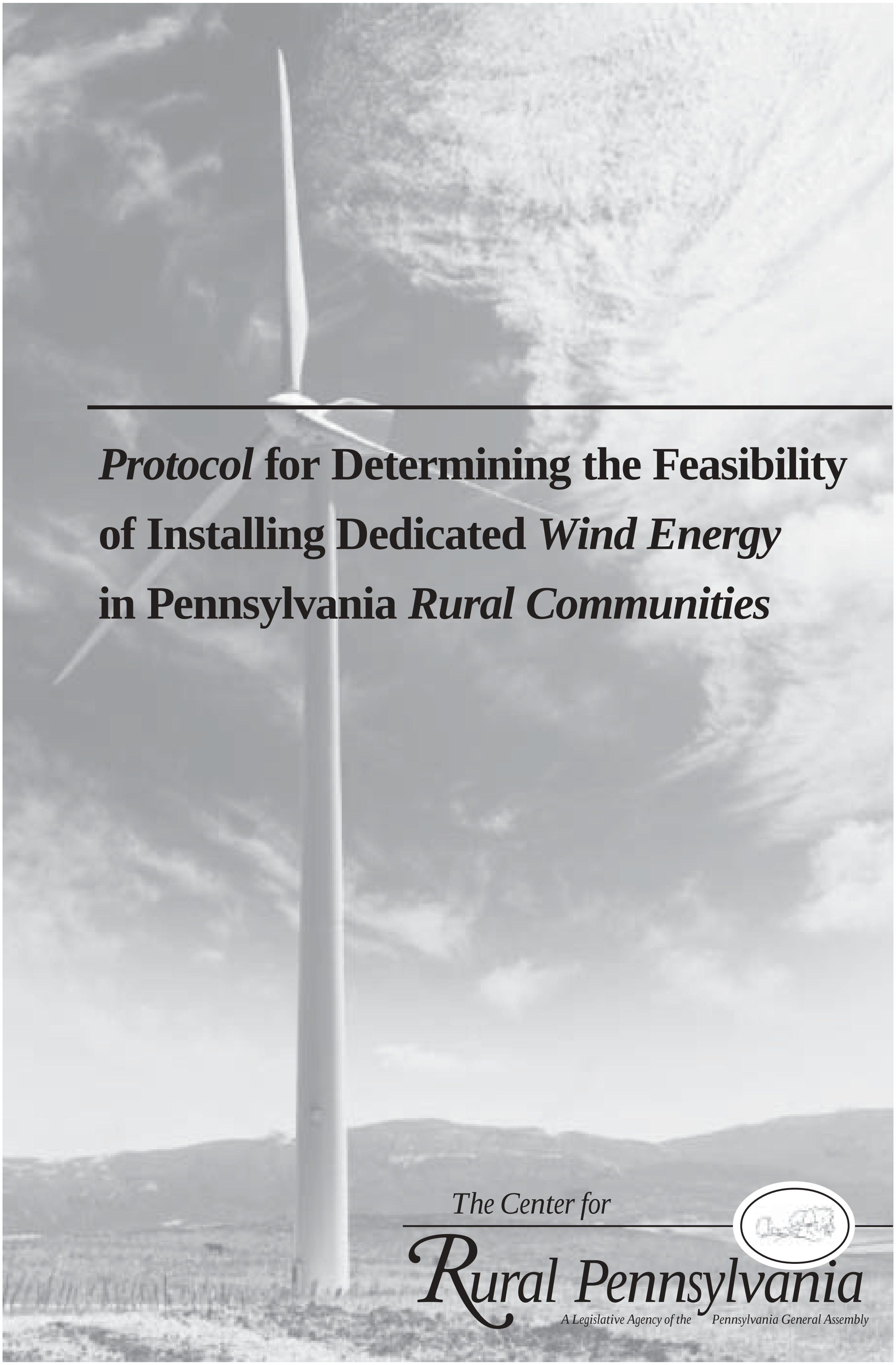
Protocol for Determining the Feasibility of Installing Dedicated *Wind Energy* in Pennsylvania *Rural Communities*



The Center for Rural Pennsylvania
A Legislative Agency of the Pennsylvania General Assembly

Protocol for Determining the Feasibility of Installing Dedicated Wind Energy in Pennsylvania Rural Communities

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Executive Summary

The goal of this study was to develop a protocol whereby homeowners, local officials and other interested parties located in rural communities can evaluate the feasibility of installing wind energy in their home, business or community and determine its cost-effectiveness. This protocol accounts for a number of variable factors, including wind capacity, installation costs, and turbine power capability. The protocol is ultimately an economic calculator where the user can determine the internal rate of return (IRR) over the life of a wind energy system, and decide if such a return warrants further pursuit of a system.

