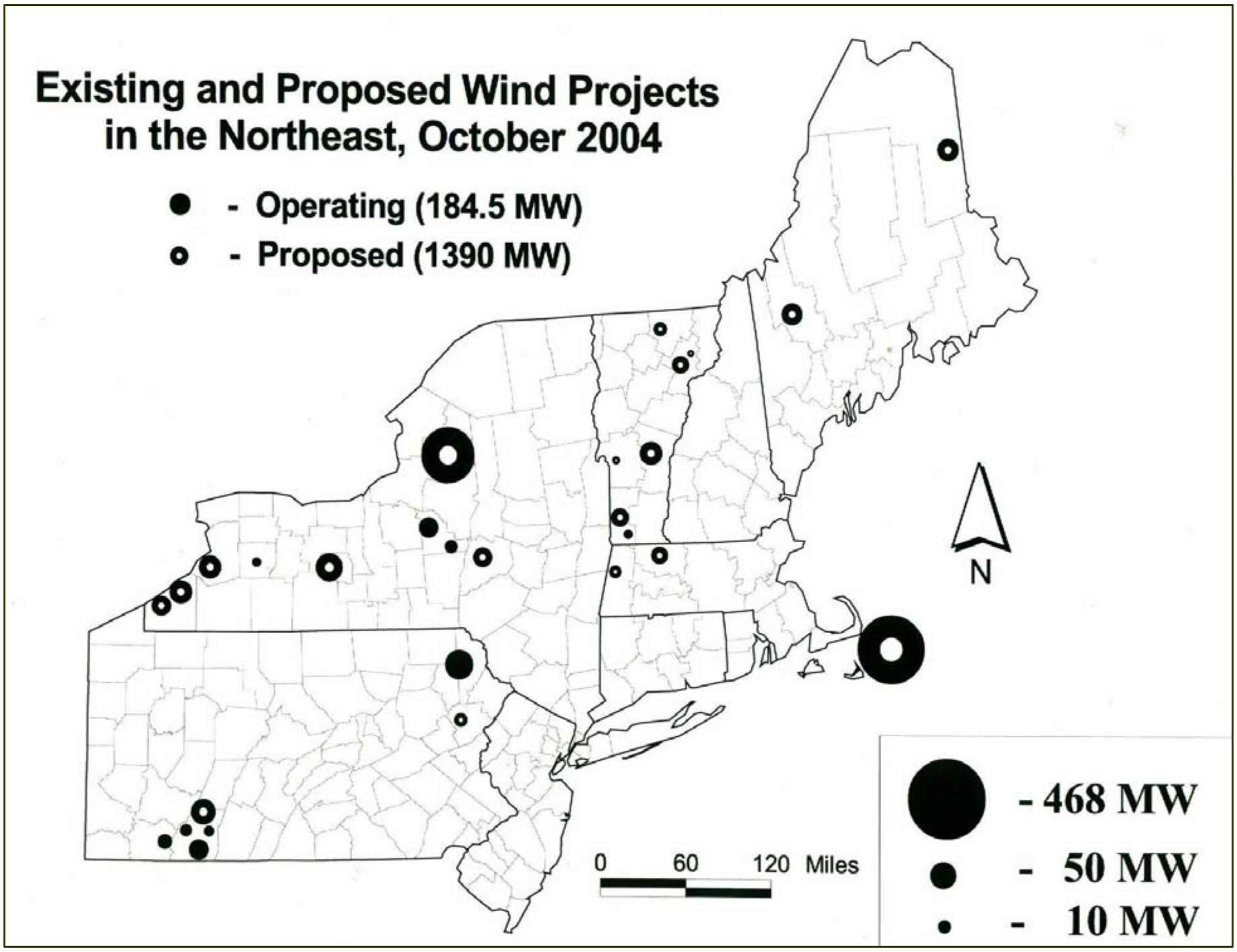

Figure 1. Existing and proposed wind projects in the Northeast

Table 1. Electricity Generation and Sales in the Northeastern US (Thousand MW-Hours)
Source: (US DOE, 2004b)

Total Generation			Renewable Generation			Total Sales		
1993	2002	Growth/yr	1993	2002	Growth/yr	1993	2002	Growth/yr
416,565	468,243	1.3%	49,522	43,305	-1.4%	348,406	400,966	1.6%

Companies such as General Electric and Florida Power and Light have decided that wind energy is profitable enough to pursue, particularly near northeastern "load centers" where so many potential customers live. The initial cost-per-kilowatt-hour for wind remains higher than coal- or natural gas-generated electricity, but its lack of social and pollution impacts makes it a target for a range of subsidies and incentives that lower its real cost to power companies and consumers.

