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Pilot project to advance distributed wind in Virginia

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Pilot Project to Advance Distributed Wind in Virginia

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Abstract

The Virginia Energy Plan of 2014 created a demand for alternative energy sources to meet the goal of producing 25% of Virginia's energy from alternative sources by 2025. One of the most promising sources of alternative energy in Virginia is wind. As a result, the Virginia Department of Mines, Minerals, and Energy (DMME) took action to incentivize distributed wind (DW) power by enabling loan assistance with highly favorable terms toward the purchase and installation of distributed wind systems. Our team identified the nine sectors considered most likely to present the strongest potential for development of DW, and landowners within these sectors were invited to apply for assistance and loan consideration through the Distributed Wind Assistance Program (DWAP) that we developed. The program received 12 applications, these were evaluated through a desktop analysis in order to select the four most competitive candidates as determined through a comprehensive scoring evaluation. The strongest applications were recommended to the DMME for state-based loans and these applicants were encouraged to seek additional support from the U.S. Department of Agriculture (USDA) if eligible. One applicant, Bradford Bay Farms, was able to advance their project at a rapid rate, thus a comprehensive site evaluation was performed including an on-site visit. The outcomes of this effort and lessons learned are described.

Table of Contents

Abstract 2
Abbreviations Used 4
Introduction 5
    Purpose 5
    Goals 5
Background on Distributed Wind 7
The DMME Project 19
  Literature Review 19
Distributed Wind Assistance Program 24
    Establishment 24
    Goals 24
Program Design and Implementation 26
  Targeted Outreach 26
  Participant Selection 33
  In-Depth Site Analysis 35
Bradford Bay Farms Case Summary 36
Conclusions 42
    Successes 42
    Limitations 42
    Future work 43
Bibliography 45
Acknowledgements 48

Abbreviations Used

Abbreviation	Term
AERL	Alternative Energy Revolving Loan
AREC	Agriculture and Research Extension Center
CBF	Chesapeake Bay Foundation
CWE	Center for Wind Energy
DMM	Department of Mines, Minerals, and Energy
DW	Distributed Wind
DWAP	Distributed Wind Assistance Program
DWEA	Distributed Wind Energy Association
ITC	Investment Tax Credit
MACR	Modified Accelerated-Cost Recovery System
PILOT	Property Taxes and Payments in-Lieu-of Taxes
PTC	Production Tax Credit
REAP	Rural Energy for America Program
REDLGP	Rural Economic Development Loan & Grant Program
RPS	Renewable Portfolio Standards
SED	Sustainable Energy Development
SGIP	Self Generation Incentive Program

Introduction

Purpose

In 2014, the Commonwealth of Virginia distributed an Energy Plan through the Department of Mines, Minerals, and Energy, which outlines a vision for the development of the energy sector for the future. Section 4 of this document discusses the use of renewable energy sources for the generation of energy in Virginia. One of the renewable energy sources discussed is wind energy. Today, several steps are taken to investigate the feasibility of offshore wind resources; however, land based wind resources are also a viable option for the Commonwealth. At a hub height of 80 meters, it is estimated that Virginia has the capacity to produce 1,793 MW (DMME, 2014). In order to work toward achieving such great wind generating capacity, the Commonwealth can deploy increased levels of land-based wind at different locations and on a variety of scales. The focus of this project involves the development of a pilot distributed wind (DW) project that can serve as a model to encourage further wind energy development in Virginia. DW systems can range from a single home turbine with a generating capacity of 5 kW to a multi-megawatt system at an industrial site. Utilizing these smaller-scale wind programs can help diversify the energy portfolio in Virginia while decreasing carbon emissions, increasing the number of jobs, and increasing our national energy security.

Goals

The goal of this project was to locate an ideal candidate or multiple ideal candidates in Virginia to install a distributed wind system on their site. Due to the timeframe, it was not anticipated that an entire system could be installed prior to the end of the project period. This candidate would be presented to the Virginia Department of Mines, Minerals, and Energy as a potential recipient for loan funding through their revolving loan program. The process that was followed to identify target sectors, perform outreach, and select qualified site hosts will also serve as a model for DMME, the Center for Wind Energy (CWE) at JMU, and future ISAT capstone students.

Background on Distributed Wind

Distributed generation describes the phenomenon of electrical power generation occurring in close proximity to where the power is consumed. Distributed generation systems are typically smaller than centralized power plants and offer several advantages, including decreased energy loss during transmission and reduced load on utility transmission and distribution lines. Distributed wind (DW) is a type of distributed generation. The U.S. Department of Energy (DOE) defines DW systems using two criteria: proximity to end-use and point of interconnection. Wind turbines that are installed at or near the point of end-use and are connected to the customer side of the electric meter or directly to the local grid are considered DW systems (2015). Distributed wind systems can vary in size but typically range from about 50 kW to several megawatts. Figure 1 below shows the size comparison of a 50 kW turbine versus a 1.8 MW turbine.

