Wind Energy in the Northeastern U.S.

Leverage Points For Growth

Prepared For:

Connecticut Clean Energy Fund

999 West Street
Rocky Hill, CT 06067

Prepared By:

Energy & Environmental Ventures LLC
23 Cardinal Road
Weston, CT 06883
Tel: (203) 227-4111

Wind Energy in the Northeastern U.S.
Leverage Points For Growth

TABLE OF CONTENTS

1. Conclusions

Present Market Conditions – Connecticut and the Northeastern U.S.

The wind energy situation in the Northeastern U.S. can be characterized by the following:

1. Wind resources considered economically feasible for land-based wind farm development (Class 5 or higher) are generally found along higher north-south mountain ridges in Vermont, New Hampshire and Maine. There are similar windy areas in both the Catskill and Adirondack regions of New York. Little data, if any, has been developed for the region's offshore wind resources, however, robust wind regions are known to exist over the easternmost portions of Cape Cod and adjacent waters. Existing data does not indicate large wind energy potential within Connecticut given today's turbine technology and electricity prices.

2. There are developable wind resources in Québec, Nova Scotia and Newfoundland; however, only imports from Québec are seen as potentially feasible for reasons of transmission economics.

3. In the entire 6-state New England region, only two wind projects are in operation: the 6 MW Searsburg project in Vermont and a 320 kW project in Massachusetts owned by Princeton Municipal Light.

4. At least four other projects are under active development: a 5 MW project in southern Vermont (Equinox), a 20 MW project in Maine (Redington), a 5 to 10 MW project in western Massachusetts (Brodie Mountain) and a 100 MW offshore project. In addition, there is a 11.5 MW project under construction by PG&E in upstate New York (Madison) and one 100 MW project (Le Nordais) owned by Axor, of which 50 MW is operational and the other 50 MW is in construction in the Gaspé Region of Québec. Le Nordais will sell power to Hydro-Québec under a politically-driven, long-term, above-market-price contract.

5. Wind power is generally more expensive than prevailing wholesale power, however, the premium varies significantly depending upon on wind regime, project size and location (i.e. transmission-related issues). The non-dispatchable nature of wind power further erodes its value in conventional wholesale power exchanges.

6. Working in wind power's favor are the federal production tax credit of 1.5¢/kWh, currently in effect until December 31, 2001, and the premium consumers are willing to pay for green power. On California's APX, this green premium ranges from 0.5¢/kWh to 1.5¢/kWh. Anecdotal evidence from Pennsylvania's market indicates the green premium can be several ¢/kWh over the standard offer in informal (bilateral) transactions.

7. Transmission constraints during peak periods (both summer and winter) do not favor imports into Connecticut from new generation sited in Vermont, New Hampshire, Maine or New York – regions with the most abundant wind resources. ISO-New England's present settlement-based tracking system does little to alleviate this problem. (See #10 below.)

8. Deregulation in Connecticut coupled with relatively high default generation prices (5.0¢/kWh to 5.5¢/kWh for residential customers in the territories of CL&P and UI, respectively, and about 0.5¢/kWh less for commercial customers) has caused a number of green power marketers to take interest in the Connecticut market. However, wholesale prices are also relatively high thus reducing the potential for green power marketers to profit by marketing firm blends of green and "brown" power as has been done in Pennsylvania.

9. Renewable Portfolio Standards which have been passed into law in Connecticut, Maine and Massachusetts would appear to provide an incentive to new wind developments; however, enforcement of the Connecticut RPS has been delayed due to DPUC concerns over whether there is a sufficient amount of renewable energy "reasonably available" for retail sale within the State. Vermont is also reportedly considering a RPS.

10. ISO-New England operates on a settlement-based tracking system with hourly settlements. This system is unfriendly to wind power because: (a) hourly tracking intervals do not inherently "smooth" the intermittent nature of wind, and (b) where transmission of green kWh is transmission constrained, so too are trades of green attributes. A hybrid approach incorporating some element of tagging is being discussed within NECPUC and ISO-NE.

11. ISO-NE has made a recent filing (3/31/00) on a Congestion Management System that would encourage location-based pricing of power. In general, this would tend to penalize wind power generated behind transmission constraints (i.e. Maine, New Hampshire, Vermont) and favor new generation near load centers in the Boston-New York corridor.

Possible Market Development Scenarios

Several non-mutually exclusive scenarios for windfarm development were examined and are summarized in Table 1.

Table 1. Wind Power Development Scenarios

Scenario	Outlook
Relatively small (20 MW or less) wind farms in central and northern New England and upstate New York.	This scenario is likely but, due to siting and transmission constraints, will likely add only moderate amounts of wind energy to the region.
Larger (50 MW and greater) offshore wind farms off the coasts of Cape Cod and possibly southern Long Island, Rhode Island and eastern Massachusetts.	This scenario, untried in the US but popular in northern Europe, is also likely and has the potential to add hundreds of MW's of wind energy to the region.
Distributed wind energy resources (less than 250 kW) on a behind-the-meter basis within Connecticut and elsewhere.	This scenario is likely but will add relatively small amounts of wind energy to the region.
Large (50 MW and greater) wind farms in Québec by independent developers with the green power re-marketed by Hydro-Québec into New England via the Radisson HVDC line.	This scenario is only moderately likely as it is believed Hydro-Québec has not even begun to consider the possibility to market wind power to New England as premium-priced green power.

CCEF Leverage Points

Given the foregoing, CCEF activities that may have the most impact on catalyzing windfarm development in the region were identified – both in terms of direct investment as well as "capacity building" activities that help create an enabling environment for wind energy.

Investment Activities

- Invest "rational" (i.e. financially sound) equity in "first mover" wind farms (i.e. those that are ahead of the development of the green power market) or projects that otherwise contribute in an important way to achieving the long-term goal of 2 GW of wind capacity for the region. This might be done in collaboration with the Massachusetts Technology Collaborative (MTC), Rhode Island Renewable Energy Consortium (RIREC) and/or other state funds (e.g. NYSERDA). The type of capital most needed by project sponsors at the present time is:
  - Development stage (i.e. pre-construction) equity
  - Permanent equity that takes green premium risk

Capacity Building Activities

- Support the active engagement of the Connecticut DPUC and other relevant state agencies (or participate directly) in ISO-NE's development of a tracking system best suited to create an open, transparent, flexible and liquid market for green power in New England.

- Convene public sector (i.e. government) stakeholders in New England to coordinate relevant policy and regulation to create an open and transparent market for green power and possibly to implement specific green-oriented projects, programs and/or investments.

- Convene public and private sector interests (including sources of project finance) to foster the development of commercial mechanisms for the marketing and financing of green power.

- Support (i.e. fund) green power market analyses in Connecticut (and on a regional basis in coordination with MTC, RIREC and others) and disseminate the data to inform the actions of policymakers and the private sector.

- Co-fund wind measurement and data logging in regions where little data exists today (e.g. offshore, selected sites south of transmission constraints (i.e. Massachusetts and Connecticut).

- Convene environmental stakeholder groups to proactively identify an inventory of potentially developable wind farm sites.

- Foster a dialogue with Hydro-Québec concerning their participation in the green power market in New England.

Issues/Questions

There were many issues and questions raised that were beyond the scope of this study but deserve mention due to their potential impact on the conclusions.

1. Securing a long-term market for wind-generated power at a sufficiently attractive price is the single greatest challenge facing wind farm developers today. Transmission issues are closely linked with marketing issues depending upon the commercial structure under which the wind energy is sold and transmitted.

2. Siting is the second greatest challenge; however, this risk can be managed through careful site selection and proactive engagement of stakeholders.

3. In projecting the size of the Connecticut green power market, it is extremely difficult to extrapolate data from California and Pennsylvania due to differences in program design and demographics. Not until July 1, 2000 when the entire state is deregulated will we begin to acquire first-hand experience as to the size of the green power market and the associated green premium consumers are willing to pay.

4. It is not known how much of the existing Connecticut installed base will qualify for Green-e certification. (There is 168 MW of installed hydroelectric, landfill gas and waste tire capacity in Connecticut in addition to 171 MW of incineration capacity.[1]) It is also not yet known whether the owners of that generation will market power from their Green-e certified facilities as green power.

5. A detailed analysis of the various tracking proposals under consideration at ISO-New England, including the associated timeframe for implementation, has not been undertaken as part of this study. However, in a financial tracking system such as currently exists, the non-dispatchable nature of wind energy degrades its market value by the value of capacity. For an "all requirements" purchaser, wind energy must be "firmed" by capacity from another source which adds to the cost of the wind energy. In this instance, can consumers purchase partial energy requirements from a wind farm and have the local utility "firm" those purchases? This would result in the consumer having two separate suppliers of generation. Alternatively, an all-requirements provider or energy marketer could incorporate wind energy into its generation portfolio (which includes dispatchable generation) and offer a blended price to consumers.

6. The Connecticut Renewable Portfolio Standard calls for 0.5% (i.e. ~30 MW) of the kWh sold in the State (excluding retail sales by municipal and cooperative utilities) to come from Class I technologies (i.e. solar, wind, sustainable biomass, landfill gas and fuel cells in 2000 rising to 6% in 2009 as compared to installed Class I capacity of about 7 MW. The RPS is the burden of energy retailers. Implementation of the RPS has been delayed by two years (and may be further delayed) since the DPUC has determined the shortfall in Class I generation is not reasonably available. However, there is no guidance as to what price points (¢/kWh) for Class I energy are within the zone of reasonableness. The higher the "reasonable price", the more renewable supplies are likely to appear.

7. Will ISO-NE's proposal to implement a congestion management system and the resultant trading of financial congestion rights create a financial incentive for the development of distributed generation resources in the region and what impact will this have on wind farm development?

8. Will a forward market and associated financial derivative contracts develop around the green premium?

[1] Connecticut Siting Council – 1999 Forecast of Loads and Resources, www.state.ct.us/csc/paul/htmlrev/forcst99.htm

9. To what extent will project finance lenders assume commodity price risk on renewable energy projects (e.g. wind farms) that presumes a higher clearing price than that assumed for non-renewable merchant projects?

2. Introduction

The fundamental question poised by this study was the following:

> ***"What would be required in order for the Northeastern United States, and Connecticut specifically, to be supplied with a significant[2] amount of wind-generated power?"***

A multifaceted approach to this question was taken where various aspects of windfarm development were examined, including:

- Assessment of technical wind resource potential in New England, New York and eastern Canada;
- Examination of key siting and permitting issues affecting the ability to site new windfarms;
- Assessment of the regional power transmission system to move power from windy areas to load centers and programs currently being developed around open transmission access;
- Review of existing wind turbine technology and commentary on the activities of major wind turbine vendors;
- Review of current research on green power markets, specifically, consumers' willingness to pay a higher price for green power; and
- Review of the current regulatory structure, in Connecticut and elsewhere in New England, as it impacts the development of new wind capacity.

There are several limitations of this study imposed by the finite nature of available data, particularly with respect to the potential for wind generation both in Canada and offshore New England. Furthermore, many significant policies (e.g. renewable portfolio standards, transmission tracking systems) potentially affecting the future of green generation in the region are very much in flux which could cause different conclusions to be reached once final policies have been implemented. Finally, this study is intended as both a primer on wind power in the region and as a guide to those seeking to promote additional wind energy development by highlighting those issues key to the success of the wind industry at this time.