Due to high initial costs and neighborhood opposition, the dream of thousands or millions living "off the grid" with a small windmill in the backyard has not yet materialized even for strong proponents of individual wind power. So, the most obvious sign of wind power on the landscape has been utility-scale wind developments with towers standing over 200 feet, and blades stretching 100 feet higher. The energy produced by these structures goes directly to the grid, just as energy from coal-fired or nuclear plants. Growth of the wind energy industry raises two interdependent geographic questions. First, why have wind energy developments been proposed or located where they have in the region? Second, where should we expect future developments to be proposed?

Factors influencing the siting of wind farms, as they are often called, are diverse and complex, but they can be broken down into four categories:

1. Wind patterns
2. State government policies
3. Economic status/Local attitudes
4. Population concentrations.

These influences vary in importance depending on the location and time of proposal, but they each play some role in the siting of nearly every wind development.

WIND PATTERNS

For profitable operation, current wind turbine technology requires a minimum of 15.7 mph mean wind speed at 50 meters elevation. Variability in wind is important when considering power sources to complement wind power. In the Northeast summer has the lowest average wind speeds, but the less the seasonal variation the better. Higher winds, even of hurricane force, should only cause minor damage to modern turbines which have self-adjusting blade and rotor angles and total shutdown at 45 to 80 mph, depending on the model (Iowa Energy Center, 2005). The 15.7 mph mean wind speed represents wind power class 4 on a scale running from 1 to 7 (Pasqualetti, 2004) (Table 2). Such conditions can only be met in a limited number of areas in the Northeast: at the edge of escarpments and along ridge tops exposed to the west or northwest, and along coastlines (Figure 2). The best sites with mean wind speeds in excess of 18 mph are rarer still, and still located on highly visible ridges or outcroppings. Many ridges and coastlines are considered scenic resources, key to tourist and vacation real estate values. So, siting turbines that stretch over 300 feet above these places is a problematic process with many strongly opinionated stakeholders. In northern New England, in particular, much of the ridge top land is in National or State Forests, creating the possibility of a more open, deliberative process of wind development. However, preliminary public meetings organized by Vermont officials to consider wind development on Green Mountain ridges stimulated a strong, uncompromisingly negative reaction from the community (Miles, 2004).

The US Department of Energy continues to emphasize low-wind speed technology in its research. The ability to produce electricity at lower wind speeds would greatly expand the field of potential locations for wind projects. Lowering the threshold for economical power generation from class 4 to class 3 (14.3 mph mean wind speed) would more than quadruple the land area considered for wind development, and it would mean that turbines could be sited in less obtrusive areas than their current ridge top locations, making them more acceptable to those concerned with the scenery. In related research, DOE scientists have confirmed that larger turbines produce power more efficiently, especially at low wind speeds (US DOE, 2004c). Designers have responded to this knowledge by building ever larger, more efficient turbines.

Table 2. Wind Power Classes by Average Annual Wind Speed
Source: (NREL, 1986)

Wind Power Class	Average Annual Wind Speed
1	0-12.4 mph
2	12.5-14.2 mph
3	14.3-15.6 mph
4	15.7-16.7 mph
5	16.8-17.8 mph
6	17.9-19.6 mph
7	19.7-26.6 mph