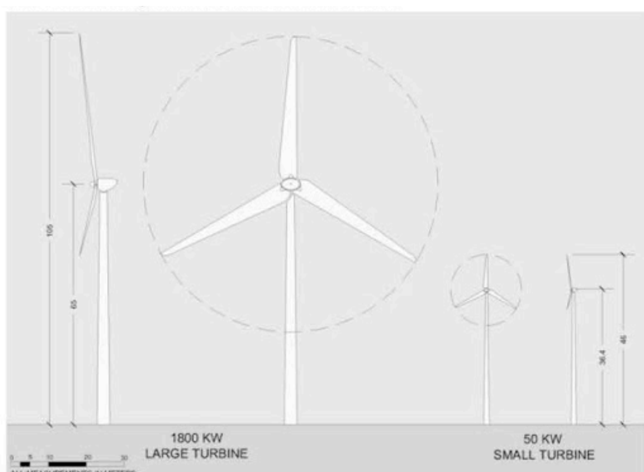

Figure 1. Comparison of a 1.8 MW and a 50 kW turbine (City of Calgary, 2012)

DW presents a rich history of providing reliable electricity generation for a variety of consumers, including homes, schools, farms, and businesses across the U.S. The installed annual distributed wind capacity has increased from 32 MW in 2003 to 906 MW in 2014, representing

1.3 percent of total installed wind capacity (U.S. DOE, 2015a). This growth, as seen in Figure 2 below, is attributed to federal policies and incentives supporting the growth of renewable energy technologies, market drivers, and developments in leasing models. While these factors have facilitated the development of DW, there are still significant challenges facing the industry in each of these areas.

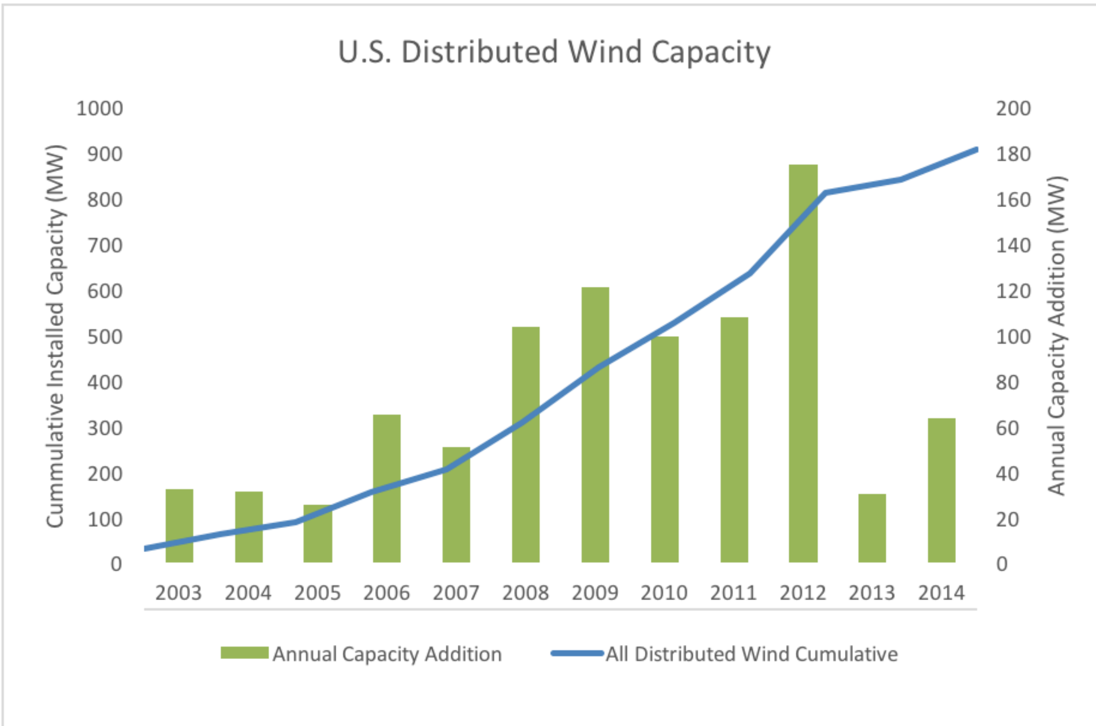

Figure 2. Installed U.S. distributed wind capacity. Data from U.S. DOE 2014 Distributed Wind Market Report

