AC 2007-2044: ENGINEERING STUDENTS TRANSFORMING PUBLIC POLICY TO PROMOTE GREEN POWER

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Abstract

Junior and senior engineering clinic students at Rowan University have been able to directly participate in the influencing of public zoning policy within the State of New Jersey as part of their work on the NJ Anemometer Loan Program[1] and the NJ Wind Working Group for Small Wind and Terrestrial Applications[2]. The project has enabled the students to learn first hand how public policy impacts the expansion of the green power market (specifically wind energy) in specific municipalities. As part of their project-based learning experience in the clinic[3-4] the student team has documented that a wide range of public policy positions, embodied in local zoning ordinances, will directly affect how many customers will pursue wind energy as a potential option for generating their own electric power. The New Jersey Clean Energy Program[5] provides some of the most lucrative rebates for renewable energy system installation in the nation and represents an embodiment of the State's policy commitment to become 20% renewable by 2020[6] This policy driver has resulted in an exponentially growing market for photovoltaic systems, but local zoning policy has limited the expansion of the wind market though many of the rebate levels are comparable (the rebates have been designed to bring simple investment paybacks below 10 years for interested consumers). This clinic experience allows students to participate in the public policy debate and they have presented their results to the NJ Wind Working group which has been set up by the State to propose changes to public policy that could lead to broader adoption and faster market expansion for wind technology. One major purpose of the student clinic project is to provide the State with a full report on the feasibility of installing wind measurement systems and wind turbines based upon the feedback of surveys sent to the zoning officers of over 80 municipalities that lie in the richest wind resource areas of the State. The result of the work has raised the students' awareness about how public policy affects their careers and the engineering projects that they attempt to perform. The interplay between public policy and project-based learning is dramatized by these types of clinic experiences where students attempt to solve the real world's problems in real time.

Background

Energy and fuel prices are rising exponentially and societal consumption habits are ever increasing the demand for power. Consumer purchasing power, now more than ever, seems to be dramatically affecting the cost of living and the environment. Population sprawl continues to plague the earth and to rapidly create communities where they had never been envisioned. Rowan University has a reputation for utilizing the skills of its professors and students in an engineering clinic program geared towards providing real time engineering solutions for local organizations in exchange for compensation of the overhead cost to do so. In recent years some of the clinic projects offered at the College of Engineering specifically address the well being of the public and the protection of the environment. One such clinic project is trying to provide solutions in renewable energy – influencing public policy toward adopting green power in particular. The State of New Jersey through its Board of Public Utilities – Office of Clean Energy has allocated funds to encourage this work.

The problems of urban sprawl affect New Jersey significantly due to its already high population density and its participation in the New York City and Philadelphia metropolitan areas. During the Industrial Revolution, population in the State of New Jersey was segregated between its northern and southern regions separated by vast amounts of farmland and forests. Now, many of its former industries lie silent and large organizations have purchased, for land development and commercial use, the land which previously embodied New Jersey's agricultural wealth and forest habitat. A vast portion of the central woodland has been protected as a national preservation area named the Pinelands National Reserve[7] and the development of that region is fiercely controlled. The presence of this large protected area has resulted in greater pressures to develop the farmland throughout the state. Where once small towns and neighborhoods relied mostly on wood, wind, and water from profitable coastlines resources, they now have become adapt to relying on public utilities to provide them with energy. Thus, New Jersey as an entity (compared to neighboring states) boasts tremendous strain on the electricity grid from the urban and suburban sprawl that was advocated by the industries which past public policy allowed for. New Jersey has transitioned into making services its main asset rather than industrialized and agricultural products.