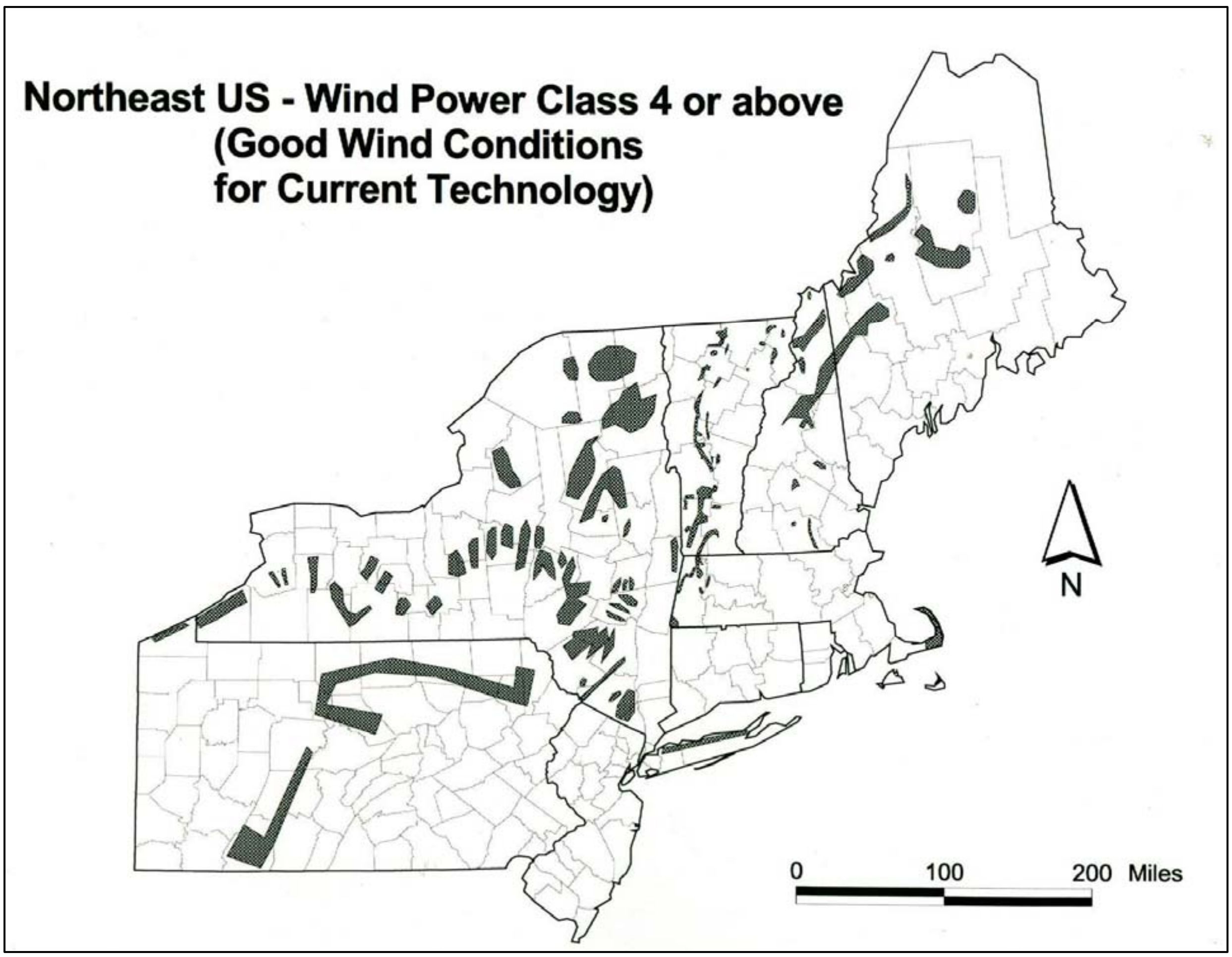

Figure 2. Northeast US wind power class 4 or above

STATE GOVERNMENT POLICIES

A key to the rapid development of large wind projects throughout the United States since the early 1990s has been a federal production tax credit (PTC) of 1.5¢ (or more) per kilowatt hour. Development of wind power over the past decade has followed a "boom or bust" cycle as the PTC has been allowed to expire and then to be reinstated. Most recently, installation of wind turbines was postponed at most proposed US sites at the end of 2003 when the PTC expired. It was only re-approved by Congress on September 28, 2004, retroactive to December 31, 2003, and extending until the end of 2005. The measure was signed by President Bush as part of a large tax bill on October 5, 2004 (Vinluan, 2004). Delayed construction will now proceed at many sites nationally, including the largest proposed project in the East, the Flatrock Project, 188 - 1.5 megawatt turbines on the Tug Hill Plateau in Lewis County, NY, twenty miles east of Lake Ontario (Watertown Daily Times, 2004).