It is important to note that the protocol is intended to be a first step in determining whether installation of a wind energy system is suitable for a particular site.

Protocol test results were compared with the results from other studies published on the economic feasibility of installing a wind energy system. Results using the protocol showed good correlation with the other published results, with some conservatism. The protocol was then used to determine the feasibility of installing a wind energy system at two locations in Crawford County, where meteorological towers had been erected and data acquired for a period of one year. Results indicated that neither site was viable without grants, based on the IRR from the protocol and the acceptability threshold identified by the landowners. The researchers concluded that, ultimately, any landowner wishing to pursue a wind energy system should have an expert evaluate their site to ensure that a wind turbine will be able to harness a sufficient amount of wind to make the investment worthwhile.

State incentives and/or rebates may enable more landowners to pursue the installation of wind energy systems. In addition, there is a critical need for an unbiased wind professional to assist landowners in the evaluation of their wind resource and get them started on using the protocol to make intelligent decisions. Various options may allow such a part-time position to be funded by the state and support the growing efforts by rural communities to investigate wind energy. The researchers suggest that the unbiased wind professional could be funded within the Pennsylvania Department of Environmental Protection, where renewable energy initiatives are already in place.

The Wind Turbine Economic Feasibility Protocol and Household Electricity Use Estimation Sheet are available online at www.ruralpa.org and www.pserie.psu.edu/academic/engineering/AppliedEnergyCenter/projects.htm. Instructions on using the protocol and information on understanding the protocol worksheets also are available at www.ruralpa.org.

Introduction

As the planet continues to industrialize at a feverish pace, the demand for fossil fuel resources continues to rise and is outpacing increases in the available supply. This will have far-reaching effects on many communities, especially those in rural areas.

To understand the severity of the problem, it is important to understand the global and national energy situation as it currently exists. For example, worldwide consumption of crude oil increased 30 percent from 1982 to 2002 [1]. The trend in the United States is similar, where energy consumption of crude oil increased by 29 percent for the same 20-year period. During this period, the U.S. production of crude oil dropped by 16.5 percent, while production of oil by the Organization of Petroleum Exporting Countries (OPEC) increased by 51 percent. This resulted in an increase in the U.S. import of crude oil to heat homes and fuel vehicles.

The U.S. electric power grid has approximately 73 percent of its power generated using either coal (52 percent) or nuclear energy (21 percent) [2]. The remaining energy used to generate electricity is from natural gas (16 percent), hydroelectricity (7 percent), oil (3 percent), and other technologies, such as renewable energy sources (1 percent). As domestic energy consumption increases, due to an increase in the U.S. population, there is a need for new sources of energy. Unfortunately, little new infrastructure has been installed to date to meet these needs, especially in the Northeast. There have been no new orders for nuclear power plants since 1978 [3], and only recently have new coal-fired and co-generation plants been proposed [4]. The time frame for when these new plants come online is between the years 2015 and 2030. This is significant because these plants require so many years to design and construct they may or may not be available to meet present and future energy needs.