Growth of the DW market in the United States has been directly impacted by federal policies and financial incentives. One of the most significant tax incentives facilitating the development of DW has been the federal business energy investment tax credit (ITC). Established by the Energy Policy Act of 2005, the ITC is valued at 30 percent of the initial installed cost of eligible facilities, and includes solar energy, fuel cells, and microturbines (U.S. DOE, 2015b). In 2008, the ITCs were expanded to include small wind turbines (up to 100 kW in capacity), geothermal heat pumps, and combined heat and power systems. The ITC is only available to projects for commercial, industrial, and agricultural sectors as well as investor-owned utilities and cooperative utilities. Additionally, the initial ITC was capped at $4,000 for eligible wind turbines; however, in 2009 the $4,000 credit cap was removed, enabling all small wind projects to receive the maximum ITC of 30 percent (U.S. DOE, 2015b). A similar federal tax incentive, the Residential Renewable Energy Tax Credit established a 30% ICT for all small residential wind projects placed in service between 2008 and 2009 (U.S. DOE, 2015b).

Another federal tax credit that has significantly influenced the wind industry is the federal renewable electricity production tax credit (PTC). First enacted in 1992, the PTC is a 10 year, inflation-adjusted, per-kWh tax credit for eligible electricity generating entities (U.S. DOE, 2015b). In order to be eligible for this tax credit, electricity generated at the wind plant must be sold to a third party. As a result, most DW projects are not eligible; however, some mid-size and large-scale DW projects are structured such that independent power producers, rather than the end user, own and operate on-site wind turbines. Additionally, in lieu of the PTC, eligible wind generating facilities are eligible to claim a 30 percent ITC (U.S. DOE, 2015b). A final tax incentive, which has influenced the development of wind energy in the U.S, is the Modified Accelerated Cost-Recovery System (MACRS). MACRS enables parties in the commercial, industrial, and agricultural sectors to recover investments made on small wind projects through depreciation deductions over a five-year period (U.S. DOE, 2015b).

In addition to tax incentives, federal loans and grants have also significantly shaped the distributed wind project landscape in the United States. Through the Rural Energy for America Program (REAP), established in 2002, the United States Department of Agriculture (USDA), provides guaranteed loans and grants to eligible agricultural producers and rural small businesses to implement renewable energy or energy efficiency projects. For renewable energy projects, REAP loans, grants, or a loan/grant combinations are available for up to 75 percent of the total project costs (USDA, 2012). REAP was most recently altered by the 2014 amendments to the Farm Bill, which included measures to provide continued funding for the program. While REAP expenditures have declined since 2010, when funding peaked at $361 million, the program continues to provide assistance for DW projects in the agriculture sector and rural areas (AWEA 2011). Due to the decrease in funding, only $405,442 of REAP funding was awarded to 15 small wind projects to generate 840 MWh annually in the year 2014 (U.S. DOE, 2015a). The breakdown of the total number of projects and funding by state can be seen below in Figure 3. Currently, REAP is set to receive $50 million in mandatory funding until 2018 (USDA, 2014).