The Renewable Portfolio Standard (RPS)

Since the PTC is federal law, its impact is uniform throughout the Northeast. However, several states have extended renewable energy requirements or incentives beyond the federal initiative. The most evident impact from state policy is the Renewable Portfolio Standard (RPS) which mandates that a certain percentage of electricity retailed in a state must come from renewable energy resources by a certain target date (NY PSC, 2004; Heiman and Solomon, 2004). RPS is part of an effort to deregulate the energy marketplace while using market forces to steer energy policy toward cleaner, renewable technologies. Although percentages and the mix of renewables vary by state, an RPS does exert considerable pressure on electricity marketers to diversify their energy sources.

They can go out of state or to Canada for renewable energy supplies, but for new sources their choice is most often wind. Wind is currently the easiest and least expensive renewable to install, so turbines are more likely to be seen in states with an ambitious RPS target (Table 3).

Maine's definition of sources for RPS includes efficient cogeneration projects which burn fossil fuels, helping to boost the state's currently acceptable usage to nearly 70%, and rendering its 30% RPS goal meaningless without reform (MECEP, 2001). New Hampshire does not have an RPS program, concentrating instead on regulating power plant emissions, including the first program in the country to regulate carbon dioxide (Energy User News, 2002). Vermont has seriously considered RPS for two legislative sessions, but it has not yet enacted legislation (Central Vermont Public Service, 2004).

Massachusetts' RPS took effect in 2003, requiring that 1% of energy retailed in Massachusetts should come from a strict set of renewable fuels: wind, solar, ocean thermal or tidal, landfill or digester gas, or low-emission biomass. The total should rise at least 0.5% each year through 2009 to 4%, then 1% per year from 2010 until the legislature terminates the program (Massachusetts Code of Regulations, 2004). Significantly, hydro power is not included as a renewable in this definition, raising the profile of wind as an alternative to conventional sources such

Table 3. RPS Status of Northeastern States, October 2004, by % of Total Power Consumption

State	RPS Target	Current (2004)	Target Date
ME	30%	70%*	2000
NH	None		
VT	None		
MA	4%	1.5%	2009
RI	15%	3% (2007)	2019
CT	7%	1.5%	2010
NY	25%	19.3%	2013
NJ	6.5%	3%	2012
PA	Variable		

*Includes efficient cogeneration using natural gas or coal as natural gas.

Rhode Island's RPS, enacted in June 2004, looks farther into the future, starting with an intermediate level of 3% of electricity from renewables in 2007, reaching an ambitious 15% in 2019 (State of Rhode Island, 2004). As with Massachusetts, hydropower is not eligible for RPS standing in Rhode Island. Likewise, Connecticut's RPS goal of 7% by 2010 emphasizes wind, solar, biomass, landfill gas, and ocean-based sources, along with new, small hydro facilities (<5 MW) (US DOE, 2004d).

In terms of raw supply, New York's RPS goal of increasing renewable share from 19.3% currently to 25% by 2013 is the most ambitious in the region. Hydroelectric power from the Niagara River and other sources currently constitutes 18% of the state's energy market, but energy from large hydro projects is not acceptable for new sources in the RPS (NY PSC, 2004). Thus, the amount of RPS-approved energy should rise from 1.3% to 7% over the next nine years. With a summer capacity of over 37 GW, and a projected increase of 1.3% per year, New York State will need to add nearly three GW of renewable energy, the equivalent of 2000 large wind turbines, over the next nine years (NYSERDA, 2004). Currently, wind projects proposed or under construction in New York account for 551 MW, approximately 1/5 of this total.

Pennsylvania's RPS threshold is both low and variable, applying first to 20% of customers served by selected power companies, then to increasing numbers of customers at progressively higher levels. Pennsylvania has been a leader in developing wind projects, largely due to its wind patterns and large, rural hinterland, but its RPS is unlikely to have a significant effect for several years.

The market-based RPS is both politically popular and effective at stimulating renewable energy development. Although RPS programs are geographically flexible and variable in effectiveness, they create a strong incentive for power companies to work with wind developers to augment the power supply in their local regions. Enforcement procedures vary by state, but include fines, payments by non-compliant utilities into a renewable energy research fund, and revocation of operating licenses in extreme cases. Cooperative efforts between state officials and energy companies are preferred (Petersik, 2004). States with effective, realistic RPS programs are likely to see continued utility-scale wind power development.