The high cost of energy from fossil fuels, as well as the uncertain future for new coal or nuclear power plant development, has made the need for the development of alternative forms of energy extremely important. These alternative energy sources not only help feed the power grid, but they typically also generate the energy without fossil fuel emissions, thus protecting our environment. One of the most widely used alternative energy sources is the wind. Energy is extracted from the wind by a turbine that is connected to a generator, enabling power to be generated. Compared to other alternative energy sources, wind turbine technology is relatively mature and robust. Wind turbines are now capable of generating over three megawatts (3 MW) of power, enough to power almost 1,000 residential homes at any given time [5,6]. In addition, the cost of such generation is now at a level that makes wind energy a potentially economically viable alternative to fossil fuel generation ([7,8]). Wind farms, where land is allocated for large-scale wind energy production, are now operating in more than 30 states [9]. In Pennsylvania, for example, existing wind energy projects range in size from 130 kilowatts (kW) to 64.5 megawatts (MW). Some of these projects include:

a) Waymart Wind Farm in Wayne County, capable of generating 64.5MW.

b) Meyersdale Wind Farm in Somerset County, capable of generating 30MW.

c) Locust Ridge Wind Farm in Schuylkill County, capable of generating 26MW.

d) Bear Creek Wind Farm in Luzerne County, capable of generating 24MW.

e) Mill Run Windpower in Fayette County, capable of generating 15MW.

f) Garrett Wind Park in Somerset County, capable of generating 10.4MW.

During the research time period (2006-2007), Pennsylvania had 179MW of existing wind power capability, with over 300MW of new capacity

One of the most widely used alternative energy sources is the wind. Energy is extracted from the wind by a turbine that is connected to a generator, enabling power to be generated.

being proposed or under construction.

Wind resources are described in terms of the wind power classes as defined by the National Renewable Energy Laboratory (NREL, an entity of the U.S. Department of Energy). The classes range from class 1 (the lowest) to class 7 (the highest) as shown in Table 1. Each class represents a range of average wind speeds at specified height(s) above ground or an equivalent average wind power density (in the units of [W/m^2]). Areas designated class 3 or greater are suitable for most wind turbine applications, whereas class 2 areas are generally considered marginal for large-scale wind energy generation. Class 1 areas are generally not suitable, although a few locations may exist in some class 1 areas where the local topography may generate an adequate wind resource for small wind turbine applications.

The use of wind turbines to generate electricity has become a part of a larger national effort now underway whereby the increase in the power grid energy supply is achieved through distributed generation rather than via only traditional coal or nuclear power plants [10]. In distributed generation, small suppliers feed the power grid using generators powered by fossil fuels, as well as waste heat turbines, and renewable energy sources such as wind and solar. One important benefit is that distributed generation does not require the long-term planning that the larger, centrally located plants require and that additions or changes are easily made.

Today, federal and state governments can often play a critical role in the development of renewable energy. For example, California allows a tax credit for approved solar and wind energy systems [11], and North Carolina allows a tax credit for a variety of renewable energy processes, including solar, wind and biomass [12]. A consolidated database of state initiatives in renewable energy can be found in the Database of State Initiatives for Renewable Energy (DSIRE), which is funded by the U.S. Department of Energy and managed by the North Carolina Solar Center [13].

Table 1 – NREL Wind Classes

Wind Classes for Wind Power at 50 m above the ground			
Class	Speed [mph]	Wind Power Density [W/m^2]	Suggested use
1	< 12.5	<200	Possible Small Wind
2	12.5 – 14.3	200 - 300	Small Wind / Large Wind
3	14.3 – 15.7	300 - 400	Large Wind Production
4	15.7 – 16.8	400 - 500	Large Wind Production
5	16.8 – 17.9	500 - 600	Large Wind Production
6	17.9 – 19.7	600 - 800	Large Wind Production
7	> 19.7	>800	Large Wind Production

At the federal level, a 1.9-cent per kilowatt-hour (1.9¢/kWh) tax credit exists to help spur the use of wind energy [14]. These incentives contribute to the economic viability of renewable energy sources.

In Pennsylvania, a 1998 settlement between the Pennsylvania Public Utility Commission and representative utilities (First Energy, Allegheny Power, Pennsylvania Electric Company, Pennsylvania Power and Light) for electricity deregulation resulted in the development of the four Sustainable Energy Funds [15]. The purpose of the funds is to promote:

- the development and use of renewable energy and clean energy technologies;
- energy conservation and efficiency;
- sustainable energy businesses; and
- projects that improve the environment.