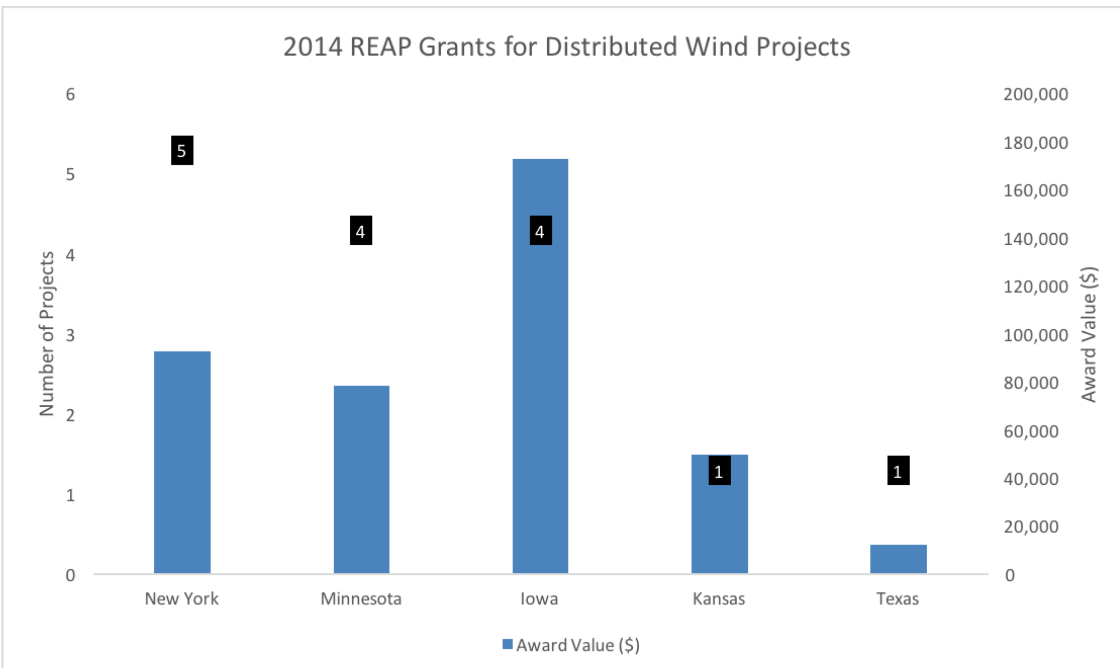

Figure 3. 2014 REAP Grant DW projects by state. Data from U.S. DOE 2014 Distributed Wind Market Report.

The overall impact of the aforementioned federal tax incentive, grant, and loan programs has been to stimulate the DW industry by alleviating market barriers, such as high capital cost. Since 2003, the cumulative installed capacity of DW in the U.S. has increased from 32 MW to

906 MW in 2014 (U.S. DOE, 2015a). The most significant increase in DW energy occurred in 2008, when the annual installed capacity was 104 MW, more than twice the capacity installed in 2007. This dramatic shift was the result of U.S. policy being more favorable to wind energy development than at any other time in the preceding decade. Most notably, the PTC was extended, the $4,000 cap for the ITC was removed, and eligible entities were allowed to accept a 30 percent ITC rather than the PTC (U.S. DOE, 2015b). From 2008 to 2012, DW energy development continued to increase because of favorable federal policies and the continuation of tax credits, loans, and grant programs. In 2013, DW energy development decreased dramatically from 175 MW capacity added in 2012 to 30 MW additional capacity installed in 2013 (U.S. DOE, 2014). This decrease is reflective of the expiration of the PTC and ITC alternative as well as decreases in REAP funding availability.

While federal policies and incentives have played an integral role in supporting or obstructing the deployment of wind energy projects within the last decade, market drivers have also shaped DW development throughout the country. The primary barriers, which have prevented DW development from accelerating at a more rapid pace, have included permitting challenges, performance prediction variability, and market competition. Many state and local governments have failed to implement permitting regulations that effectively and efficiently enable the development of DW projects. In order to combat this challenge, the Distributed Wind Energy Association (DWEA) has created model wind ordinances to guide state and local governments in the development of effective and appropriate small wind ordinances (DWEA, 2013). Variability in reliability of performance predictions has also created a lag in the development of DW projects in the U.S. Unlike large-scale wind energy projects, which typically utilize long-term data obtained from on-site wind analysis, small-distributed wind projects typically apply modeling tools and wind resource maps to determine wind resource availability and financial feasibility for potential project sites. Variability in performance estimates and uncertainty in the reliability of financial estimates have prevented stakeholders from readily investing in DW projects. This challenge has been mitigated to some extent through the use of higher-resolution resolution wind maps and more sophisticated desktop wind resource analysis tools. Several market factors have also significantly affected the development of DW infrastructure throughout the U.S. These factors include competition with solar photovoltaic (PV) project developments, declining natural gas costs, and decreased income of farmers. Due to lower prices of agricultural commodities, project developments and expenditures by farmers have decreased, which has further weakened the demand for DW development (U.S. DOE, 2015a).

Despite these challenges, the market for DW development looks promising. Most recently, implementation of the third-party leasing model in the U.S. has added an increasing number of DW installations. Based on this model, customers are able to have a wind project installed on their property without some of the key economic risks associated with project development. Instead, the customer pays the third party according to the terms of a leasing agreement for the electricity generated on the site. By using this model, economic risks pertaining to wind resource and performance uncertainty, reliability, as well as high capital costs for installation are shifted from the customer to the third party leasing company. A leader in this financing model is United Wind, a New York-based company. United Wind financed 67 projects in 2014 and 2015. In 2016, the company announced its intent to expand to Kansas (United Wind, 2014). The initial success of United Wind demonstrates the success of the third-party leasing model for instigating the growth of DW projects.