The System Benefit Charge (SBC)

A second state program that contributes directly to the development of wind power is a systems benefit charge (SBC) which is levied on power companies (and indirectly on customers) to pay for improvements in energy efficiency, research and development, and low income issues. A significant part of this charge may be re-invested in renewables, specifically wind and solar projects. In New York, the NY State Energy Research and Development Authority (NYSERDA) administers much of the income from the SBC to provide everything from direct subsidies for new wind projects to research and development of new wind and solar technology. Over the past two years $32 million from Massachusetts' SBC has gone to finance five renewable projects, four in Massachusetts and one in New Hampshire. Two of these projects are wind developments in western Massachusetts, totaling over 40 MW of capacity (Broehl, 2003; AIM Foundation, 2004). Under their agreement, Massachusetts will buy the first ten years of energy from these projects at a slight premium, increasing the chance of financial success dramatically, and encouraging other potential developers to consider the state. Pennsylvania also offers a $20 million Green Energy Fund which invests in renewable energy technology. While New York, Pennsylvania, and Massachusetts have the largest SBC programs, all states in the region have some kind of surcharge for renewable energy development.

ECONOMIC STATUS/LOCAL ATTITUDES

The complex interplay of economic status and local attitudes is perhaps the most important determinant in the siting of wind developments. Wind energy installations have been more welcome in areas traditionally supported by agriculture or mineral resources. Not coincidentally, many such regions have suffered from stagnant economies for generations. The combination of utilitarian views of the landscape and economic need have driven support for utility-scale wind developments in rural regions of Pennsylvania and New York. Major projects in southwest Pennsylvania (Mill Run), central New York (Madison County), and northern New York (Lewis County), all in economically depressed resource or agricultural regions, encountered little opposition during their planning and building. The Lewis County project, Flat-Rock Wind, the largest in the East with 188 turbines proposed, promises $1.23 million per year for 10 years for the town of Martinsburg, as well as leases of up-to-$6000 per turbine for individual land owners, and as many as 15-20 permanent jobs (Knauss, 2004).

In traditional tourist or second-home areas, however, resistance to wind development has been intense. In these regions, views from points such as beaches, overlooks, or vacation homes are commodities to be frozen in time for urbanites escaping the asphalt and structures of the city. The assumption among tourist operators and second-home real estate interests is that their customers will be repulsed by towers soaring above ridgelines or above open ocean water, and, doubtless, many are and would be. According to this reasoning, the tourist landscape should be static and pastoral, or sylvan, or at least have no obvious human impacts. Subtle human impacts are everywhere, even in so-called "pristine" environments, but there is nothing subtle about a modern wind turbine. Opponents typically use the term "industrial" when referring to wind turbines, although proponents often refer to them as moving sculptures, or elegant designs (Austin, 2004; Righter, 2002).

The most infamous case of resistance to wind power development is the Cape Wind proposal for 130 wind turbines stretching over 400 feet to the tip of the blade sweep above Nantucket Sound five miles off Cape Cod. It is especially notable because it has split the environmental community between those who favor wind power because it does not produce greenhouse gases or other air pollutants, and those who feel the size and location of the turbines is scenically inappropriate. The turbines would be visible from shore, but opinions on their visual impact seems to be correlated to one's opinion of the project. Proponents see them as barely visible specks on the horizon, while opponents see them as towering over their precious sound (Gershon, 2004). Opposition has also slowed or stopped wind projects in Vermont's Green Mountains, in Cherry Valley, NY (near Cooperstown), and off Montauk Point on Long Island (Belluck, 2003; Economist, 2003). These areas' economies depend on vacation dollars. For most locals, the scenery is their primary commodity, and they reap all of the benefits from it nearby. Wind power's benefits would be spread over a wide region, but the feared impacts of wind power would be borne locally.