In addition, in 2004, Pennsylvania passed into law the Alternative Energy Portfolio Standards Act, more broadly known as a Renewable Portfolio Standard (RPS) [16,17]. This law separates the alternative energy sources into two “tiers.” Tier I is made up of renewable sources, such as wind and solar, while Tier II consists of other sources, such as waste coal, municipal solid waste, and large-scale hydropower. For Tier I, the law requires that, within two years of the law taking effect, at least 1.5 percent of the electric energy sold by an electric distribution company or electric generation supplier be generated from Tier I alternative energy sources [17]. Further, this amount of generation must increase until at least 8 percent of the electric energy will be generated from Tier I alternative energy sources within 15 years of the law taking effect.

Pennsylvania's rural areas have needs that are distinct from their urban counterparts. Rural areas in the state may not have easy access to the power grid due to remoteness or the terrain. This could make access to grid power potentially impractical and/or expensive[1]. In addition, rural communities and homeowners who are on the power grid will likely wait longer to have their power repaired in the event of an outage when compared with other residential customers [18]. Thus, having a means of both supplying power to the grid to reduce fossil fuel emissions (while also being able to reduce overall electricity costs by generating power), and providing a means of powering a local residence or community should grid power be removed (though this may require the addition of a battery storage system), all make wind energy worth investigating.

Wind energy generation, like most technologies, has both its advocates and its detractors. The main source of information and support for wind energy generation is the American Wind Energy Association (AWEA) [19], which is the national wind industry trade association. AWEA, along with the rest of the wind industry, promotes wind energy as a clean source of electricity for consumers around the world, and works with the government to help ensure that wind industry interests are addressed in renewable energy legislation. It also is a strong advocate for education, information sharing and outreach in promoting wind energy generation.

Alternately, there are people and groups concerned about various issues regarding wind energy generation. These issues include environmental (land and water use and/or property values), biological (flora and fauna), and avian (birds and bats) concerns, and noise and aesthetics. Some of these groups have recently started to work with both the government and the wind industry[2] to address the issues previously mentioned.

In any event, an emphasis needs to be placed on educating the public about the benefits and costs of wind energy generation.

Goals and Objectives

The goal of this study was to develop a protocol whereby homeowners, local officials and other interested parties located in rural communities can evaluate the feasibility of installing wind energy in their home, business or community and determine its cost-effectiveness. This protocol accounts for a number of variable factors, including:

- wind capacity (assessment of the potential for energy generation);
- power and energy requirements based on the capability of the wind turbine;
- regulatory costs;
- installation costs;
- cost of the tower and associated hardware;
- cost of land preparation;
- cost of interfacing with the utility grid; and
- economic return on investment (capital recovery period).

This protocol can then be applied to a variety of rural constituents:

- Individual homeowners, farm owners, or small communities who wish to investigate renewable wind energy to reduce their grid energy consumption and supply power back to the grid.
- Individuals interested in building on land that is not close to any existing electric power lines, but would like to have electricity available.
- Local government officials who wish to know how incentives in the purchase of wind energy can benefit their community by showing how long it will take for an investment in wind energy to be recouped with and without such incentives.

[1] Rural electric cooperatives and public utilities can provide access to grid power for rural sites but this can be an expensive proposition. For example, the We[illegible] Rural Electric Cooperative charged $6/foot of connection for access to primary distribution lines and $2/foot for secondary lines.

[2] PennFuture was selected, along with Audubon Pennsylvania, to serve as co-facilitator of the Pennsylvania Wind and Wildlife Collaborative. The collaborative is a joint effort among Pennsylvania government agencies, environmental advocacy groups and the wind industry to develop recommended policy, adaptive strategies, guidance and procedures that appropriately protect wildlife resources while allowing for beneficial wind power development. See http://www.dcnr.state.pa.us/info/wind/.