---

[2] For purposes of the study, "significant" was defined as a regional usage of 2 GW – a rather large jump from the present installed capacity of 6.4 MW in the entire New England region.

3. Assessment of the Technical Wind Resource Potential

Overview of Wind Resource in the Northeast Region

Wind resource maps of the Northeastern states published by Pacific Northwest National Labs in "Wind Energy Resource Atlas of the United States" are shown in Figures 1 through 3. An extensive area, including most of Vermont and New Hampshire, as well as much of Maine, Massachusetts and Connecticut, has annual average wind power of class 3 or higher on exposed locations. Highest powers (Classes 5 and 6) occur on the best exposed mountain and ridge tops in Vermont's Green Mountains, New Hampshire's White Mountains, and Maine's Longfellow Mountains and off the coast of Cape Cod. The remainder of the hilltops and mountain tops in this area that are outside of these major ranges have Class 3 or 4 wind power. At the highest elevations this wind power increases to Class 6 and 7 in the winter.

Table 2. Classes of Wind Power Density

	@ 10 m (33 ft)		@ 30 m (98 ft)		@ 50 m (164 ft)	
Wind Class	Density w/m^2	Speed m/s (mph)	Density w/m^2	Speed m/s (mph)	Density w/m^2	Speed m/s (mph)
1	< 100	4.4 (9.8)	< 160	5.1 (11.4)	< 200	5.6 (12.5)
2	< 150	5.1 (11.5)	< 240	5.9 (13.2)	< 300	6.4 (14.3)
3	< 200	5.6 (12.5)	< 320	6.5 (14.5)	< 400	7.0 (15.7)
4	< 250	6.0 (13.4)	< 400	7.0 (15.7)	< 500	7.5 (16.8)
5	< 300	6.4 (14.3)	< 480	7.4 (16.6)	< 600	8.0 (17.9)
6	< 400	7.0 (15.7)	< 640	8.2 (18.3)	< 800	8.8 (19.7)
7	< 1000	9.4 (21.1)	< 1600	11.0 (24.7)	< 2000	11.9 (26.6)

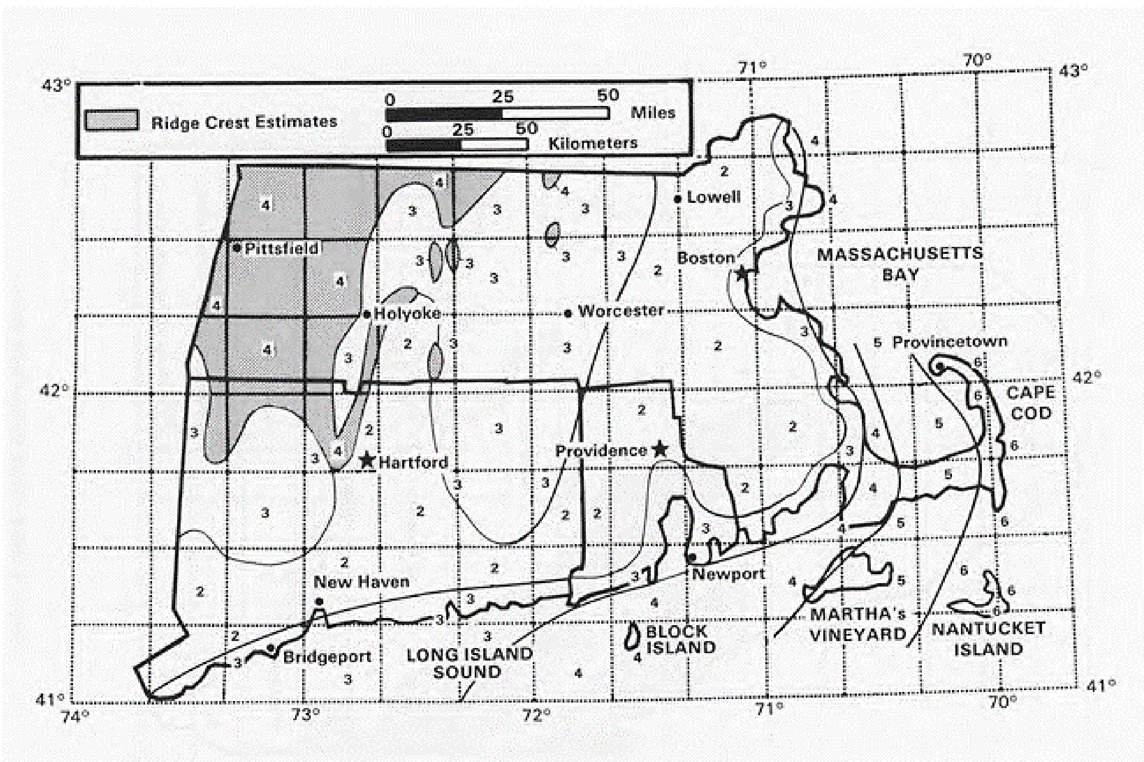
Average wind speed may vary significantly from one ridge crest to another and is primarily influenced by the height and slope of the ridge, orientation to the prevailing winds, and the proximity of other mountains and ridges. For example, the White Mountains are indicated to have a Class 6 wind power, but Mount Washington, at 1,917 m (6,288 ft) elevation, is known to have considerably greater wind power as a result of terrain-induced acceleration as the air passes over the mountain. Wind power of Class 3 and higher is estimated for the high elevations of the Adirondack Mountains of northeastern New York. Two of the highest mountains, Mt. Marcy and Whiteface Mountain, have at least Class 6 wind power. As in the case of Mount Washington, wind measurements on Whiteface Mountain indicate higher than Class 6 power because of local acceleration effects. Mean upper-air wind speeds appear to be about the same over the Adirondack Mountains as they are over the mountains of northern New Hampshire and Vermont.[3]

[3] "Wind Energy Resource Atlas of the United States", Chapter 3, NREL, www.rredc.nrel.gov/wind/pubs/atlas/chp3.html

State By State Wind Energy Potential[4]

Figures 1 through 3 illustrate the general pattern of wind resource in New England.

Figure 1. Estimated Wind Resources for Connecticut, Massachusetts and Rhode Island



4 "An Assessment Of The Available Windy Land Area and Wind Energy Potential In The Contiguous United States", Pacific Northwest Laboratory, Richland, WA, August, 1991.

Figure 2. **Estimated Wind Resources for Vermont and New Hampshire**

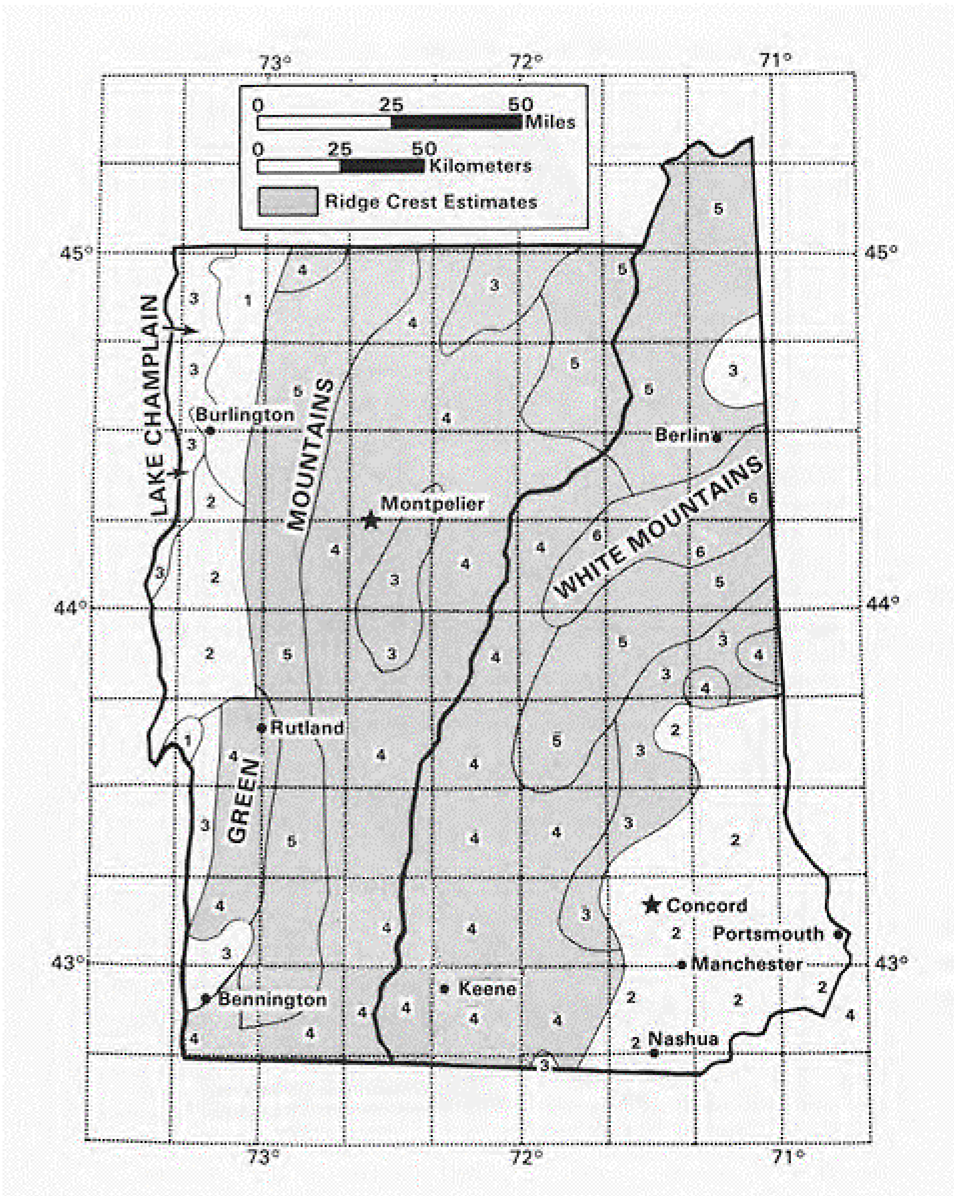
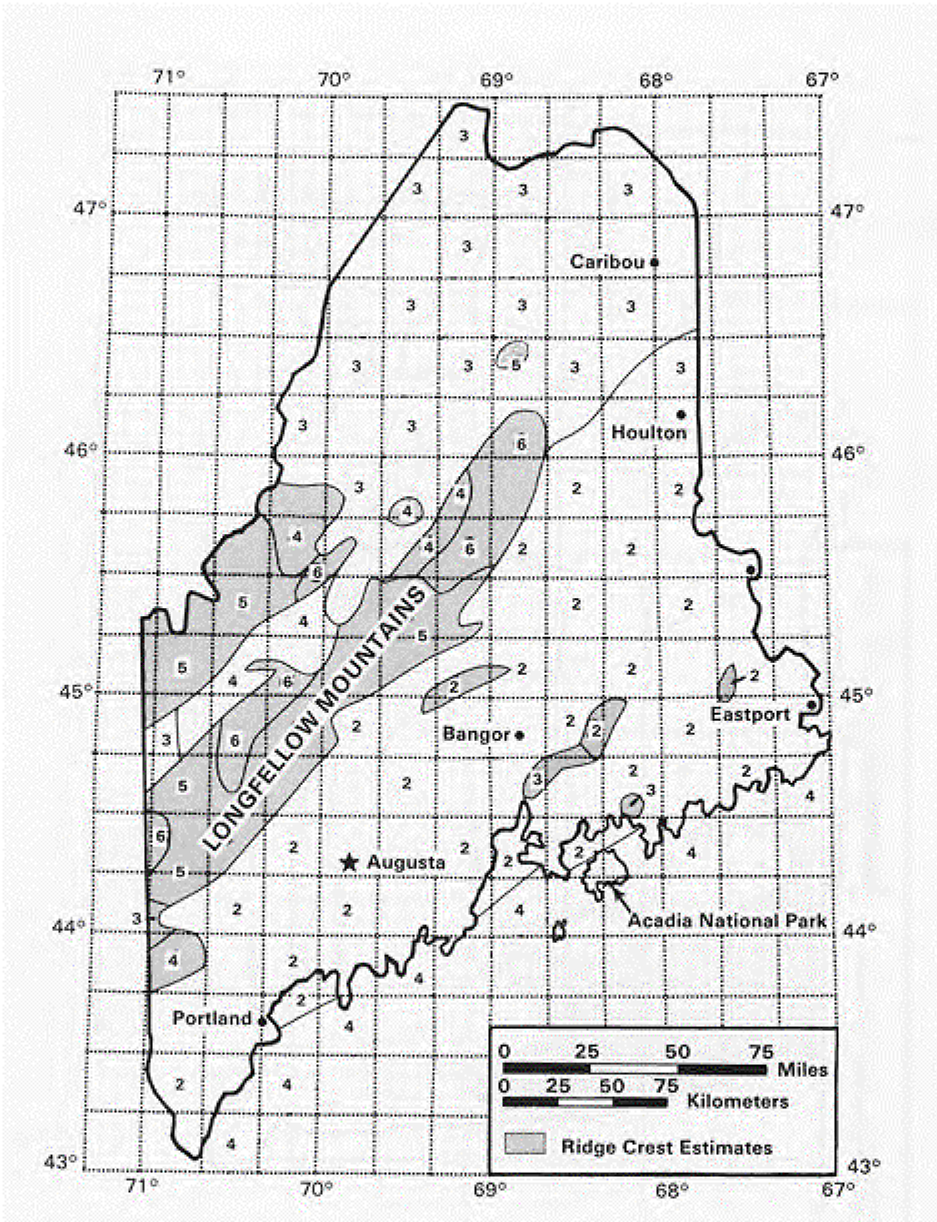