Despite the federal policies and incentives supporting the growth of renewable energy technologies, market drivers, and the third-party leasing models, the prevalence of DW energy development and growth has been extremely variable across the United States. Currently, twelve states contribute to 80 percent of the nation's electricity generated from wind power. The leaders in DW are Texas, Minnesota, and Iowa with 635 MW of cumulative DW capacity installed from 2003-2014 (U.S. DOE, 2015a). The distribution of this installed DW capacity by state can be seen below in Figure 4. The discrepancy in DW development observed between states can be attributed to several factors including variation in state wind resources, policies and financial incentives for DW development, and renewable energy portfolios.

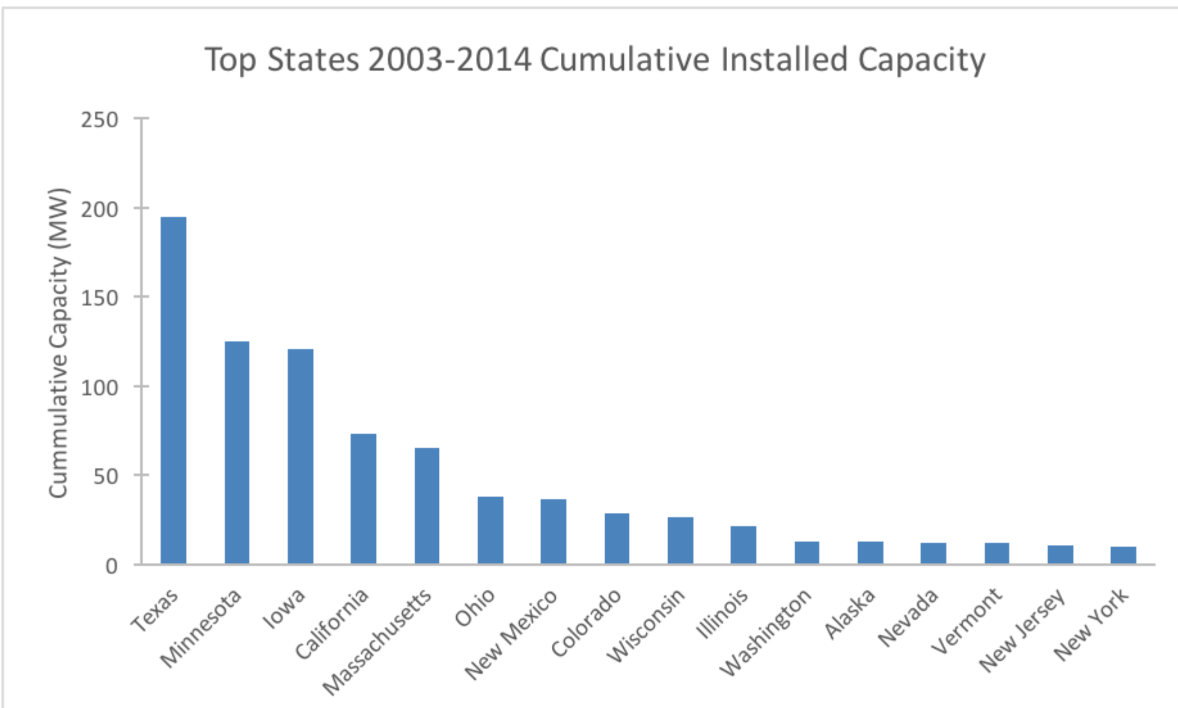

Figure 4. Cumulative installed DW capacity by state

A primary factor in DW development is the financial viability of the project. For economic viability of a DW project, adequate wind resources are crucial. The leading states in DW development, Texas, Iowa, and Minnesota, have sufficient wind speeds to support a robust and growing DW market. However, a reliable wind resource does not fully explain the history of DW distributed wind projects in the U.S. For example, the Midwestern states of North Dakota, South Dakota, Nebraska and Kansas have significant wind resources, but together these states presented a cumulative installed DW capacity of only 20.6 MW from 2003 to 2014 (U.S. DOE, 2015a). In North Dakota specifically, 75 percent of the state's net electricity generation comes from coal and 17.5 percent from wind. Iowa, which has a similar wind resource to North Dakota generates 27.4 percent of the states electricity from wind (EIA, 2016). A similar comparison can be made between Virginia and California. In 2014, only 6.4 percent of Virginia's electricity generation came from renewable energy, 75 percent of which was from biomass. In the same year, California generated 6.6 percent of the state's electricity generation from wind. This trend suggests that policies, financial incentives, and renewable energy portfolios are a necessity for creating sustained and substantial DW project growth.