Methodology

The investigators developed an economic calculator that can be accessed at www.ruralpa.org or www.pserie.psu.edu/academic/engineering/AppliedEnergyCenter/projects.htm. The protocol can be downloaded from these websites to a home computer. This calculator was developed using Microsoft Excel®, a widely used program available on the vast majority of personal computers. With this calculator, rural landowners and other interested parties are able to have a preliminary estimate of the economic return for their investment in a wind energy system. Economic calculators already exist for evaluation of wind energy. Examples of calculators available for use are:

1. Windustry [20] – This organization's mission is "working to increase wind energy opportunities for rural landowners and communities."
2. Homer [21] – This is the wind energy calculator associated with the National Renewable Energy Lab.
3. RETScreen International [22] – This is the calculator from Natural Resources Canada (NRCan), built along with international partners including NASA.
4. Wasp [23] – This is a product of the Danish Wind Energy Association.

The calculators listed above are all highly detailed and typically intended for wind energy professionals to evaluate potential wind energy generation projects. In this regard they may be less user friendly to the rural landowner with limited knowledge or initial access to professional advice.

The economic calculator developed for this project is purposely tailored towards rural landowners who are not experts in wind energy. It is set up to enable the user to input information regarding energy use, wind turbine information, and costs. The output of the economic calculator is a rate of return that enables the user to know whether the investment is a good idea. It is called a protocol because the user will look at the rate of return and decide whether the value exceeds a threshold that corresponds to a reasonable investment.

Users of this calculator should have some knowledge of home economics, such as mortgages and taxes. The calculator is intended to provide not only numerical feedback on the feasibility of a wind energy project, but also information for landowners to consider as they pursue a wind energy project. Two of the worksheets developed for this calculator identify specific costs and regulations that may need to be investigated during the initial evaluation of a project. Thus, the landowner or interested party obtains a better overall scope for purchasing and installing a wind energy system.

The economic calculator developed for this project is purposely tailored towards rural landowners who are not experts in wind energy. Users of this calculator should have some knowledge of home economics, such as mortgages and taxes.

Discussion of the Protocol

One of the most important lessons learned by the investigators during the course of this project was the need to have qualified personnel involved in the wind energy decision-making and installation process. For example, the process of erecting meteorological (MET) towers to perform the wind resource assessment requires significant planning and knowledge (including using a licensed and insured general contractor for the installation). While the erection of a MET tower may not ultimately be justifiable for the rural landowner interested in a single small wind energy generation system (< 50kW)[3], it would certainly be advisable to make a detailed assessment for a

[3] In that case, a knowledgeable wind energy professional can make an assessment of the rural landowner's wind resource by carefully observing the terrain and likely wind patterns at the proposed site.

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larger (>100 kW) community based wind energy system. The investigators do believe, though, that, in either case, such expertise will be required for most landowners or communities who are interested in erecting a wind energy system. This feature of the process has an important effect on the development of this protocol. Since the protocol is being designed for use by a variety of interested parties, including rural landowners and communities, ideally it should be set up to ensure that anyone can understand its details. However, the investigators believe it is unrealistic to develop a protocol that could encompass the needs of every possible condition for all rural landowners as well as communities. Such a detailed protocol would be both unwieldy and extraordinarily complex, and would therefore hinder rather than help the efforts of the landowner or community to make educated decisions regarding the financial aspects of wind energy systems.

The protocol is therefore designed to cover the main economic issues that may be raised by a landowner or community during the initial process of deciding whether to proceed with an evaluation of wind turbines for their location. Many of the same issues arise between a landowner and a community regarding installation of a wind energy system. One difference between the two concerns the types of incentives available: for example, the community (if tax-exempt, and if it owns its own distribution system) may use the Renewable Energy Production Incentive (REPI), while the landowner may use net metering or production tax credits. There may also be differences in the regulations that will need to be satisfied between taxable and tax-exempt entities. Individuals who use the protocol should have a basic knowledge of mortgages, cash flows, and taxes. However, the investigators strongly believe that the protocol should be used only as a "first step" in their evaluation. If the protocol provides economic results that are favorable for the landowner or community, then the investigators recommend that the responsible individual contact an expert in wind energy systems for consultation. The consultant can focus on the specific circumstances and desires of the landowner, and be able to make recommendations based on the data and information at that particular location.

Test Cases

Once the protocol was developed, a series of test cases was then analyzed. The test cases are broken into two main groups. In the first group are case studies where the authors of each case study provide an internal rate of return (IRR) as part of their analysis. The protocol was then validated by comparing the results from the protocol with those from the authors of each case study.