Figure 3. **Estimated Wind Resources for Maine**



Calculating Wind Energy Potential Figures and Land Use Assumptions

Because the values for wind power classes shown on the wind resource maps apply only to areas well exposed to the wind, the map area does not indicate the true land area experiencing this power. The fraction of the land area represented by the wind power class shown in Figures 1 through 3 depends on the physical characteristic of the land-surface form. On a flat open plain, for example, close to 100% of the area will be in the same wind power class, but in hilly and mountainous areas, the wind power class assigned will only apply to that small proportion of the area that is well exposed. For example, throughout the Appalachian mountains, suitable wind resource only exists on a small fraction (1-20%) of the land area. In many mountainous areas, only about 2-5% of the total land area is estimated to be well exposed.

The reduction in estimates of land available for wind energy development from the wind resource maps, reduced as described above by terrain characteristic form the base case for estimates of wind energy potential. The amount of land for wind energy development defined by the base case then is further reduced by environmental factors and land use factors.

Table 3 provides estimates of wind energy potential in MW for each of the Northeast states, and indicates that the total wind energy potential for the 6-state region is 18 GW based on the regional wind resources of Class 3 or greater.

> ***However, note that Table 3 grossly overestimates the economically feasible wind generation potential in the region since, given today's wind turbine technology and electricity market prices, a minimum wind resource of Class 6 is typically required for a financeable wind project.***

Table 3. Wind Energy Potential in the Northeastern United States[4]

State	Installed Wind Capacity (MW)	Wind Energy Potential (MW)	Annual Wind Energy Potential (Billion kWh)	% of In-State Electricity Consumption
NY	0.0	7,080	62	48
ME	0.0	6,390	56	486
MA	0.4	2,880	25	58
CT	0.0	571	5	18
VT	6.0	537	5	99
NH	0.0	502	4	48
RI	0.0	109	1	15
Total	6.4	18,069	158	68

For the estimates of wind energy potential appearing in Table 3, the following classifications of land uses were excluded:

- 100% of environmentally protected lands such as parks, wilderness areas and wetlands
- 100% of urban areas
- 50% of forest lands
- 30% of agricultural lands
- 10% of range lands.

In coastal areas, at least 50% of the land area was excluded as coastal areas are generally recognized to have a higher concentration of environmental and recreation areas where industrial development would be precluded. Wind turbine spacing of 10 turbine rotor diameters by 5 turbine rotor diameters, 50 meter hub height, 25% efficiency and 25% losses (e.g. due to wake effects) were assumed in calculating the MW potentials. Numerous local considerations such as siting approvals, transmission and road access to resource areas, production and demand match (because wind is an intermittent resource with seasonal variations), public acceptance, local ordinances, and other technological, avian, safety and institutional factors and will further reduce the developable potential. (See ***Siting***, below.)

4. Siting and Permitting

Siting

Overview of Siting Issues in Northeast

Wind turbine siting is especially difficult in the Northeast due primarily to the fact that wind speed increases with elevation in this region making the prime sites for wind development mountain ridges which are highly visible, potentially ecologically sensitive and recreationally desirable. One need only look to the current battles being waged against cell phone towers on ridges by grass roots environmental and local organizations as well as more visible environmental organizations such as the Conservation Law Foundation and the Appalachian Mountain Club to begin to understand the opposition wind energy faces. Siting of attendant transmission lines, roads, substations and other support buildings or infrastructure further exacerbate the "viewshed" issue.

Siting issues, in addition to viewshed, include:

- Effects on wildlife, especially avian wildlife
- Effects on fragile high elevation ecosystems, including soil erosion and runoff
- Noise
- Land use
- Public health and safety
- Need for attendant public services/infrastructure (e.g. access roads, transmission lines)

The Appalachian Mountain Club has published a "General Policy on Windpower" that rates potential windfarm sites as "Most Suitable", "Moderately Suitable", "Moderately Unsuitable", and "Unsuitable" with respect to the following characteristics:

- Ownership and land use (prefer private lands near existing road and transmission line infrastructure and where there are other commercial activities such as timber harvesting);
- Soils and topography (avoid disturbing steeper slopes);
- Roads and access (locate as close as possible to existing roads);
- Vegetation and natural communities (locate in areas dominated by common second-growth northern hardwood or spruce-fir forest types avoiding rare communities and wetlands);
- Wildlife (locate away from bird migration routes and away from habitats for species of concern such as certain small mammals or birds);
- Scenic (locate in areas where there is already evidence of permanent human development such as ski areas or where the viewshed is only impacted from developed areas or more than 5 miles from undeveloped areas); and
- Recreation (locate in areas where use is compatible with existing recreational activities such as snowmobiling and hunting and where backcountry use is low).

Siting Process

The siting process for wind farms in the Northeast is described anecdotally by the following excerpt from a Green Mountain Power (GMP) publication describing the steps undertaken by GMP which resulted in the selection of the Searsburg, Vermont site for the development of a 6 MW windfarm.

> "In the late 1970's, GMP and its consultants designed and implemented a Wind Turbine Site Prospecting and Evaluation Program. This program's objective was to locate the best potential wind sites in, or near the company's service territory. The best sites would be those that have a strong and steady wind resource, would be close to existing roads and electric lines, and could be developed in an environmentally acceptable manner. To identify these sites, a 3-phase screening process was used.
>
> In the first phase, areas that would likely have a strong enough wind resource were identified based on the fact that wind speeds generally increase with elevation in the inland areas of New England. This resource characteristic has rather direct implications as to the types of land areas and uses that will be windy enough for a commercial scale wind project. They will be the exposed hills and mountaintops and not the valleys where the most human development activity is centered. Over 400 individual hill or mountain tops over 1500 feet in elevation were identified in the first phase of the program.
>
> Then, individual sites were grouped into 'clusters' that had sufficient land area available to logically be developed as one project. The windiest (highest elevation) of sites were subjected to a second level of screening. Sites that were the closest to existing access roads and transmission lines were given highest priority (this tends to remove from consideration those remote areas that are valuable for their wilderness characteristics.) The remaining sites were then examined to eliminate those that had obvious environmental and land use conflicts. For example, sites that were known to be habitat for protected species, or that were otherwise biologically or physically unique were excluded. Also eliminated were sites that were in close proximity to major hiking trails (land use conflicts) and ski areas (safety reasons related to turbines shedding ice). While the potential for visual impacts was considered, this alone was not reason for disqualifying a site area in this level of screening. Eight site areas were then selected for further investigation.
>
> In the third phase of evaluation and screening, wind measurement equipment was installed at each of the eight wind sites areas. Field studies were conducted by biologists, botanists and civil engineers to further assess the practicality of developing a site. All things considered, on the basis of the information collected during this phase of the program, four site areas emerged as having the best potential for development:
>
> - The ridge to the north of Bolton Ski Area in Bolton, Vermont;

> - The ridge between Haystack Mountain and Mt. Snow in Wilmington and Dover, Vermont;
> - The highlands straddling State Route 8 in Searsburg and Readsboro (the Eastern and Western Site Areas), Vermont; and
> - A section of ridge straddling the Vermont/Massachusetts border in Stamford, Vermont and Florida, Massachusetts.
>
> In the early 1990s (Ed. Note- over ten years after the process was started), attention focused on the Searsburg/Readsboro site and the site in Stamford and Florida. While these were not the windiest site areas, they were thought to have the most desirable set of features for the first wind project. The potential for land use conflicts at the other sites was greater – a hiking trail had been established along the Mt. Snow/Haystack Ridge in the mid 1980s and the Bolton site did not have enough available space away from ski area activities. GMP met with the town officials in Florida, Clarksburg, MA, Stamford, Searsburg, and Readsboro to get their input on the potential to develop these sites. Meetings were also held with state and regional planners and with environmental and citizens groups to solicit their input and ideas. On the basis of all of the information gathered in the site evaluation process, GMP decided in 1993 to proceed with further meteorological and environmental studies in connection with plans to develop a portion of the Searsburg/Readsboro site area as the first commercial-scale wind development in Vermont."[5]

GMP originally considered building its wind power plant on a combination of private and federal lands in the Eastern Site Area. The US Forest Service (USFS) administers the federal lands in this region and the use of this land requires a Special Use Permit. GMP initially applied for the permit in 1993. However, the review of their application was delayed due to limited staff resources within the USFS. In 1994, to help expedite the review process, GMP agreed to pay for a consultant to assist the USFS with its workload.

Shortly after the consultant was hired, the process was again halted due to an unrelated dispute regarding the proposed use of a neighboring land parcel. The conflict revolved around the USFS's proposal for timber management in the Lamb Brook section of the Green Mountain Forest. The USFS land that was part of GMP's proposed project was outside of, but adjacent to, the Lamb Brook area. For political reasons, the USFS decided that they wanted to resolve the timbering issue before considering the wind project.