Like federal policies and financial incentives, state policies and incentives have significantly shaped the DW development throughout the country. In 1999, only 25 states had financial incentives for distributed wind development. Except for California which offered a rebate, and Illinois which offered a rebate and tax incentive, the remaining 48 states offered only tax incentives (Rhodes-Weaver et al., 2011).   Over the next 11 years, the policy landscape for DW continued to shift. In 2010, 17 states had tax incentives whereas 23 states had rebates or performance incentives. Additionally, eight states were operating grant programs for distributed wind development. During this time, California lead the way in providing incentive funding with $8.6 million going to DW development projects with a cumulative capacity of 3.7 MW (Rhodes-Weaver et al., 2011). Currently thirty states have favorable policies and incentives for distributed wind, including rebates and tax incentives, loan and grant programs, permitting policies, small wind ordinances, and favorable net metering policies (U.S. DOE, 2015b).

Some of the most successful programs to enhance DW development have been state rebate programs. These programs provide upfront funds to cover project development and construction costs. One example of a successful state rebate program for DW is the Self Generation Incentive Program (SGIP) in California. Since 2002, this program has provided financial incentives for customers installing distributed generation technologies, including wind and solar. However, no DW wind project received funding from SGIP until 2005, when two DW projects were completed with a combined capacity of 1.6 MW. By 2013, 20 DW projects representing 23.7 MW of installed wind capacity had received rebates from the SGIP program (California Public Utilities Commission, 2016).

Some states have begun to offer sales tax and property tax reductions for DW systems. In order to help make wind projects financially competitive, many states, including Minnesota, have implemented a sales tax incentive in which 100 percent of the sales tax for any wind energy project or materials used to manufacture, install, or repair wind energy systems is covered (U.S. DOE, 2015b). Similarly, property tax incentives have had a significant impact on promoting the development of DW projects. Since adding a wind turbine to a property could significantly increase the value of the property, property tax exemptions have allowed landowners to avoid incurring additional costs. Some states and counties have implemented property taxes and payments-in-lieu-of-taxes (PILOT) programs in which landowners do not pay property taxes but instead make separate payments to the local tax authority (DWEA, 2015). These programs have removed some of the economic burden from the property owner while still enabling communities to benefit from the development of a wind energy project. Other states, like Minnesota, have created property tax exemption based on the project size, where properties less than 250 kW in capacity are completely exempt and larger projects are taxed according to the scale of the project (U.S. DOE, 2015b). Twenty states across the country currently offer these incentives for distributed wind development (U.S. DOE, 2015b).

In addition to tax exemptions and rebate programs, several states are operating loan and grant programs for DW, some of the most successful of which have been revolving loan programs. A primary example of the success of these programs on DW development has been the Iowa Alternative Energy Revolving Loan (AERL) program. Since 1996, the program, which offers 0 percent interest loans for up to 50 percent of the renewable energy project costs, has been used to fund 47 small wind (less than 20 kW) and 115 large wind projects (Iowa Energy Center, 2015). Since the loans are repaid, the AERL program is able to use the funds for continued support of additional renewable energy projects. The LoanSTAR Revolving Loan Program in Texas has also been successful in providing funds for renewable energy projects, including wind (National Association of State Energy Officials, 2013). Lack of statewide and countywide permitting policies, wind ordinances, and net metering policies has been a historical and significant barrier to DW development. In recent years, states have taken steps to mitigate this barrier by implementing standard permitting rules, model wind ordinances, county wind ordinances, and net metering legislations. These rules have helped to reduce construction time for DW projects.

Renewable portfolio standards (RPS) are regulatory mandates to increase a state's renewable energy production (NREL, 2015). These standards have had a direct impact on improving the environment for distributed wind generation in the U.S. By 2010, 29 states had passed an RPS, including Virginia which specifies a goal of 15 percent of electricity generation using the base year of 2007 to be met by renewable energy in 2025 (U.S. DOE, 2015b). Many of these policies contained specific requirements for distributed energy generation. For example, in 2004 the state of New York established an RPS with the mandate that 25 percent of the state's electricity generation would come from renewable sources by 2013 (U.S. DOE, 2015b). To support this program, the state implemented a significant rebate program to provide funds for renewable energy development. As of 2015, the number of states with an RPS had increased to 37, further helping to improve the environment for DW development (U.S. EPA, 2015). Additionally, the U.S. Environmental Protection Agency's (EPA) Clean Power Plan represents a historical shift in U.S. policy favoring the development of renewable energy projects. As part of the EPA's policy, each state is required to submit a plan to the EPA by 2021 for the reduction of CO_2 emissions (U.S. EPA, 2015). While the policy does not require states to implement an RPS, the Clean Power Plan encourages states to improve or create RPS mandates. As a result, the Clean Power Plan represents a significant opportunity and push for DW development throughout the country.