In the second group are real-life case studies for rural landowners in Pennsylvania. The investigators developed a homeowner write-up that enabled prospective landowners to determine whether installation of a MET tower would be of interest to them. Based on personal contacts, as well as publicity generated by the Center for Rural Pennsylvania, a total of nine sites were identified and subsequently evaluated after site visits. Two sites, both located in Crawford County and about 20 miles from each other, were chosen as the recommended sites. MET towers were erected at the sites. With the MET towers erected, the investigators collected one year's worth of wind speed, wind direction, temperature and air pressure data. In addition, the investigators estimated the electricity use for each landowner by having each landowner fill out Electricity Use Estimation Sheets. With this information and some additional assumptions, the investigators were able to use the protocol and make recommendations regarding the purchase and installation of a wind energy system at each landowner location.

Results

Simulated Case Studies

A total of nine case studies were performed for comparison with published IRR results. Each case was found from an Internet search. Cases chosen ranged from residential sized projects (on the order of kilowatt size turbines) to commercial scale projects (up to 40 MW).

For the pre-tax IRR, the standard deviation is slightly above 2 percent, providing a reasonable degree of confidence that the protocol will yield an answer that is consistently below the website value by approximately 2 percent. For the after-tax IRR, more variability exists, which may be due to the challenges of maneuvering within the tax code. The conservative results from the IRR for both pre-tax and after-tax conditions are considered acceptable since the investigators do not want to present an overly rosy picture of economic feasibility for a landowner, only to have the landowner install a system and not reach the expected economic return.

It is entirely possible that protocol numbers may change based on an individual assessment of each case. For example, it is possible to imagine two rural landowners coming up with different rates of return for the same project depending on the values of parameters chosen. It is hoped that with sufficient information gathered ahead of time, such differences will be minimized.

Pennsylvania Rural Landowner Case Studies

Meetings with both landowners occurred in May 2007 to discuss both the results of the wind assessment study and the protocol for their wind resource. The landowner for Site 1 was interested in a residential size wind turbine to subsidize some or all of the electricity costs at his home. The investigators evaluated 18 turbines as to their suitability for the available wind resource and ran the protocol on the three cases deemed most appropriate for the site. These three cases had the best combination of energy production and capacity factor. As seen in Table 2, the IRR for all

Table 2. Summary of Results from Site 1.

Wind Turbine Model	Monthly Energy Produced (kWh)	Total Construction Cost	Internal Rate of Return (Percent, Pre-Tax)
Proven WT 6000	819.5	$55,532.00	-4.82
Proven WT 15000	2075	$73,890.00	-2.64
EMS E15-35	8053.4	$142,000.00	-5.64

Table 3. Summary of Results from Site 2.

Wind Turbine Model	Monthly Energy Produced (kWh)	Total Construction Cost	Internal Rate of Return (Percent, Pre-Tax)
Proven WT 6000	875.1	$55,532.00	-3.92
Proven WT 15000	2217.4	$73,890.00	1.34
EMS E15-35	8541.4	$142,000.00	0.33
Northwind NW 100	13110.8	$225,000.00	-0.29
Fuhrlander FL 100	13855.4	$250,000.00	-0.68
Fuhrlander FL 600	71131.2	$975,000.00	-1.45

three turbines came out negative, indicating the landowner would never recoup his original investment in the wind turbine without significant grants. Each case was also far below the landowner's acceptance threshold of 5 percent IRR.

The landowner for Site 2 was interested in both a residential wind turbine and a commercial wind turbine. In this case, about 30 turbines were evaluated for their suitability to the available wind resource. The same three residential wind turbines as Site 1 proved to have acceptable capacity factors and were evaluated using the protocol. In addition, three mid-size, commercial wind turbines were also evaluated at this site. Results for Site 2 are provided in Table 3 and indicate that two of the residential size turbines yielded a positive IRR, although not as high as the acceptance threshold indicated by the landowner (again, 5 percent IRR or greater). In this case, the investigators determined that grants totaling $27,000 would enable the landowner to achieve a 5 percent IRR on the Proven WT 15000 turbine. The EMS turbine would not be impacted as much by an equivalent grant due to its much larger upfront cost.