The delay by the USFS continued for several months and had the potential for stretching into years, and as a result, GMP began to evaluate other siting options for the project. An alternative site was laid out in the Eastern Site Area using only private lands. This revised layout utilized the same transmission line and access roads as the original site but had lesser visual impacts. It was estimated by GMP that a larger tract of land adjacent to the project

[5] "Wind Power News," Green Mountain Power, August 1995.

site could be developed to a maximum capacity of 20 to 25 MW but would require use of federal lands."[6]

Conclusions

Siting is difficult in the northeast due to unique topographical, environmental and local land use issues. As a result, the developable resource is considerably less than what the PNL data suggests and as highlighted in Table 3. Because wind is perceived by the public as being "green", it might be worthwhile to proactively work with environmental stakeholder groups to develop a list of potentially acceptable sites.

Permitting

State-By-State Overview of Windfarm Permitting

The permitting of energy and specifically wind energy facilities varies from state to state but generally always has the following common elements:

- A state-level regulatory process
- A local process, including public hearings
- Environmental impact assessment including avian and other wildlife studies and simulations of the viewshed with the wind farm in place

Maine The state of Maine has two regulatory bodies: the Department of Environmental Protection (DEP), which has jurisdiction over development in incorporated towns, and the Land Use Regulatory Commission (LURC) which deals with unincorporated areas. (See the discussion below on Kenetech's Boundary Mountains project for more detail.)

Vermont Vermont's state-level process requires a Certificate of Public Good pursuant to Section 248 of Chapter 30 of the Vermont Statutes. This process requires the notification of a number of state agencies as well as local municipal planning agencies and legislative bodies, public hearings (both technical and non-technical) conducted by the Public Service Board locally to the project, and participation of the Agency of Natural Resources as a party in the permitting process, providing evidence and recommendations that the facility will not have adverse impacts on aesthetics, the natural environment, etc. (See the discussion below on the Searsburg project for more detail.)

New Hampshire Electric generating facilities of at least 30 MW must have an approval from a 12-member committee representing various state agencies. An application for the certificate of approval is filed with the New Hampshire Public Utilities Commission and must include an environmental impact statement and proposals from the applicant for studying and mitigating environmental problems. The committee must hold at least one

[6] Green Mountain Power Wind Power Project Development ", US Department of Energy Turbine Verification Program, Prepared by Global Energy Concepts, Kirkland, Washington, December, 1997, pp. 3-2 –3-3.

public hearing in each county in which the proposed facility will be located. Facilities under 30 MW are presumed to fall only within the jurisdiction of local permitting authorities.

Cost of Permitting

The permitting cost for the 6 MW Searsburg facility was $240,500, or 3% of the total project cost of $9.6 million. The permitting process for this project is described below and included avian, wildlife (black bear), visual impact, noise, archeological and cultural studies and surveys of residents.

Permitting Process

The following is the description of the permitting process for one existing and three proposed windfarms: and Green Mountain Power's Searsburg Project (6 MW), the Kenetech Boundary Mountain Project in Maine (210 MW) which is no longer under development, and the Sugarloaf Project (5 MW) which was permitted by Endless Energy but is no longer under development.

Searsburg Project[7]

> "GMP's 6 MW Searsburg Project was subject to the regulatory jurisdiction of the State of Vermont Public Service Board. Pursuant to 30 V.S.A. Section 248, GMP was required to obtain a Certificate of Public Good for the construction and operation of the Project and the associated transmission line extensions. The petition for the certificate was filed with the Vermont Public Service Board on May 5, 1995.
>
> In response to the state permitting requirements, GMP researched a number of potential issues associated with the project development and expended a considerable amount of effort to support the review process. This work included environmental studies, economic and technical analyses, supporting evidence and documentation, responding to interrogatories, site inspections, public hearings and a "Technical Hearing." The Technical Hearing had a quasi-judicial format in which expert witnesses presented testimony and were cross-examined by other parties to the proceedings. As a result of this process, GMP provided extensive detail on all aspects of the project development to the Public Service Board and the information was recorded in the public domain.
>
> In November 1995, the parties to the certification process submitted briefs. The Vermont Department of Public Service and the Agency of Natural Resources filed letters supporting GMP's brief. One group, the Green Mountain Forest Watch, filed a brief opposing the approval of the project. The basis of their opposition was that the site was adjacent to a wilderness area. A few landowners voiced objections to the project on aesthetic grounds.

[7] "Green Mountain Power Wind Power Project Development", US Department of Energy Turbine Verification Program, Prepared by Global Energy Concepts, Kirkland, Washington, December, 1997, pp. 4-1 to 4-13.

The approval was issued by the Public Service Board in April 1996 (13 months after the filing of the petition with the Public Service Board.)

Avian Impacts

GMP used several consultants to conduct avian studies in the vicinity of the project site over a period of several years. Independent consultants took inventories of bird activities, including an inventory of raptors during their migration seasons and a study of springtime songbird migration. It was determined that no extraordinary concentrations of breeding birds occurred at the site, that the breeding community was typical for the southern Vermont forest, and that none of the breeding birds found on the site were endangered or threatened. The studies concluded that the project was not likely to adversely impact songbird populations or migrating raptors.

GMP specified the use of tubular towers to eliminate perching and single pole transmission towers to reduce the chance of electrocution of birds with large wingspans.

The State of Vermont received US DOE grant money through the Sustainable Technology Energy Partnerships (STEP) program to continue avian studies during the project operation period.

Wildlife Impacts

A consultant for GMP coordinated with the Vermont State Department of Fish and Wildlife to conduct an analysis of the impact of the project on wildlife other than birds. Of particular interest was the black bear population because there are critical habitat areas for the black bear near the site. However, it was concluded that because of the substantial separation distances between the project and the habitat and the dense vegetation in between, potential visual or noise disturbances to the habitat were judged to be minimal. Minimizing the clearing and allowing the vegetation to grow back along the transmission line route and access road would further reduce the potential for impacts on wildlife movement in the area. The requirements of the re-vegetation plan for the site and the treatment of the access road with respect to clearing are specifically detailed. Also, as a condition of the permit, GMP agreed to monitor bear movement in the project area.

Impacts on Areas of Archeological, Cultural, and Historical Significance

A study was also conducted of the archeological, cultural and historical areas of significance in the vicinity of the site. In the first phase of the study it was identified that there was a high probability that cultural resources might be found in the project area consisting of the ruins of a homestead and cemetery, dating back to the 1800's, bordering the site and the road to the site. However, in the second phase of the study that was conducted in conjunction with the Vermont Division of Historic Preservation and included selective excavation, it was concluded that no significant historic or cultural resources would be disturbed by the project.

Visual and Aesthetic Impacts

In order to assess the visual impacts of the project, including the access road, transmission line, and substation, a series of computer-generated presentations were developed showing the view of the wind project from the most prominent viewpoints in the area.

The analysis concluded that the project would not be seen from sensitive areas such as population centers, scenic corridors, major recreation areas, wilderness areas, or historic sites.

While the project was found to have an adverse impact upon the scenic and natural beauty of the area, the impact was not judged to be "unduly adverse", and therefore met the requirements of 30 V.S.A. Section 248.

To further reduce the visibility of the project, GMP specified that the towers be painted a neutral color to minimize contrast with the background under average lighting conditions. Minimizing the tree clearing also reduced the visual impacts of the project. Three neighboring landowners objected to the project based on its visual impact. GMP met individually with these residents to discuss their concerns and took these comments into consideration when deciding what steps to take to reduce visual impacts.

Noise Impacts

A study was done to assess the noise from the turbines (as well as construction of the project though this noise obviously was temporary) on nearby residents as well as wildlife habitat. Ambient noise levels were measured and the noise from the turbines were modeled using measured noise data from the turbines to be used and taking into account the effects of the forest, topography, wind speed and wind direction. A noise contour map was developed. The study showed that projected noise levels at nearby residences and wildlife habitats would be near or below ambient noise levels at those sites, and that therefore the noise would not be noticeable at most times of the day or night.

Other Impacts

A number of other project impacts of lesser importance than the ones mentioned above, such as increases in vehicular traffic, demand on local services and potential for water contamination required submittal of information by GMP along with the permit application. In addition, the utility surveyed local residents regarding their acceptance and support of the project both pre- and post-construction. The permit application also required detailed information of the economic analysis of the project, utility integration studies, erosion prevention plans and transmission line routing."

<u>Kenetech Boundary Mountains Project</u>

In August, 1995, the Maine LURC approved a preliminary development plan and zoning petition submitted by Kenetech in July, 1994 which allowed Kenetech 18 months to submit a final project development plan for approval by the Commission. The proposed project was a 210 MW wind energy facility to be built on 26 miles of ridgetops in northern Franklin County in the Boundary Mountains of western Maine. The property to be used by the Project was owned by two paper companies and consisted of 37 separate corridors 300 feet wide and ranging from 770 feet to 2.35 miles in length. A total of 639 turbines were proposed to be installed. The final project development plan was never submitted and the preliminary approval expired in February 1997.

The main environmental issues sited in the preliminary approval order were soils and avian. Visual impact issues were raised but due to the logging activities already underway, were not a major factor in the approval. The Conservation Law Foundation (CLF) supported the project for its green energy value and a group of environmental intervenes including CLF, the Maine Audubon Society, the Natural Resources Council of Maine and the Appalachian Mountain Club were supportive of the project but expressed concerns regarding the protection of wilderness lands in Maine. Kenetech agreed to provide $300,000 to a fund an entity to protect one or more ecologically significant or threatened parcels of high mountain area.

Soil Impacts

Seventy-six miles of new gravel roads and 56 miles of resurfaced logging roads were required for the project. While the Maine Soil and Water Conservation Commission (MSWCC) did not object to the preliminary approval, its policy on windpower stations in high mountain areas recommended that access be limited to low impact means, such as helicopter and snowmobile. The combination of steep slopes and high mountain areas make for a particularly fragile environment in which typical road and other construction techniques and erosion control measures would likely be inadequate in these areas because intense rain events can quickly cause significant erosion and sedimentation problems.

Avian Impacts

Much of the concern regarding avian issues stemmed from the lack of information regarding migratory birds in forested mountain areas and migratory birds and raptors specifically in the proposed areas of development. Kenetech conducted literature and field investigations of breeding bird population, raptor presence, raptor migration during 1992 and 1993 for the preliminary permit application. In a settlement with Maine Audubon, Kenetech agreed to conduct additional ongoing avian monitoring and research and to fund $150,000 for two years of research on golden eagles in the western mountains of Maine to be conducted by the Maine Department of Inland Fisheries and Wildlife.

Scenic Impact

Kenetech's testimony regarding visual impact argued that the area had little wilderness value due to the fact that it is part of a forest which is presently managed as commercial timber lands. The developer stated that only a small portion of the project could be viewed from any public road, and then only for a few moments from a moving vehicle. Further, the view from the site itself included large tracts of recently harvested forests and a network of existing land management roads, demonstrating that the area is not a wilderness. The company stated that based upon these factors, the proposed project would not have a greater adverse impact upon the area than that of the existing logging conditions.[8]

Sugarloaf Project

The Sugarloaf site received permitting from the Maine DEP for a 5 MW windfarm but has not been developed due to the construction of a ski trail on the site.

The Endless Energy Sugarloaf Project is located in the town of Carrabassett Valley and required Maine DEP approval in addition to local planning board approval from the town. The town asked the developer to first seek DEP approval, as it felt DEP had greater resources available to it with which to assess the environmental issues associated with the Project.