Some states, like Iowa, which have favorable state policies and incentives for wind, have grown a robust and thriving distributed wind industry by taking advantage of the federal USDA REAP loans and grants. As much as $741,972,182 in REAP funding was used to supported 647 wind projects throughout Iowa (USDA, 2014). Currently, Iowa has the highest electricity generation from wind, with 27.4 percent of the state's net electricity generation coming from wind. Additionally, the state has the third highest total wind capacity in the U.S. at 5,177 MW (U.S EIA, 2014). The success of distributed and utility-scale wind in Iowa can be attributed to the state's renewable energy portfolio, tax incentives for wind energy development, strategic use of REAP funding, and strong connections with Iowa State University, the Iowa Farm Bureau, the

Iowa Area Development Group, and the Iowa Economic Development Authority (DWEA, 2012). Overall, the history and growth of DW in Iowa may prove to be a valuable case study for the state of Virginia, as the Commonwealth looks to stimulate the wind industry and produce 25 percent of the state's energy from alternative sources by 2025 (DMME, 2015).

The DMME Project

In response to the goals set by the Virginia Energy Plan of 2014, DMME began seeking out ways to increase the total amount of electricity that is being produced from alternative sources. With only 5.1 percent of electricity being produced from alternative source at the end of 2014, Virginia needs a five-fold increase in the amount of alternative energy production by 2025. Programs in several states, such as Iowa and Minnesota, provided valuable models for program structures that may prove successful in Virginia. The following literature review discusses the current state of electricity generation in Virginia as well as some models and tools that were found to be beneficial throughout the project development process.

Literature Review

Goals for Wind Power in Virginia

Electricity generation in Virginia is currently heavily dependent on fossil fuels and nuclear; however, there is now a push for policy initiatives in the Commonwealth to support indigenous and cost-effective renewable energy projects (DMME, 2014). The 2014 Virginia Energy Plan provides a comprehensive overview for the projected future of energy policy in the state. Currently, 5.1 percent of the electricity generated in Virginia is from renewable resources (DMME, 2014). The voluntary renewable energy goals in Virginia call for 15 percent of 2007 baseline electricity production to come from renewable energy sources. It is estimated that onshore wind resources in Virginia have the capacity to produce 1,793 MW of electricity at a hub height of 80 meters (DMME, 2014). Wind power development will likely play a critical role in providing Virginia with cost-effective renewable energy.

Models for DW Development

Iowa is one state with significant wind resources and robust installed wind capacity that Virginia can use as an example for developing both distributed and utility-scale wind infrastructure. In 2013, Iowa was one of twelve states contributing to 80 percent of the nation's electricity production from wind. Iowa had the highest proportion of wind-generated electricity to total electricity generated, with 27.4 percent of the state's net electricity generation coming from wind energy (U.S EIA, 2014). Iowa's success in development of DW systems can be attributed to the state's renewable energy portfolio, tax incentives for wind energy development, Rural Energy for America Program (REAP) funding, and strong connections with Iowa State University, the Iowa Farm Bureau, the Iowa Area Development Group, and the Iowa Economic Development Authority (DWEA, 2012). From 2003 to 2013, REAP investments were applied to 258 wind development projects in Iowa. Further, the success of DW in Iowa has contributed to the public's acceptance of utility-scale wind projects (MidAmerican Energy, 2015). As Virginia looks to develop land-based and offshore wind infrastructure, the Commonwealth may be able to utilize a similar DW development approach as Iowa.

Another state leading the nation in DW development is Minnesota. Like Iowa, Minnesota has developed policies that support the development of wind energy infrastructure. These policies include a renewable energy portfolio specifying that 25 percent of electrical utility sales will come from renewable energy by 2025 and tax incentives for wind development projects. Further, the economic costs associated with carbon emissions for new electricity generating projects has been considered, which has helped to make wind economically competitive with conventional electricity generating facilities such as coal or nuclear power plants (Minnesota Department of Commerce, 2014). Additionally, the state has taken specific action to develop

DW projects with tariffs, microloan programs, tax exemptions, and favorable local large and small wind ordinances (Minnesota Department of Commerce, 2014). Like Iowa, REAP funding has played a critical role in the development of DW in rural Minnesota (USDA, 2012).