Even where contested wind developments are ultimately built the cost in legal fees can discourage developers. Although wind turbines are usually planned for private property, with generous leases for landowners, adjacent and nearby landowners can resist development through vocal opposition at hearings, through influence with local decision makers, and through layers of environmental litigation, e.g. the Endangered Species Act. Thus, large wind farms are currently unlikely to be located in regions frequented by tourists and second-home owners. Culture, however, is always evolving, and since wind turbines have little impact beyond the visual, they may become more accepted in future generations among tourists and vacation-home owners who understand the impacts of burning fossil fuels. Experience from Europe suggests that citizen involvement in decisions regarding wind developments is critical in working toward acceptance (Hoppe-Kilpper and Steinhäuser, 2002; Hammarlund, 2002). This acceptance might grow more quickly with obvious effects from global warming such as dramatic sea-level rise, unprecedented heat waves, or drought.

POPULATION CONCENTRATIONS

The Great Plains, stretching from West Texas through the Dakotas, north into Canada has been identified as the region with the best combination of wind conditions, economic need, and accepting attitudes in the United States (Pasquarelli ,2004). However, the region lacks the fourth factor that is key to siting wind power, a dense population of consumers. In addition, sending electricity over 1000 miles to population centers in the East and West raises technological concerns that are not easily overcome. First, as it stands, the electrical grid through the Middle West and Great Plains does not have the capacity to move large amounts of electricity to the coasts in a timely manner. So, high-capacity transmission lines would have to be built over thousands of miles to simply plug into the denser grids of the East and the West. Second, even if these new lines are built, transmission losses over such a long distance could be significant. Recent years have seen average transmission and distribution losses of approximately 7.2% in the United States (US Climate Change Technology Program, 2003). Over such long distances and through such congestion, losses would likely be greater. Thus, there is interest in locating wind projects near population centers in the East and West where transmission difficulties would be minimized. In the Northeast, coastal wind projects are particularly attractive in this sense because of the proximity of large populations to the coast. The rural Northeast, where public acceptance may be more readily accomplished, is attractive to wind energy developers, particularly sites near existing, high-capacity power lines which would need little added infrastructure.

CONCLUSION

Although only a small percentage of electric generation in the northeastern United States, utility-scale wind power is established here. There is a clear pattern of rural, economically strapped communities welcoming wind developments in New York and Pennsylvania in particular. Wind power will likely grow dramatically over the next decade where the combination of physical and social conditions is right. Almost 1400 MW of capacity is proposed or under construction in the region, enough for as many as 400,000 typical households' electricity usage. It is unlikely that all 1400 MW will be built as planned, particularly the massive Cape Wind project in Nantucket Sound. Local opposition to wind development is a major obstacle where scenery is at a premium. Nevertheless, with the federal Production Tax Credit renewed until the end of 2005, many new proposals will be brought forward over the next year. The fate of these proposals is largely a function of their location. Wind developers want to be near load centers like metropolitan Boston or New York City, or on mountain ridges where wind conditions are most favorable, but these are also the most contested locations because of the impact of 350-foot wind turbines on the scenery. With fossil fuel prices high, and federal and state incentives in place, wind developers will continue to press to site their projects favorably. If wind is to become more of a factor in the energy mix, the question remains, will attitudes toward a clean but visually prominent technology change?

REFERENCES

AIM Foundation (Associated Industries of Massachusetts). 2004. The Massachusetts Renewable Portfolio Standard: Context and Considerations. www.aimnet.org/image/Files/RPS_White_Paper.pdf

AWEA (American Wind Energy Association). 2004. Wind Energy Projects Throughout the United States. http://www.awea.org/projects/index.htmlT

Austin, J. 2004. Company buys rights to CV turbine project. *Cooperstown Crier*, June 24, 2004.

Belluck, P. 2003. A Wind Power Plan Stirs Debate in Massachusetts. *New York Times*, March 2, 2003.

Broehl, Jesse. 2003. $32 Million Targets Renewable Energy Developers. SolarAccess.com, November 13, 2003. www.hoosacwind.com/articles/2003-11-14-solar_access.html.

Central Vermont Public Service Corporation. 2004. Quarterly Report. August 5, 2004.

Economist. 2003. *A tempest off Nantucket*. Volume 368, p. 30, September 13, 2003.

Energy User News. 2002. New State Initiatives and Laws Boost Renewable Energy. http://www.energyusernews.com.

Gershon, E. 2004. Prospect of Wind-Farm Views Doesn’t Sit Well. *Cape Cod Times*, November 9, 2004.