Key issues in permitting the project were environmental (erosion, spills and effects on rare plant and animal species) and visual. Elevations above 2700 ft in Maine have shallow soils, fragile and rare ecosystems, and high visual value and therefore are protected through a fragile mountain area zoning classification. In the past, the balance has been maintained between the forest products industry and the fragile higher elevation environments in Maine because the economic value of timber decreases with elevation. As noted earlier, it is generally the opposite for wind energy production. A visual impact assessment was performed which took into account the visual perspectives from the town and the nearby Appalachian Trail. Appalachian Trail groups and the local planning board were consulted and hikers and skiers at the Sugarloaf resort were surveyed. An analysis of the visual character of the area as perceived by its various visitors and residents was conducted and the impacts of the proposed project were analyzed. The study concluded that the project would change the visual character of the area but not unreasonably.

The visual and noise effects on the ski resort, the major employer in the town, were of considerable concern to the local planning board. A noise study was provided by the developer that demonstrated low noise levels at the turbines and diminishing with distance. The noise, safety and visual issues were discussed at length at two planning board presentations and a subsequent public hearing. The ski area supported the Project and the Project received unanimous approval by the planning board. However, at a later date the ski resort put another ski trail at the site of the proposed wind farm development. Endless Energy is currently evaluating the possibility of installing a 100 kW wind turbine on the site to sell power to the ski area.

---

[8] Maine Land Use Regulation Commission, Department of Conservation, Commission Decision in the Matter of Kenetech Windpower, Inc., Oxford Paper Company, and S.D. Warren Company, Zoning Petition ZP 536 and Preliminary Development Plan for A Wind Energy Station, September 16, 1993.

Conclusions

Siting is a multi-faceted process involving technical, environmental, aesthetic, political and, ultimately, regulatory hurdles. A proactive approach taking into consideration all of these variables is the best means for ensuring a successful outcome in the shortest possible timeframe. Nonetheless, the process is lengthy and the associated costs can easily become the largest component of a project's development budget. CCEF may want to convene with environmental stakeholder groups operating in the likely areas in Vermont, New Hampshire and Maine to develop an inventory of potentially feasible sites and place this data into the public domain as an incentive to independent developers.

5. Transmission Infrastructure

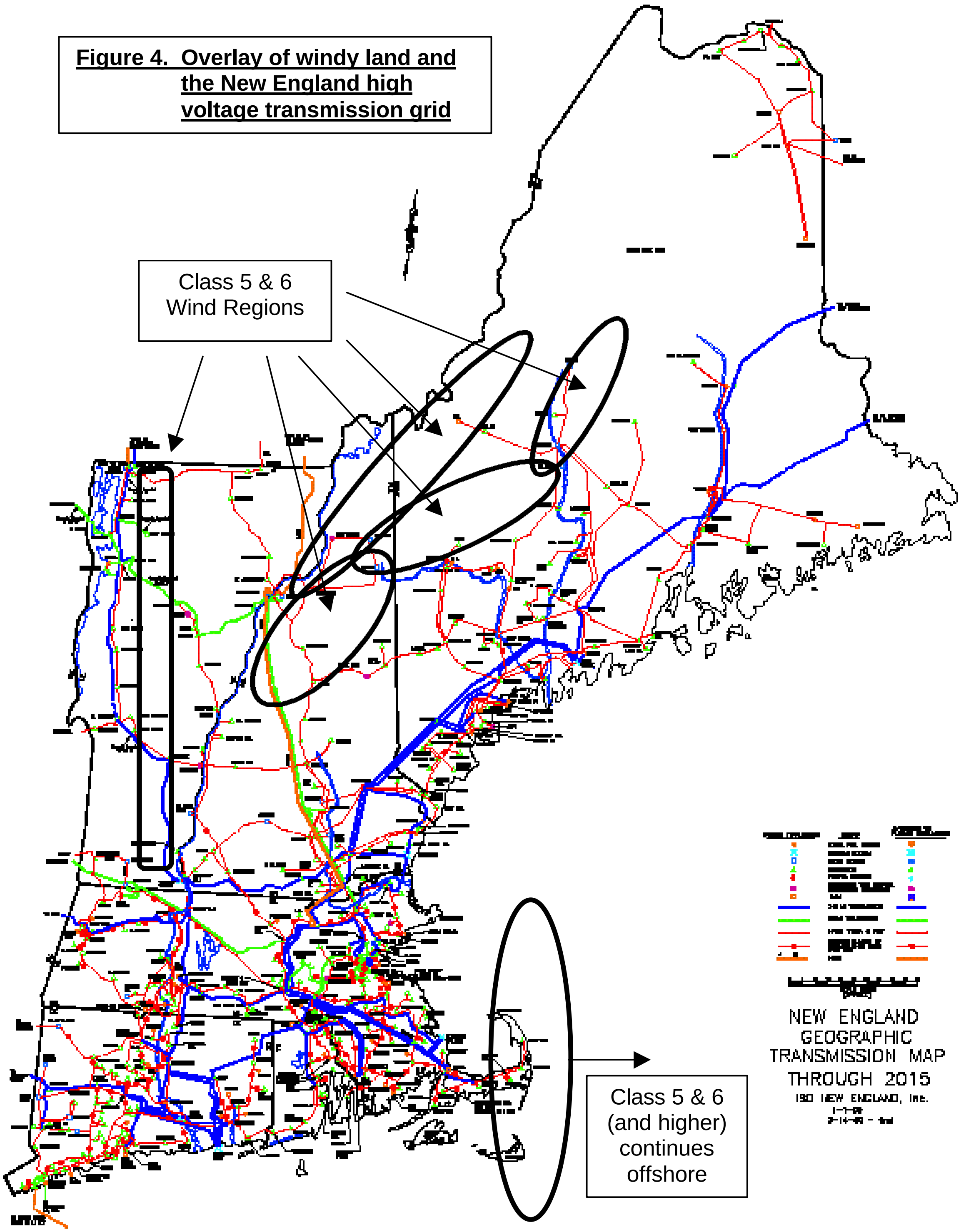
Overview of the Transmission System

The New England Power Pool (NEPOOL) bulk power supply system is comprised of virtually all of the electric systems in New England, accounting for most of the electric power production, imports and transmission in the six-state region. ISO New England, Inc. (www.iso-ne.com) is the independent system operator responsible for the management of the New England Area bulk power generation and transmission facilities as well as administering the wholesale electricity marketplace on behalf of NEPOOL. The New England electric bulk power facilities of all member companies are operated as a single power system by central dispatch of the least cost resource and transmission equipment available at any given time. This includes the sharing of operating reserves and coordination of generator and transmission maintenance scheduling. Generation and transmission plans of the various member systems to meet the region's future electricity needs are evaluated for consistency with reliability criteria of both NEPOOL and the Northeast Power Coordinating Council's (NPCC), the regional organization of the North American Electric Reliability Council, and to ensure efficient operation of the power system.

The NEPOOL bulk power supply system serves a diverse region which ranges from rural to dense urban, integrating widely dispersed and varied types of power supply resources to serve load. The New England summer and winter peak load geographic distribution is approximately 22% in the northern states of Maine, New Hampshire and Vermont and 78% in the southern states of Massachusetts, Connecticut and Rhode Island. Although the land area of the north is larger than the south, the relatively larger southern load reflects greater development and concentration in the urban areas. The amounts of generation installed in the north and south are roughly proportionate to the respective area loads. Hydroelectric plants comprise a relatively large proportion of the northern generation, when compared to the south. The dispatch, including transactions with neighboring utilities and considering the generation availability, results in multiple intra-New England power transfers of varying direction, magnitude and duration.

The bulk transmission system is comprised mostly of 115 kV, 230 kV and 345 kV circuits. Transmission lines in the north are generally longer in length and fewer in number than in the south. The increased transmission density in the south reflects the larger load and power supply concentrations. NEPOOL is interconnected with New York through two 345 kV ties, one 230 kV tie, one 138 tie, and three 115 kV ties. Currently, NEPOOL and New Brunswick are connected through one 345 kV tie, with a second 345 kV tie planned. There are also two HVDC interconnections with Quebec: a 225 MW back-to-back converter at Highgate in northern Vermont, and a 450 kV multi-terminal DC line with the capability to deliver up to 2000 MW to Sandy Pond in eastern Massachusetts. There are no AC connections between NEPOOL and Quebec since the two AC grids are non-synchronous.

Figure 4. Overlay of windy land and the New England high voltage transmission grid

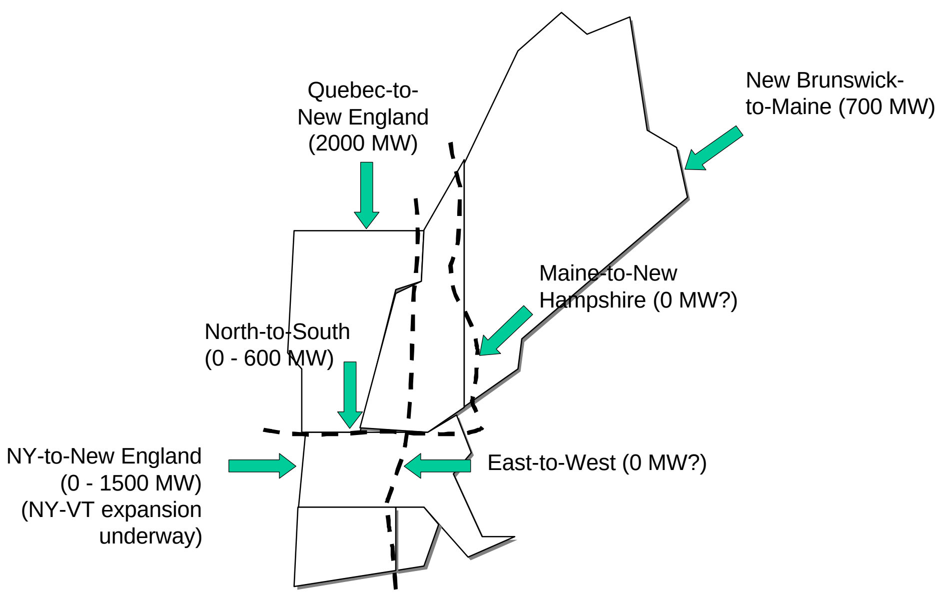


Transmission System Limitations

Numerous bulk transmission system interfaces have been identified within New England and between New England and its neighbors through planning studies and operating experience. These interfaces, composed of one or more transmission facilities, have been defined to gauge the amount of power which can be transferred between or through various areas before a transmission limitation is reached. The limiting transmission facility(s) and contingency(s) which may restrict the power transfer through an interface may not necessarily be part of the interface but may be somewhere electrically in series or parallel with it. [9]

Figure 5 is a depiction of the various capacity limitations externally and internally to the operation of the system. [10] All of the interfaces may potentially constrain the operation of the bulk power supply system. Maintaining transfers within interface limits may restrict the operation of resources, require the operation of non-economic resources, or require adjustments in imports or exports with neighboring utilities. The potential for actually being restricted by various interfaces and the precise level of the interface transfer limit are affected by a number of factors including load level, generation availability and dispatch, pumped storage operation, imports or exports with neighboring utilities, and seasonal differences in transmission facility ratings.

Figure 5. New England Transmission Constraints – Peak Summer Conditions[11]



[9] New England Power Pool, "FERC Form 715, Annual Transmission Planning and Evaluation Report", April 1999.
[10] Presentation by David B. Bertagnolli, Transmission Operations Coordinator, ISO New England, March 6, 2000.
[11] Numbers shown in parentheses indicate power transmission limitations during peak periods. Question marks indicate possible constraints pending the construction of certain planned generation facilities.