The numerous wind turbines evaluated at the two landowner sites in Crawford County yielded capacity factors that generally did not exceed 20 percent, even though these sites were considered to be the most typical of rural sites in Pennsylvania that could have wind potential of the nine originally examined. This speaks to the notion that a careful assessment of the wind resource is necessary as discussed above.

Both landowners were provided the opportunity to use the protocol and evaluate its usefulness. They were both able to see the sensitivity of the resulting IRR as different parameters (electricity cost, construction cost, annual operating and maintenance cost, etc.) were modified. Although the results at both sites did not yield an IRR that met the landowner acceptance threshold, both landowners were able to validate the protocol's functionality and overall use.

Conclusions

The results from the simulated case studies indicate the protocol can provide a reasonable first estimate for parties interested in determining the economic feasibility of installing a wind energy system at a particular location. Because of the significant number of variables associated with this estimate, IRR results will be more sensitive to some variables than others.

Wind energy capacity factors are highly variable, depending on the location. Although some reference state capacity factors up to 40 percent, a more realistic range for Pennsylvania is between 15 percent and 30 percent. To experience a wind capacity factor in the upper range, a site should be located in an optimal location, such as a ridge line. The capacity factors seen at the landowner sites were generally between 15 percent and 22 percent in the best cases. More than 30 turbines were studied in support of the landowner analyses. For some of the turbines studied, capacity factors lower than 10 percent were calculated. Clearly some turbine designs are intended for higher wind classes. It should also be noted that the two sites evaluated were considered to be the most typical of rural Pennsylvania sites that could have wind potential compared to the other sites visited by the investigators and the project subcontractor.

Users of the protocol are strongly encouraged, if they believe their location has a reasonable wind resource and favorable economics, to enlist the support of a meteorologist or other wind energy professional to evaluate their site. A wind energy system, even for home use, is a big investment. A specialist will be able to determine if the wind resource is in fact favorable, whether the costs associated with connecting to the utility grid may be excessive, and what wind turbine may be optimal for a particular site.

Policy Considerations

Pennsylvania has made great strides to make renewable energy more viable within the state. The development of both the Sustainable Energy Funds and the more recent Renewable Portfolio Standard are examples where the state has shown leadership in promoting the use of renewable energy technologies. The overall investment return for a wind energy project can be influenced by state incentives, such as rebates on purchases or tax credits on energy produced. If tax credits are considered, it is advisable to first ensure that landowners are able to concurrently take advantage of both the federal production tax credit as well as a state production tax credit. Generally, these tax credits will only be of value to larger wind energy systems that produce more energy. For smaller wind energy systems, a rebate may be viable. Any rebate should be carefully explored relative to the overall effect on state finances, as well as the benefit to landowners. Substantially large rebates may negatively impact the overall state budget while encouraging the purchase of wind energy systems for use on land that is actually unsuitable for harnessing wind energy. Small rebates, while having a positive public relations impact, may relieve little of the financial burden on landowners with potentially reasonable wind capacity. The protocol may be used as a tool to investigate the overall effect of rebates on the economic feasibility of installing a wind energy system at a particular site. Of course, different rebates, as well as different turbines, capacity factors, etc., will yield substantially different results. It may therefore be difficult to apply a "one size fits all" approach to the development of incentives for the installation of wind energy systems.

For example, the investigators found that permitting costs vary widely between townships. When erecting the meteorological towers at the two Pennsylvania landowner sites, the cost of submitting a request for a building permit to one township was $2. The other township required both a zoning permit and a building permit, which also included the requirement that an engineer review plans and visit the site. The cost for getting this township's approvals was $217.

The state has drafted a model ordinance and made it available for municipalities to use as a template [24] that can be adjusted to their specific needs. It addresses the specific areas of concern when siting a wind energy generation project, including the visual appearance of wind turbines and related infrastructure, sound levels, shadow flicker, minimum property setbacks, interference with communications devices, protection of public roads, liability insurance, decommissioning and dispute resolution. The investigators have reviewed the model ordinance and believe that it addresses these issues in a reasonable way. As municipalities encounter more interest in wind energy generation from citizens, they should consider adopting a local ordinance based on the model.