Changes Ahead

Radical and new public policy on the energy front has taken hold in the state. As one of the first states after California to deregulate its energy markets New Jersey's Board of Public Utilities recently voted[6] to assure that the state will be served by an energy mix that includes 20% renewable electricity by 2020. This is a key part of its aggressive Renewable Portfolio Standard (RPS) and has many believing that New Jersey now leads the nation in its fervor for renewable energy. Unfortunately, policies that have become entrenched at the local level over the years will resist change for many years to come. An example of this includes zoning regulations that in most municipalities in the state significantly restrict the ability to generate wind power. As we have found in our work on the NJ Anemometer Loan Program even, a wind resources assessment clinic at the University[8] , when farmers wish to evaluate their resource for wind power on a small scale (as opposed to large wind farms) current zoning restrictions make it difficult and expensive. A new era of fuel and energy has been ushered in at the state level, but significant policy changes will need to be undertaken locally as well.

The purposes of the clinic project described in this paper include: providing leadership in a partnership with the officials of the New Jersey Board of Public Utilities (Office of Clean Energy) to make consumers aware of energy efficiency and wind opportunities, and giving engineering students the opportunity to work on clinic projects which test the true possibilities of accelerating the green power market for clean energy in New Jersey.

Officials of the State of New Jersey have made possible the potential for significant leadership and advancement in local renewable generation both though rebate incentives on the technology and interconnection policy that is extremely advantageous. Both municipalities and the private sector (commercial, residential and farmers) can home grow sources of green power at economic rates and enjoy reasonable payback periods. They can enjoy net metering up to 2 MW (the most flexible interconnection in the nation) and expect rebates approaching 50% for systems up to 10kW in size. For example, in just the past few years the CORE rebate program[5] was offered by

the NJBPU - Office of Clean Energy that enabled the state to move its way up the ladder to become the U.S.'s second most abundant generator of photovoltaic energy. This is quite an impressive story of success since the solar insolation resources from the Sun's light are not nearly as abundant in New Jersey as in some of the other states in the nation. It was new state policy that overcame the lack of solar resources and created the potential for state to possess reliable and environmentally friendly sources of decentralized grid power. Public policy leadership did not stop with providing this successful CORE rebate program on manufactured green technologies, but continued on to create a tradable commodity in solar renewable energy certificates (S-REC)[9]. The S-REC is an entirely new market where citizens and organizations could receive lucrative payments for each MegaWatthour of clean power that they produced. In the past two years S-RECs generated from photovoltaic systems installed in New Jersey traded at over 20 cents per kWh (>$200/MWhr)[20]. Please note this payment is provided not for the actual energy itself, but is for the "green" value of that particular renewable source in the State. As a result of these two public policy advances the PV market rebates are significantly oversubscribed and the State is well on its way to reaching its goal of 1500 MW of PV in NJ by 2020[6].

The State's RPS considers clean energy to be that which is created in a renewable fashion. Therefore limiting the green market to primarily photovoltaics is not practical since there are other energy sources that are renewable. In the American economy, for something to be affordable, it must be plentiful and readily available so that it can compete on the market and drive the prices down as its demand goes up. As there indeed is a limit to the manufacturing potential of photovoltaic equipment, the State has incorporated clean fuels, wind power, biomass as well as hydroelectric power into the mix to assure it reaches its goals of affordability and availability of renewable energy. The green market must continue to develop and compete and must be diverse if it is to prosper in the State economy.

New Jersey Anemometer Loan Program

These ideas, along with institution of a community outreach program, have been introduced in their infancy by a partnership of the State of New Jersey and Rowan University in the New Jersey Anemometer Loan Program (NJALP). Professors and students of electrical and computer, mechanical, and civil and environmental engineering at Rowan University, have taken on the responsibility of managing the NJALP. Junior and senior clinic students at the University have been trained and given the opportunity to work towards making a small terrestrial wind energy boom that follows in the successful steps of the photovoltaic program.