The Québec Factor

The Radisson HVDC line, the only multi-terminal HVDC line in the world, began multi-terminal operation on November 1, 1992. The line is rated at 2000 MW but is operated at 1400 MW to 1800 MW due to concerns by the New England utilities about the reliability of the New England grid should there be an outage on the Radisson line. The Radisson line was originally designed with five terminals in mind: the end-terminals in Radisson, Québec and Sandy Pond (near Needham, MA) and intermediate terminals in Des Cantons and Nicolet, both in Québec, and Comerford in Monroe, New Hampshire. However, in 1988, a decision was made not to complete the installation of the Des Cantons and Comerford terminals out of concern for the reliability of line operation.

The 10-year firm energy contract between Hydro-Québec ("H-Q") and NEPOOL, which requires the delivery of 7 Twh/year, expires August 2001. Upon expiration, H-Q will be selling wholesale power in the open market. The average generation cost of H-Q is Cdn3¢/kWh on a fully loaded basis or about US2.1¢/kWh. Marginal costs of production are less thus providing H-Q with an apparent significant competitive advantage in the New England wholesale power market where spot market prices are often much higher even though transmission costs to the Sandy Pond terminal in Massachusetts over the Radisson HVDC line are not public information.

According to Daniel Garant, a senior executive in H-Q's Wholesale Supply Group[12], H-Q has not previously studied the green power market in Québec nor in New England. In Canada, the fact that most power generation does not come from thermal sources, removes the power generation sector from the public debate over clean air. Much more environmental attention in Québec is directed at the province's pulp & paper, aluminum and refining industries. Automobile exhaust, which contributes to smog in Montreal in the summer time, is also an environmental target.

H-Q has not been following the New England green power market and has little awareness of market drivers such as RPS, green tagging and Green-E. For example, H-Q has entered into a long-term power purchase agreement to buy power from the 50 MW Le Nordais windfarm (due to be expanded to 100 MW) with an initial price of just under US5¢/kWh – a price well above the prevailing wholesale market. Mr. Garant was not aware H-Q may be able to market that power in the US as premium-priced green power which would enable them to recover some or all of the above-market costs they are presently being forced to bear by the Provincial government.

As far as new windfarm development is concerned, both H-Q and the Province have conducted in-depth wind mapping and have determined the Gaspé Peninsula has, by far, the best wind regime in the Province. (This wind data is not in the public domain.) It is unlikely, however, that H-Q will be the developer of new wind capacity. Because of their commanding presence in hydro generation, the government is encouraging the private sector to undertake new generation projects and would rather H-Q purchase power at wholesale

---

[12] Telephone interview, 3/24/00.

for remarketing to the retail sector and wholesale exports to New England. To date, these power purchase arrangements have usually consisted of an initial negotiated price per kWh with a fixed annual escalator.

Québec has directed H-Q to conduct a solicitation for new private power generation, a portion of which is earmarked for wind.

Conclusions

Transmission constraints coming south from Maine, New Hampshire and Vermont and coming east from New York could be a major inhibitor to delivering firm, wind generated power to southern New England. There is considerable activity within ISO-NE and elsewhere to develop a more fair and transparent method of providing generators, marketers and end users access to the bulk transmission system without compromising reliability. It is beyond the scope of this study to examine in depth each methodology and its potential impact wind energy potential. However, some of the more prominent aspects of the current system as well as the substance of what's being debated for the future are discussed in the following sections.

Transmission Rates

In New England, transmission lines are classified either as "pooled transmission facilities" (PTF) or non-PTF. PTF are all transmission lines generally greater than 69 kV that provide parallel flow capability. PTF lines fall under the jurisdiction of ISO-NE while non-PTF lines are under the jurisdiction of the local "wires" companies.

Generators interconnected to PTF can wheel their power anywhere in New England without explicitly having to pay for transmission as these costs are borne by consumers throughout the system. Generators interconnected to non-PTF lines, however, must pay the local wires company for transmission to get their power to the PTF line when they serve customers outside of the local utility service area in which they are located. This represents a significant cost to a wind or other renewable energy supplier, particularly because it is normally charged on an installed kW basis. The low load factor of a wind farm means that the per kWh charge can be quite significant, as much as 1.0¢/kWh. Because of the remote nature of wind sites, it is highly likely that only low-voltage, non-PTF transmission lines will serve these sites.[13]

Congestion Management System

NEPOOL has been quite delayed in submitting a plan to FERC for a congestion management and multi-settlement systems (CMS/MSS). However, on March 31, 2000, ISO-NE made the filing instead. As stated in the filing:

---

[13] Energy Producers of Maine, "Challenges Facing Renewable Energy In New England." February, 2000.

"The CMS will manage transmission congestion in NEPOOL through the implementation of locational prices for energy. The price of energy at each point on the system in both the day-ahead and real-time markets will reflect, in addition to the underlying as-bid cost of the energy, the marginal cost of congestion and losses caused by injections and withdrawals of energy at that point. All obligations of generators and other energy resources will be priced at the node where the resource is connected to the system but obligations of physical loads will be based on average prices for load zones (which generally correspond to reliability regions) because of state regulatory considerations. Bilateral trades can be priced at any location including a node, a load zone or the trading hub which will be established to facilitate such trades.

The CMS also introduces financial congestion rights (FCRs) to manage congestion risk. FCRs entitle the holder to payments equal to the congestion costs associated with a particular energy transaction and thus act as a hedge against those costs. FCRs relating to the entire physical transmission capacity of the NEPOOL system will be sold in periodic auctions, some for terms of a month and some for terms of one to five years. Revenues from the auction will be allocated to entities, both Participants and transmission customers, who pay congestion costs under either the Restated NEPOOL Agreement or the NEPOOL Open Access Transmission Tariff."[14]

Financial congestion rights (FCRs) are a form of financial transmission right corresponding closely to the FTRs trading in the Pennsylvania-New Jersey-Maryland (PJM) interconnect and the TCCs trading in the New York Power Pool (NYPP). Ownership of an FCR will entitle the holder to be paid the difference in the congestion components of the location prices between specific point or points of receipt and the specified point or points of injection of electricity.

FCR holders will be entitled to payments based upon the difference in the congestion components of the locational prices when those differences are positive, and will be obligated to make payments when the locational differences are negative. As stated further in the ISO-NE filing, "the aggregate revenue stream resulting from the congestion components of energy prices will be calculated by the ISO and placed in a separate fund for payment of FCRs."[15]

The most significant impact this policy concerning wind power development seems to be a further degradation of the value of energy generated in transmission constrained areas such as the windy regions of northern New England. However, further analysis is warranted on this policy as well as tracking system proposals currently before ISO-NE as discussed below.

14 ISO-NE filing to FERC concerning amendments to the Restated NEPOOL Agreement, March 31, 2000, pp. 4-5

15 ISO-NE FERC filing, March 31, 2000, p. 76.

Tracking Green Power Transactions

To enable identification of an electricity product's characteristics, including environmental or green benefits, for purposes of disclosure or compliance with green power certification, industry stakeholders have proposed tracking techniques that follow the flow of dollars from customers to marketers to generation sources. At least four tracking methods are possible:

- Settlement-based
- Tagging
- Audit
- Hybrid

Settlement-Based Tracking

The settlement-based method, which is one option currently being considered in New England, would use an independent system operator's financial settlement system for wholesale electricity sales and purchases to also track environmental attributes, such as generation source and associated pollutants. Under this methodology, if a Green Marketing Company makes a wholesale purchase of 10 units of electricity from a Wind Plant, then the Green Marketing Company could sell 10 units of wind electricity to its retail customers. With this type of tracking, electricity and its green attributes would be bought and sold together.

Proponents suggest that settlement-based tracking: 1) better reflects the reality of the electricity market by bundling energy transactions and energy attributes; and 2) makes best use of existing centralized infrastructure, such as an independent system operator's (ISO) settlement system.

Critics suggest that settlement-based tracking: 1) may be difficult and costly for independent system operators to administer; 2) may impede the liquidity of the energy market; and 3) may limit a supplier's ability to develop green power products if settlement occurs on an hourly basis.

On this third point, the Renewable Energy Alliance has argued that the use of hourly settlement could inhibit the renewable market and hinder development of retail products such as a 100 percent renewable energy product. It noted the following example:

> Assume a supplier owns a wind generation facility and serves a load. The intermittent nature of generation from wind, and fluctuations in corresponding load, may require the supplier to sell excess generation and its assigned attributes in the spot market in hours when the supplier's generation exceeds its load. Conversely, in hours when the supplier's load exceeds its generation, it would be required to purchase the undesirable attributes from the spot market to adjust for the difference.

As a result, the Renewable Energy Alliance argues the hourly settlement-based system may inhibit a supplier's ability to cost-effectively offer desirable products and increase the cost of green power.

Another feature of the settlement-based system which has been criticized as being detrimental to the development of green power markets is the pro-rata treatment of system and spot market transactions. Consider the following example:

> Supplier A owns 10 MW of wind and 10 MW of oil. In hour X, supplier A's load is 10 MW and it sells 10 MW into the spot market. The pro-rata treatment of Supplier A's resources by the settlement-based system would allocate 5 MW of wind and 5 MW of oil to its own load and the same attributes to its 10 MW sale into the spot market. Instead of assigning the attributes of its wind generation to its own load, Supplier A would be required to sell half of those attributes into the spot market. The pro-rata treatment would also assign half the attributes associated with Suppliers A's oil generation to its own load. Supplier A would not be able to offer its customers a 100 percent wind product even if its wind generation matched its load in hour X.

Finally, the settlement-based approach, since attributes and underlying commodity are bundled together, means that transmission constraints that impede the flow of firm kWh likewise impede the transfer of attributes. For example:

> Supplier A has access to 10 MW of wind generation in southern Vermont. Because of transmission constraints, he is forced to look to sell power within Vermont even though he can realize a higher green premium from customers in Massachusetts. Settlement-based tracking may result in Supplier A from realizing a lower all-in price for his wind-generated power if his Vermont customer were unwilling to pay as high a green premium as would a customer on the other side of a transmission constraint.

Tagging

Another proposed approach is called "tagging." Under this approach, a Wind Plant could sell electricity and green power attributes separately. When the Wind Plant generates 10 units of electricity, it would receive wind "tags" for 10 units of electricity. The Wind Plant could then sell the electricity and the wind "tags" to the same buyer. Alternatively, the Wind Plant could sell 10 units of electricity of to a Power Marketing Company and then sell the corresponding wind "tags" to another buyer, Green Company. Green Company, in turn, could purchase electricity from another power generator, Gas Plant, and attach the wind "tags" purchased from the Wind Plant to those 10 units of electricity. The "tagging" approach, in effect, creates two wholesale markets, one for electricity and one for "tags."

Benefits of tagging include: 1) it is simple; 2) it is based on units of energy and therefore does not discriminate against intermittent resources; 3) it does not affect the liquidity of wholesale energy transactions; and 4) it allows for the creation of a secondary market for green attributes that might also accommodate credit trading associated with renewable portfolio standards. Another important feature is that the tag market is virtual, that is, it is unconstrained by limitations in the transmission network. This would allow a wind farm in Maine to sell energy locally and sell green tags in Connecticut. However, a potential drawback associated with tagging is customer acceptance. Market research shows that consumers find the settlement-based system to be more credible because there is a more direct cause-and-effect perception concerning the purchase and sale of green power.