During this project, the impact of the Uniform Construction Code (UCC) on the overall project cost was raised. Ensuring that the UCC is satisfied may potentially add substantial overall costs to the wind energy system. It is currently not clear whether there will be uniform enforcement of the UCC throughout the state for wind energy system installations.

Finally, it has long been assumed and promoted by some wind turbine manufacturers that ***any*** class 1 or 2 wind regime could support small wind turbines. This is based on the power curves published by the manufacturers, which show energy production at wind speeds within a class 1 wind environment. However, what these manufacturers don't say is that the resulting capacity factors will likely be significantly smaller than required to yield a wind energy generation system that is economically viable for those wind regimes. The scenarios presented in this report via the protocol have demonstrated that the wind resource is very much site specific and, more importantly, that matching the wind turbine to the wind resource is critical to a successful wind energy generation system installation. The level of expertise required to do this successfully is not something that the average person can readily do.

One of the main drivers for the protocol is the capacity factor, the amount of power that a wind generator is producing compared to its rated power (as described above). Getting to this number is difficult since tools, such as wind maps, have often misled people into believing there is sufficient wind for any type of turbine at their site.

There is a critical need for an unbiased wind professional to assist landowners in the evaluation of their wind resource, in general, and to get them started on using the protocol so they can make informed decisions.

This wind professional should have a wide range of experience in the wind energy field and be able to address small wind as it relates to farms and homes as well as community scale wind projects. The unbiased wind professional could be a part-time state employee, an academic person, or an independent contractor. A wind resource meteorologist or someone of similar background would be preferable because such a person would be able to use the protocol and tailor its use to individual landowner conditions, such as terrain and siting. The person should not be in the business of selling wind turbines or associated with a particular wind energy project developer as that could be considered a conflict of interest.

The wind professional could guide the landowner to the protocol, ask specific questions about the proposed location and the landowner's needs, and give the landowner basic information that is tailored to the site.

It is estimated that the level of contact with the typical rural landowner would take approximately 45 minutes to one hour per call. Anecdotal information from county conservation district personnel (offices in Erie and Westmoreland counties) and Department of Environmental Protection (DEP) personnel (offices in Meadville, Pittsburgh and Harrisburg) indicates that each office gets about three to five calls per week from people interested in wind. Thus, having a dedicated information resource as described above would be very useful.

Based on the state government's desire to increase the amount of renewable energy generation within the state, this unbiased wind professional should probably be a position funded by the state.

A source of funding for this professional could come from a fund set aside specifically for small scale and community wind projects since this activity would be considered a feasibility study and is therefore not supported by the existing Pennsylvania Energy Development Authority (PEDA) or Energy Harvest Grant programs.

Another possible source of funding could be via an educational grant through a Pennsylvania college or university, as this would be considered community outreach and education. Lastly, it is possible that the position could be partly funded through a fund pool sponsored by the rural electric cooperatives throughout the state since there are many rural customers whose power is supplied by these regional co-ops.

Considering these different options, the investigators believe that the most viable is for the unbiased wind professional to ultimately be funded within the state DEP. Although DEP is known primarily in its regulatory capacity, it is also already performing functions in support of renewable energy, such as through the PEDA and Energy Harvest Grant Programs. DEP is already cognizant and supportive of renewable energy and the positive impact it can have on improving the environment, reducing dependence on fossil fuels, and providing a positive economic benefit to rural landowners and communities. It is clear that citizens have already considered DEP as a potential source of information based on the number of inquiries already received by DEP relative to wind energy systems.

This option provides the best approach to developing a critical mass of knowledge in the area of wind energy systems, whereby the unbiased wind professional could interact with other DEP personnel who have wind energy experience.

The Wind Turbine Economic Feasibility Protocol and Household Electricity Use Estimation Sheet are available online at www.ruralpa.org and www.pserie.psu.edu/academic/engineering/AppliedEnergyCenter/projects.htm. Instructions on using the protocol and information on understanding the protocol worksheets also are available at www.ruralpa.org.

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