Students have been given the opportunity to learn through this program many aspects of wind power (facility, planning, generation, equipment siting, estimating turbine production, etc.) while providing data that potential consumers and the State may be able to use as a method for driving broader adoption and faster market expansion for wind technology. In addition to providing location specific data measurements of wind resources, by loaning and installing anemometer masts to southern New Jersey farmers and residents, students are able to provide findings concerning the inclination of municipalities to allow installation of wind masts. Note: It is imperative to take wind speed measurements as speed and the swept area of a turbine system combine to dictate exactly how much energy can be transferred from wind in to usable electricity. Since laminar flow of wind occurs at distances higher than most of the height

regulations existing in the municipalities of New Jersey, feasibility analyses for wind turbine installations in zones that do not allow the erection of an anemometer mast over thirty feet are quite impossible (accurate data should be captured well above thirty feet). It would be unwise to install a wind turbine, regardless of the magnitude of its power output, if one cannot capture an accurate estimate of the wind resources available at the installation site. Although the State provides a significant portion of the equipment cost through a wind turbine rebate, the energy savings from using the power generated from the turbine must pay off the remainder of the system costs. If there is not sufficient wind to power the system, than the equipment and installation costs may exceed the savings potential over the life cycle of the system. This condition is not ideal for expanding a market in New Jersey or in any State.

With a limited number of anemometer masts available for loan through the New Jersey Anemometer Loan Program, Rowan students decided that prioritization of a recipient queue based on zoning allowances and wind resources was the most logical way to install masts and begin recording data. A clean energy symposium was held at the University to help New Jersey farmers sign in to the queue. After the queue was built, a mail survey was administered to approximately seventy-two municipalities. Details of the survey concerned whether or not it was acceptable for an anemometer to be erected on land in a particular municipality and under whose authority it was to be made acceptable. Preliminary responses were scant, but some municipalities did respond by returning a completed survey letter. To reach those who did not respond, students proceeded to man the clean energy telephone hotline based out of Rowan Hall which was in use for all clean energy activities underway on our State grants. The clean energy intern team pursued almost all of the municipalities in New Jersey with significant average wind speeds (as by the USDOE/NREL[11] and Wind Energy Resource Atlas of the US[12]). It was quite tedious to get responses from many of the officials who manned the local zoning offices. Despite the difficulties seventy-two municipalities were contacted via telephone and their responses were obtained. These responses are summarized in Figure 1 below. Note that although green zones allow for wind masts without a variance, permits are often required.

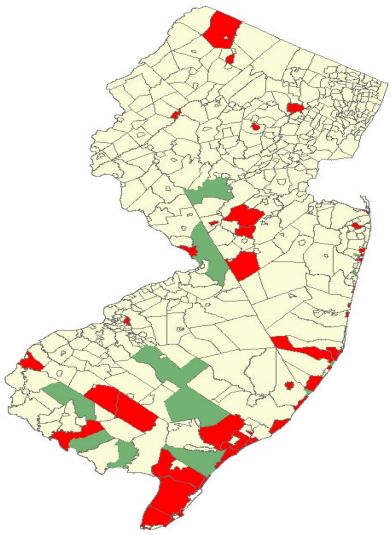

Figure 1: Green Zones are Acceptable for Wind Masts Red are not Acceptable

From the data collected it is clear that the current zoning restrictions are a major barrier to the expansion of wind power in the State. On a positive note, since the time Rowan University began its work in promoting wind power and installing anemometers throughout the region to assess the wind resource in 2004, three southern New Jersey municipalities (Deerfield Township, City of Millville and Pittsgrove Township) have altered their zoning codes[13,14,15] to specifically promote and support windmill energy projects in their communities. In each of these communities the normal 30 foot height limit has been extended, and windmills up to 80 feet (Pittsgrove) and 300 feet (Deerfield and Millville) are specifically allowed by ordinance for residential, commercial or farm owners provided these wind facilities are for the generation of electricity for their own use (not a Wind Farm). With the exception of these three, our inquiries of the municipalities with wind speed regimes in excess of 5.5 m/s revealed that forty-three municipalities had zoning ordinances that require the applicant to obtain a height variance to perform a wind assessment beyond 30 feet in height. This prevents Rowan students and faculty from performing engineering analysis in some of the more promising wind resource areas. More importantly, it prevents those who are interested in investing in wind power on their properties to pursue tem as well. These local policies prevent the small terrestrial wind market from being established in the very areas of New Jersey were wind is likely to be viable resource for reducing strain on the electricity grid. It is likely that existing zoning ordinances that mandate height variances were drafted to prevent tall buildings and city scale development, however, stakeholders of the State of New Jersey believe that it is time to re-evaluate if in fact the ordinances are actually still in the best interest of the community.