Audit

The California Energy Commission (CEC) has a tracking mechanism that closely resembles an audit model but also allows for tagging. Instead of tracking the flow of electricity from the point of generation to the supplier, the CEC collects data from generators and suppliers who wish to offer a product different from the average system mix. The tracking of information is claims-based and requires a third party audit or verification to match generation with supplier claims other than the system average. The CEC is currently finalizing a pilot program that will formalize electricity tagging that should be operational by spring of 2000. [16]

Table 4. APX Green Ticket Premiums

Month	Premium $/MWh
May 1999	3.72
Jun 1999	3.98
Jul 1999	4.34
Aug 1999	4.92
Sep 1999	4.96
Oct 1999	4.96
Nov 1999	3.30
Dec 1999	2.63
Avg.	4.10

The for-profit entity Automated Power Exchange (APX) has implemented a tagging system for its wholesale green market in California. APX introduced the APX Green Tickets program in May of 1999. The prices for APX Green Tickets are determined by the market and represent the wholesale premium that buyers, such as energy service providers, are willing to pay to provide power from environmentally preferred sources to their end-use residential, commercial and industrial customers. The monthly average Green Tickets

[16] Environmental Futures, "Retail Marketing and Green Power Market Rules." 1999.

premiums are listed in Table 4. APX reports it is trading about 700 MW of renewable energy through its exchange.[17]

Hybrid Approach

The hybrid approach, which will be used in New York, combines tagging and settlement-based tracking methodologies. Under the hybrid approach, bilateral transactions made directly between a known source of generation and a supplier would use a settlement-based tracking approach to bundle green attributes with their associated kWh. Other transactions, such as spot market transactions, would utilize a tagging system to determine the attributes assigned to products. As an example:

> Supplier A owns a single hydropower plant. In the first hour, the plant generates 1 MWh but his load is 2 MWh. Supplier A buys the additional MWh from the spot market where the spot MWh has the attributes of the system average. In the next hour, the hydro plant produces 3 MWh and the load is still 2 MWh, thus 2 MWh are sold into the spot market. In a pure settlement-based system, each hour is treated separately which means Supplier A supplied 1 MWh + 2 MWh for a total of 3 MWh from his hydro plant out of a total 4 MWh that were consumed by his customer. Therefore, for those 2 hours, the supply was 75% hydro and 25% system purchases. In a hybrid system, Supplier A would be able to match the attributes of the MWh is sold in the second hour to that of the MWh it purchased in the first hour. After this allocation, Supplier A's generation from the 2-hour period would be 100% hydro.

Tracking Policies of ISO-New England

There are some clear potential advantages to tagging and hybrid tracking approaches. However, ISO-NE presently operates on a pure settlement-based system with hourly clearing. Based upon discussions with ISO-NE[18], NECPUC has recommended quarterly clearing as a means to remove a disadvantage to intermittent, renewable resources. In addition, ISO-NE is evaluating different approaches for incorporating tagging into the existing settlement-based system that would result in a hybrid system. They anticipate there will be some resolution on this by the end of 2000.

Conclusions

The type of tracking system ultimately adopted by ISO-NE could have a material affect on the amount of wind capacity developed in the region, particularly given the well documented transmission constraints that separate regions of high wind potential from regions of high

---

17 "Estimates of Renewable Energy Developed to Serve Green Power Markets", Lori Bird and Blair Swezey, NREL, April 2000.

18 Meeting with Dave Bertagnolli, Ellen Foley, Craig Kazin and Jim Sinclair at ISO-NE on 3/6/00.

electric demand. The more flexible the approach, such as that offered by tagging, the more likely the development of wind capacity. However, there is a real concern over customer acceptance of tagging as an acceptable means of purchasing green power. A hybrid approach combining the best features of settlement-based and tagging systems is clearly in the best interest of the wind energy industry.

In addition, the recent filing for a CMS introducing locational pricing for energy should also be further examined for its impact, not only on wind power, but on the entire market for renewable energy.

CCEF is a stakeholder in this process and should be actively involved, possibly through the Connecticut DPUC, as an advocate for a renewables-friendly tracking solution.

6. Major Wind Turbine Vendors

For the purpose of this study, we examined the activities of the three largest wind turbine manufacturers active in the US market, Enron, NEG Micon and Vestas. Each company manufactures large, grid-connected turbines and has a large installed base in the US. Smaller companies, such as Atlantic Orient and Northern Power Systems, both located in Vermont who manufacture much smaller machines primarily for the village power or remote power market, were not considered a significant factor for the purpose of this study.

Enron Wind

Enron Wind (www.wind.enron.com), a wholly-owned subsidiary of Enron Corporation, has the dual objective to selling its own line of wind turbines and developing Enron Wind-owned windfarms utilizing their own equipment. However, they will also sell equipment and provide turnkey installations for windfarms owned by other project sponsors. Enron Wind's product range (550 kW to 1.5 MW) encompasses machines formerly produced by Zond Energy Systems, Inc. and Tacke Windenergie GmbH. Enron Wind is in the process of integrating the best features of both product lines into one, their TZ line of wind turbines, all of which are a 3-blade upwind configuration. Their goal is to start manufacturing TZ turbines at their Tehachapi, CA facility by the end of 2000. Under a NREL Next Generation Turbine Program contract, they are examining ways to improve the reliability of their product and are reportedly working on a 2 MW model.

Enron Wind has a presence in New England with a person in Albany who is pursuing the upstate New York market and another person in Boston. Enron Wind's strategy is to secure long-term power purchase agreements for their windfarms and finance the projects on a limited recourse basis with third party capital. Enron Wind secures even the equity from third parties (e.g. GE Capital) where as a matter of policy thus minimizing its own capital at risk. Thus, the popular notion that Enron can and will balance sheet finance its windfarms is not accurate.

Enron Wind was selected by NYSERDA for a grant to partially finance a 10 MW windfarm in New York. The primary candidate power offtaker was GreenMountain.com. However, when security arrangements for the power purchase agreement could not be resolved (because GreenMountain.com is not viewed as a creditworthy entity), the project fell apart. The wholesale power trading group within Enron Corporation also stepped forward with a proposal to take the power, however, the economics apparently were insufficient to justify the project. Moreover, Enron has no retail energy marketing organization that makes accessing the retail green power market all but impossible without relying upon retail aggregators such as GreenMountain.com.

Enron Wind differentiates its technology on the basis of its variable speed drive that, they claim, maximizes the efficient capture of wind energy. NEG Micon's machines operate at a constant speed turbine while Vestas has a 2-speed design. The largest proportion of Enron Wind's installed base consists of 750 kW turbines (mostly Z50 and some Z48) of which some 500 MW are installed and operating.

NEG Micon

NEG Micon (www.neg-micon.dk) is a Danish wind turbine manufacturing company with a manufacturing plant in Champaign, IL. Unlike Enron Wind who does project development as well as manufacturing, NEG is concerned only with selling equipment but can also do turnkey installations as well as O & M[19]. NEG's product range features 3-blade, stall regulated, constant speed turbines ranging from 600 kW to 1.5 MW rated capacity. An offshore 2.0 MW turbine is slated for launch during 2000.

NEG's core markets are Denmark, Germany, Spain and the U.S. where it has focused its attention primarily on California, the Midwest (i.e. Minnesota and Iowa) and Texas. They see Texas as the largest market in the US over the next 5 years because of the Texas RPS which (they say) requires 2,000 MW of new renewables to be in place by 2009.

NEG competes primarily on price and believe their constant speed turbine offers the lowest cost wind-generated electricity. NEG installed 500 – 700 turbines in California during the 1980's. In the 1998-99 time period, they installed 378 turbines in the US plus another 130 turbines for the Le Nordais project in Québec. Since 1981, the Company (including its predecessor entities) has installed over 7,000 turbines worldwide and holds about a 20% market share of the worldwide (about 30% in the U.S.) installed base of wind turbines.

NEG recorded record sales of $630 million in 1999, a 50% increase over 1998, but experienced losses of $85 million due mainly to cost overruns associated with its US projects and its notorious problems with its gearboxes supplied by Flender (UK). Although 60 gearboxes experienced serious problems, NEG and Flender put together and funded a program to retrofit all 1200 gearboxes in the field. While NEG's share price plummeted in October and trading was temporarily halted, the stock price has since rebounded more than 50% since December when it received a $100 million capital infusion from its 5 largest shareholders.

Vestas Wind Systems A/S

Vestas (www.vestas.dk) was the largest worldwide manufacturer of wind turbines in 1999 with sales of $620 million and operating profit of $86 million, both significant increases from 1998. Vestas shares have increased over 500% over the past 12 months reaching an all-time high of DKK2854/share in March 2000.

[19] NEG partially owns an independently operated project development company, M & N Windpower of San Diego, whose operations are financially separate from NEG.

Vestas is a manufacturer of turbines in sizes ranging from 225 kW up to 2 MW (offshore version) and has over 6,400 wind turbines installed worldwide. Vestas developed the first offshore windfarm in the world located off the Danish coast. Vestas-American Wind Technology, Inc., their wholly-owned US subsidiary, will do erection and O & M but is not in the project development business. They will, however, provide technical support to developers in return for an exclusive on the turbine order.

Vestas competes on the basis of its proven, reliable designs. They boast the largest engineering staff of any wind turbine manufacturer and make most of their own components, except for gearboxes which they source from German, Belgian and Finnish suppliers. They make their own blades.

Their US East Coast sales activities are managed from Ontario and they have active projects underway in Virginia, Pennsylvania, New York as well as an offshore project. They were the first turbine manufacturer to complete an offshore project (10 X 500 kW in Denmark) and are currently planning numerous offshore windfarms throughout Northern Europe. However, the onshore market is their focus in the US. They presently have no US manufacturing or assembly but this strategy is under review.

7. Green Power Markets

Latent Demand For Green Power

Market surveys by utilities over the past few years have consistently shown that 52% to 95% of residential customers say they are willing to pay at least a modest premium for power from renewable energy sources. An average of 70% say they are willing to pay at least $5 per month more; 38% say they will pay $10 more; and 21% will pay $15 more. Assuming an average monthly residential usage of 1000 kWh/month, this translates into a per-kWh premium for green energy of 0.5 to 1.5¢/kWh. These data were collected by 14 surveys in 12 utility service areas in 5 states and the results are highly likely to be replicated in other surveys. Moreover, these data support national polls that have documented a longstanding preference among US adults and electricity customers for renewable energy.[20]

Demand For Green Power in Deregulated States

California

While the figures quoted above demonstrate significant market potential, they cannot be construed as the proportion of customers who will sign up for green electricity programs. Current experience in Pennsylvania and California, the only two states with deregulated and competitive retail electricity markets as of the present, has shown that far fewer customers than predicted by the surveys actually purchase green power.