Hammarlund, K. 2002. Society and Wind Power in Sweden in *Wind Power in View: Energy Landscapes in a Crowded World* edited by M.J. Pasqualetti, P. Gipe, and R. W. Righter. New York: Academic Press, pp. 101-114.

Heiman, M.K. and Solomon, B.D. 2004. Power to the People: Electric Utility Restructuring and the Commitment to Renewable Energy. *Annals of the Association of American Geographers* 94(1): 94-116.

Hoppe-Kilpper, M. and Steinhäuser, U. 2002. Wind Landscapes in the German Milieu in *Wind Power in View: Energy Landscapes in a Crowded World* edited by M.J. Pasqualetti, P. Gipe, and R. W. Righter. New York: Academic Press, pp. 83-99.

Iowa Energy Center. 2005. *Wind Energy Manual.* Ames, IA: Iowa Energy Center www.energy. iastate.edu /renewable/wind/wem-index.html

Knauss, T. 2004. A Mighty Profitable Wind: Towns, School Districts Cash in on Renewable-Energy Project. *The Post-Standard* (Syracuse, NY), March 21, 2004.

Massachusettts Code of Regulations. 2004. 225 CMR 14.05-14.07.

MECEP (Maine Center for Economic Policy). 2001. State Initiatives for Clean Energy Development. Choices: Ideas for Shared Prosperity (MECEP Newsletter) 7 (9): 6-7.

Miles, Jeanne. 2004. Wind Farm Opponents to PSB: 'Slow Down' *The Caledonian Record* (St. Johnsbury, VT) January 14, 2004.

NREL (National Renewable Energy Laboratory). 1986. *Wind Energy Resource Atlas of the United States.* Golden, CO: National Renewable Energy Laboratory.

NY PSC (State of New York Public Service Commission). 2004. Order Regarding Retail Renewable Portfolio Standard. September 24, 2004.

NYSERDA. 2004. State Energy Plan – 2003 Annual Report and Activities Update. Memorandum from The Energy Coordinating Working Group, February 24, 2004.

Office of the Governor (New York). 2003. Governor Announces Cooperation on Clean Air intiative. Press Release, July 24, 2003.

Pasquarelli, M.J. 2004. Wind Power: Obstacles and Opportunities. *Environment* 46 (7): 22-38.

Petersik, T. 2004. *State Renewable Energy Requirements and Goals: Status through 2003.* Washington, DC: Department of Energy, Energy Information Administration Analysis Paper. http://www.eia.doe.gov/oiaf/analysis.htm.

Righter, R.W. 2002. Exoskeletal Outer-Space Creations in *Wind Power in View: Energy Landscapes in a Crowded World* edited by M.J. Pasqualetti, P. Gipe, and R. W. Righter. New York: Academic Press, pp. 19-41.

State of Rhode Island. 2004. House Bill 7375 – An Act Relating to Public Utilities and Carriers-Renewable Energy Standard.

US Climate Change Technology Program. 2003. Technology Options for the Near and Long Term, November 2003.

US DOE (US Department of Energy). 2004a. Wind Energy Resource Potential. www.eere.energy.gov/wind andhydro/wind_potential.html.

-----. 2004b. *State Electricity Profiles 2002.* Washington, DC: Energy Information Administration, Office of Coal, Nuclear, Electric, and Alternative Fuels. http://www.eia.doe.gov/cneaf/electricity/ st_profiles/e_profiles_sum.html)

-----. *2004c. Wind Power: Today and Tomorrow*. Report by National Renewable Energy Laboratory, March 2004.

-----. 2004d. Electric Industry Restructuring in Connecticut. Office of Energy Efficiency and RenewableEnergy. www.eere.energy.gov/regions /northeast/docs/connecticut_7_1_04_clean.doc

-----. 2005. Wind Powering America – State Wind Resource Maps. Office of Energy Efficiency and RenewableEnergy. www.eere.energy.gov/windandhydro/ windpoweringamerica/wind_maps.asp)

Vinluan, Frank. 2004. Wind energy gets updraft as Bush OKs Tax Credit. *Des Moines Register* October 5, 2004.

Watertown Daily Times (Watertown, NY). 2004. Wind Farm Plan Now Ready to Roll. September 28, 2004. p. D8.