New Jersey Wind Working Group

The many stakeholders who would like to see wind power expanded, although they appear to be a minority in their mindset, have been given the opportunity to play a part in the renewable energy market by influencing public zoning policy within the State of New Jersey. They have joined together to form an official New Jersey Wind Working Group (NJWWG). Its first kick off meeting was hosted by Rowan University on October 6th, 2006. Engineering clinic students have found themselves directly in the middle of this effort as they were intimately involved in the formation of this important interest group. Those students with similar interests with those of this group are beginning to make a difference as they work collectively with their clinic advisors and the working group itself. Wind Powering America Wind Working Groups offer valuable forums to examine issues, gather stakeholders to develop solutions, and provide an effective networking tool. The formation of these groups demonstrates that a state is proactive about wind power development. Wind working groups can be instrumental in overcoming initial market barriers to wind energy and initiating the first projects. The lessons learned from the experiences of such groups provide valuable insight to renewable energy technology outreach and acceptance in other states. Across the U.S. there are over 30 formalized wind working groups[16] as shown in Figure 2.

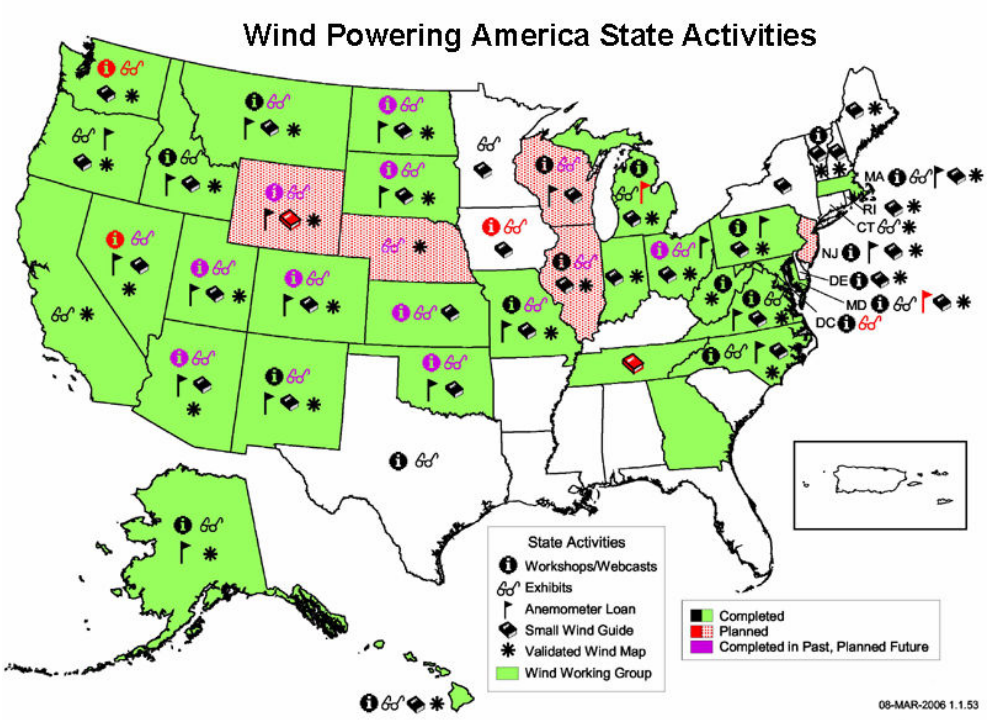

Figure 2: Wind Working Groups Are Shaded States

The experience thus far has been encouraging. An engineering student (and co-author of this paper) is currently planning to present the results of the first NJWWG and the statistics from the follow-up survey to the second meeting of the NJWWG to be held at Rutgers University in January 2007. The results of the first meeting identified key barriers that must be removed and sub-committees of the working group that need to be quickly formed to address those barriers. Tables 1 and 2 below provide the summary results of the online strategic assessment completed by NJWWG members