California was deregulated in March of 1998, but as of November 1999, only 1.4% of eligible utility customers had switched suppliers. The California PUC reports that 85% of the 200,000 residential consumers who have switched suppliers have chosen to purchase green power. However, the initially low switch rates in the California market are widely attributed to regulatory distortions including:

- Low default generation prices (equal to the wholesale price of power) leave no room for new energy service providers (ESPs) to provide value to the customer in terms of reducing his electric bill.
- Lax ESP registration rules led to 250 ESPs in the initial stage of the deregulated or direct access market, some of whom were not legitimate. Due to this and the low default rate, few ESPs, legitimate or otherwise, could deliver on promises made to consumers.
- Consumer advocate dissatisfaction with direct access led to a major ballot initiative to overturn the legislative mandate for direct access.
- Negative media coverage (as a result of the above) and a consumer education campaign by the Public Utilities Commission which sent ambivalent messages regarding consumer

[20] Farhar, Barbara C., Ph.D., "Willingness to Pay for Electricity from Renewable Resources: A Review of Utility Market Research." National Renewable Energy Laboratory, July 1999.

choice, created a negative feedback loop which discouraged consumers from participating in direct access.[21]

In California, thirteen providers are registered as renewable energy suppliers as of August 1999, seven of which are certified to use the "Green-e" logo that guarantees at least 50% renewable energy content[22]. In 1998, the price premium ranged from 1.1¢/kWh to 2.5¢/kWh. However, in 1999 at least three companies reduced their price to 5% below the state Power Exchange price. This was made possible by the Renewable Customer Credit Subaccount, administered by the California Energy Commission, which provides a 1.5¢/kWh rebate (Customer Credit or "CC") for qualifying renewable energy sold to residential customers. Whether or not intended by the regulators, the CC became the only source of margin for ESPs. As a result, there is much concern among the green ESPs that the CC is expected to decline rapidly in 2000, even though the average residential green consumer is likely to value the greenness of his electricity more than the dollar value ($0.60/month) of the discount.

Table 5. Default Generation Prices (per kWh) , Customer Switch Rates (%) and Green Power Rates (per kWh) for Pennsylvania Market

			GMP Products % Renewables Offered in Blend			
Utility	**Default Rate (¢/kWh)**	**% Customers Switched**	**1% (¢/kWh)**	**50% (¢/kWh)**	**100% (¢/kWh)**	**100% Green Premium Over Default**
Allegheny	3.243	1.9	4.03	5.05	5.69	2.45
Duquesne	4.750	21.7	4.97	5.88	6.38	1.63
GPU Energy	4.525	6.5	5.03	5.87	7.09	2.57
PECO	5.650	16.1	5.52	6.46	7.09	1.44
Penn Power	4.880	6.6	4.93	5.87	6.49	1.61
PP&L	4.630	3.6	5.48	6.03	7.09	2.46
UGI	4.316	4.0	5.13	5.94	7.09	2.77

Source: Office of Consumer Advocate, State of Pennsylvania. Data updated February 2000.

Pennsylvania

In Pennsylvania, default generation prices vary widely by utility (see Table 5). Customer switching activity varies with the default price as might be expected, but the relationship is not precisely linear. Choice for most consumers in Pennsylvania started in 1999 and by July

21 "Green Power in California: First Year Review From a Business Perspective," Warren W. Byrne, Foresight Energy Company, February 2000.

22 "Information Brief on Green Power Marketing," Blair Swezey and Lori Bird, NREL, August 1999.

1999, 12% had switched suppliers, of which 15% went green. By January 2000, about 0.5 million utility consumers had switched suppliers. About 25% of residential customers choosing a competitive generation supplier have chosen renewable or cleaner generation products. Of that number, half have chosen renewable electric products, while the other half have chosen products that include no coal or nuclear generation.[23] Premiums for green power vary, reaching as high as over 2.5¢/kWh over the default price (see Table 5).

Conclusions

In Connecticut, the default generation price for residential customers is 5.5¢/kWh and 5.0¢/kWh in the service territories of CL&P and United Illuminating, respectively. If the Pennsylvania experience is any guide, it can be expected a fair number of customers are likely to switch. For example, if 15% of Connecticut customers switched and 15% of those switched to renewables, the implied renewables market in the Connecticut is (15%)(15%)(6000 MW) = 135 MW in the first year of deregulation. However, this result is highly anecdotal and cannot be confirmed by any market research of which we are aware. By one report[24], green power marketers are predicting 4-10% of the market is likely to purchase green energy within 5 years of deregulation which translates into a future green demand in Connecticut of approximately 250 to 650 MW. This is a far cry from the 52% to 95% of residential customers surveyed who responded in favor of paying a modest price premium for green energy.

Although this level of green purchasing is still only a fraction of the 2 GW goal cited at the beginning of this study, it nonetheless points out the potential upside within the State for the sale of green power.

[23] Penn Futures, "Go With the Wind," E^3 Vol. 1, No. 9, Sept. 14, 1999.
[24] "Green Power Marketing in Retail Competition: An Early Assessment," R. Wiser, Lawrence Berkeley National Laboratory; J. Fang, K. Porter, A. Houston, NREL, February 1999.

8. Regulatory Environment

Connecticut

Electric Deregulation

Public Act 98-28, Connecticut's electric restructuring law, was passed on July 1, 1998. Provisions of the Act include competitive open access to the regional interstate electric transmission grid (i.e. ISO-NE), utility unbundling of generator assets, and consumer choice of electric generation. Restructuring also addresses emission and performance standards for electric generation, portfolio standards, systems benefit and service charges for conservation and other public programs, and treatment for securitization of stranded utility investments. Under the Act, transmission and distribution services remain regulated by the DPUC.

Renewable Portfolio Standard

Public Act 98-28 imposed portfolio requirements of Class I and II renewable energy sources on licensed retail electricity suppliers effective January 1, 2000. A 1999 revision to the law allows the DPUC to delay implementation of the RPS targets by up to 2 years if it finds the requirements cannot be reasonably met (HB 6621, Sec. 19). It is understood that an additional delay of 2 years, until the end of the standard offer in 2004, is currently being discussed for the same reason.

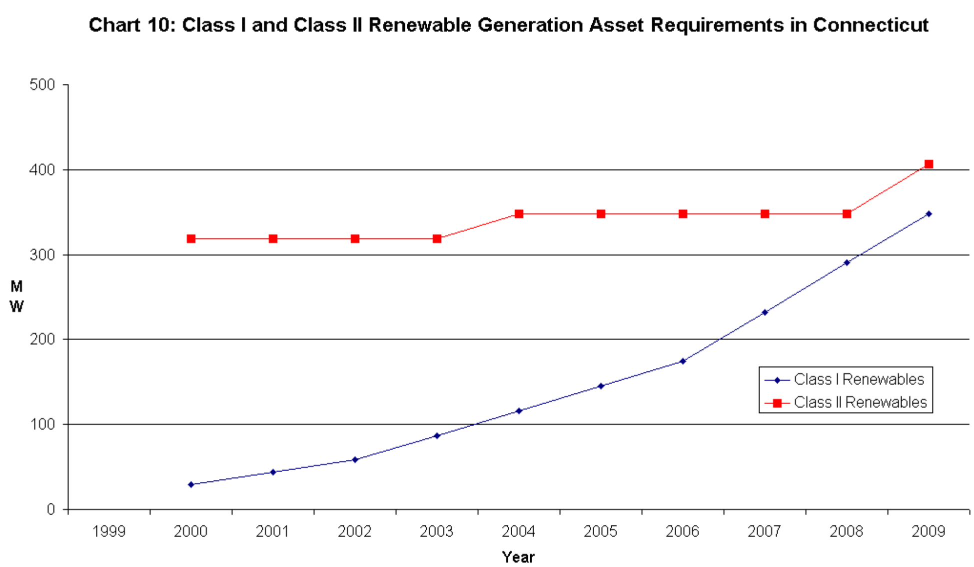
The RPS creates two classes of targets as shown in Table 6 and Figure 6.

> ***The dilemma concerning implementation of the RPS presents an interesting irony for renewables in Connecticut: lawmakers are concerned with a lack of renewable energy supply and project developers are concerned about the lack of a market to sell green power thus creating a "chicken and egg" situation. Certainly if the price signal were high enough, renewable energy developers would flock to the State. However, the RPS requirements do not amount to "renewables at any price." Because there is no guidance provided as to what green electricity price is "reasonable" insofar as the RPS is concerned, it is up to the DPUC to judge for itself when to implement the RPS.***

Table 6. Summary of Connecticut Renewable Portfolio Standard

	Technologies	Targets (excluding delays)	2000 Installed Base
Class I	Solar, wind, "sustainable" biomass, landfill gas, fuel cells	2000: 0.50% (~30 MW) 2001: 0.75% 2002: 1.0% 2003: 1.5% 2004: 2.0% 2005: 2.5% 2006: 3.0% 2007: 4.0% 2008: 5.0% 2009: 6.0%	~7 MW (primarily landfill gas); **GAP = 23 MW**
Class II	Hydro, MSW, other biomass	2000: 5.5% 2005: 6.0% 2009: 7.0%	1,274 MW (primarily MSW) **NO GAP**

Figure 6. RPS Targets in Public Act 98-28



Source: Connecticut Siting Council

New England

All of the New England states are in some stage of electricity deregulation. Table 7 summarizes key dates and the status of deregulation, particularly with respect to Renewable Portfolio Standards. As can be observed, in addition to Connecticut, only Massachusetts'

RPS provides a legislated incentive to the development of new renewable generation. Further study of the Massachusetts situation is warranted to understand the implementation timetable as well as other details of the RPS as it affects the potential for wind power, especially in view of the Massachusetts Supreme Judicial Court decision of April 19, 2000 which dismissed a lawsuit filed by certain electric customers against various Commonwealth of Massachusetts agencies and the State's investor-owned and municipal utilities over the legality of systems benefits charges imposed by the State's electric restructuring law.

Table 7. Summary on Electric Restructuring and RPS's beyond Connecticut

State	Date Of Deregulation Legislation[25]	Date of Retail Competition	Status of Renewable Portfolio Standard[26]	Eligible Technology
ME	May 1997	Mar 2000	Highest RPS in country at 30%; however, may have no practical effect because currently renewables constitute 46-51% of Maine's generation mix.	Fuel cells, tidal power, solar, wind, geothermal, hydro, biomass, MSW, and cogeneration (under 100 MW)
MA	Nov 1997	Mar 1998	▪ 1% increase in kWh sales from new renewables measured over a base of existing renewable energy in operation as of 12/31/97 by the earlier of: (a) 12/31/03 or (b) one year from when the average cost of any renewable technology is within 10% of the overall average spot market price/kWh in the State ▪ +0.5% per year until 12/31/09 ▪ +1% per year after 2009 until a date determined by Division of Energy Resources	Solar PV, solar thermal, wind, ocean thermal, tidal, fuel cells using renewable fuels, landfill gas and low-emission advanced biomass conversion technologies qualify as existing renewables. In addition, hydro and MSW can be counted in the existing base but not as new supply for facilities in operation after 12/21/98.
NH	May 1996	Jan 1998 (1)	None	--
NY	May 1996 (2)	Apr 2000	None	--
RI	Aug 1996	Jan 1998	None	--
VT (3)	--	--	--	--

[25] EREN: Green Power Network webpage, www.eia.doe/gov/cneaf/electricity/chg_str/tab5rev.html
[26] *The Solar Letter*, September 11, 1998, p.327.

Notes:
1. PSNH filed an agreement with the PUC in August 1999 to end litigation over stranded costs which was blocking competition in PSNH territory. The agreement must be approved by the legislature.
2. In New York, deregulation is being effected through PUC order, not legislation.
3. The Vermont PSB issued its plan to restructure the electric utility industry in December, 1996; to date, the legislature has not passed the necessary legislation to deregulate.