Table 1: Strength and Weaknesses of NJ Small Wind Market

Strengths	
Favorable Net Metering Laws	88%
Rebate Factor is a Huge Incentive for Small Scale Systems and Municipalities	80%
A Viable and Proven Renewable Energy Credit Market	80%
The Availability of Existing Wind Resources in New Jersey	80%
Weaknesses	
Inconsistent Local Zoning and Variance Laws	88%
The Lack of Accurate Available Wind Data	76%
No Requirements in the Renewable Portfolio Standard for Municipalities to Purchase Class 1 Wind Power (Wind does not have as Convenient of a REC System as Does Solar)	64%
Underperformance of Existing Small Systems and Limited Data Available	56%

Table 2: Opportunities and Threats of NJ Small Wind Market

Opportunities	
Using Entities of Critical Infrastructure as Demonstrations for Clean and Secure Potential	68%
To Kick Start Small Wind Projects by Mimicking the Recent PV Boom and Implementing Performance Based Incentives (Perhaps and Wind Energy Credit)	68%
New Jersey Wind Working Group is a Great Opportunity to Merge Stakeholders And Influence Public Policy	64%
Taking Advantage of Some of the Locations where there are Existing Wind Resources	64%
Threats	
The Authority of Local Officials Concerning Ordinances	72%
NJBPU May Move Wind Projects in to the Solar Queue	64%
The Latitude Inherent in Zoning Ordinances	56%
Actions of "NIMBY" (not in my back yard) Groups	52%

All of the above data was organized such that 100% indicates utmost significance of a particular facet of the online strategic assessment. For example, 68% is interpreted as the average level of significance for using entities of critical infrastructure as an opportunity for the small terrestrial wind market in New Jersey. Likewise, participants indicated how adamant they felt about establishing particular sub-committees to support the strengths and opportunities and to combat the weaknesses and threats of the market. Table 3 summarizes the tentative suggestions for subcommittees to be built. Note that these results as well as the previous (Tables 1 and 2) were derived from the responses of a total of twenty NJWWG participants whom all indicated that they are committed to working for the advancement of the group.

Table 3: Tentative Subcommittees to be Formed

Effective Subcommittees	
Wind Resources Assessment	72%
Public Policy Input from Stakeholders	64%
Local Zoning	48%
Communications	44%

More Policy Change for the Future

The kick-off meeting of October 6th 2006 at Rowan University was the first of hopefully a long list of proactive wind market advancement meetings. Led by representatives of the New Jersey Board of Public Utilities and The New Jersey Office of Clean Energy and directed by Dr. Jansson of Rowan University, the meeting served its purpose adequately by giving state officials, citizens, environmentalists, renewable technology manufacturers, independent investors, university faculty and students, and consultants the opportunity to unite for cooperative discussion and networking for advocating small terrestrial (land based or on-shore as opposed to off shore) wind power applications and activities. Electrical, mechanical, civil / environmental, and chemical engineering students were able to participate in the working group both by organizing the event and presenting data and findings from over a year's worth of engineering work and correspondences through the New Jersey Anemometer Loan Program and the NJCEP Wind and Energy Efficiency Outreach programs based out of Rowan University. It is our hope

to continue this aggressive pursuit of public policy transformation to promote green power in New Jersey. It is clear that the impact on participating students was positive. The student co-author of this paper played a key part in the 2nd NJ Wind Working Group Meeting as a speaker held at Rutgers University in January 2007. The following quotation from him (a graduating senior civil and environmental engineering student) is quite telling: "I enjoyed working with public policy issues and feel that the experience I gained from the project will serve as an excellent baseline for the future endeavors in my career. Most importantly, the work summarized in our paper contained an element of real-life problem solving that is not attainable from traditional academic course work. The experience as a whole has been very valuable to my education as an engineering student." It is believed that all the students involved have had their engineering education broadened by this project based learning experience in which they have engaged in important public policy issues and made a difference in the State of New Jersey.

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