The Minnesota Flip business model for distributed wind development has also been successful in reducing the capital investment burdens for local landowners developing wind power. In this model, local investors provide the land and necessary support for project development up to the installation phase. Next, an investor provides the necessary capital for the installation, and the commissioning of the wind power project. Until a designated time or amount of profit is reached, the capital investor maintains ownership of the project. After this point in time, the ownership is "flipped" back to the local land investors (Orrell et al., 2013).

Other business methods for DW development include cooperative- and municipal-owned project development models. In the cooperative business model, community members that would be receiving electricity from the wind power plant provide the capital investment for the project and thus all share ownership in the project. This model can be beneficial in that it enables people to fully and actively participate in the project development project. However, this model also necessitates that the community members become responsible for both the success and failure of the project (Harper, Matthew, & Bolinger, 2007). In municipality-owned projects, the local government owns and controls the wind power plant. In this model, the community members receive several economic benefits resulting from not having to invest their own capital in the project and lower consumer costs due to the tax-exempt nature of the project (Harper, Matthew, & Bolinger, 2007). The Minnesota Flip, cooperative, and municipal-owned business models may all be viable options for DW development in cities and towns throughout the Commonwealth.

Financial Incentives

Several policies and programs have been implemented in Virginia to enhance the development of renewable energy projects throughout the state. Federal tax credits for renewable energy projects have had the effect of reducing the levelized costs for solar and wind projects. For example, wind and solar projects that are in service by the end of 2016 will receive a thirty percent investment tax credits for capital investments. After 2016, this incentive will be reduced to ten percent (U.S. DOE, 2015). The Commonwealth has also taken action to streamline the permitting process of smaller-scale renewable energy projects through the Regulatory Advisory Panel for wind energy, which came into effect in 2010.

A nationwide incentive for enhancing renewable energy development and energy efficiency measures is the Rural Energy for America Program (REAP). This program, which is supported by the USDA, provides guaranteed loans and grants to eligible agricultural producers and small business in rural areas to implement renewable energy or energy efficiency projects (2014). For renewable energy projects, REAP loans, grants, or loan/grant combination are available to support up to 75 percent of total project costs. REAP loans are available for $5,000 to $25 million and REAP grants for renewable energy projects are available for $2,500 to $500,000 (USDA, 2014). The primary economic benefits from REAP for agriculture producers and small businesses is the opportunity to obtain higher loan amounts, lower interest rates, and longer loan repayment periods as compared to other loan programs (USDA, 2014). Further, REAP offers a cost-effective way to implement renewable energy projects, such as DW projects.

The 2014 amendments to the Farm Bill provided $880 million for energy programs to expand the 2008 Farm Bill. These amendments include improvements and continued funding for the REAP program as well as fund reallocation, making REAP the top funded program in the

Farm Bill. There is now mandatory funding of $50 million per year from 2014-2018 with an additional $100 million in discretionary funding for this period. The REAP application system was also reformatted by these 2014 amendments to create a three-tier system based on the total cost of the proposed project. Projects costing $80,000 or less will undergo a less complex application process while projects over $200,000 will have the most complex application (Flack, 2014).

Research Tools and Resources

At present, a variety of tools is available to assess the viability of potential sites for wind power development. The Center for Wind Energy at James Madison University has developed several tools and resources for assessing potential sites throughout the Commonwealth. These tools include GIS-based tools, wind measurement systems, computer modeling and analysis software, siting instruments, and educational and community outreach tools (CWE). Through the implementation of these resource and outreach tools, the CWE has identified several counties throughout Virginia with favorable conditions for DW wind projects.

Distributed Wind Assistance Program

Establishment

As the demand for on-shore wind energy development in Virginia has grown, the Center for Wind Energy (CWE) has worked to identify target groups of landowners that may be responsive to this need. In June 2015, the CWE presented nine target sectors to Virginia's Department of Mines, Minerals, and Energy and requested funding to begin seeking interested landowners from within these sectors. As a result, the Center for Wind Energy was contracted to work directly with DMME toward this goal. The CWE enlisted the authors of this document, Kayla Cook and Sydney Sumner, as ISAT senior capstone students to address this effort. The goal of the effort overall was to identify one applicant for state revolving loan funds who wished to develop a distributed wind energy project with DMME support, to present a model for this wind sector as a means to advance growth of renewable energy throughout Virginia. As a result, the Distributed Wind Assistance Program (DWAP) was formed.

Goals

In the Virginia Energy Plan of 2014, Recommendation 5-C called for the creation of "flexible financing mechanism to help put in place key additional energy assets and support priority energy programs" (VEP, 2014). In order to meet this recommendation, DMME established two separate programs that would provide these financing mechanisms. The first is the Virginia Saves Green Community Program (www.vasavesgcp.com). This program is open to private commercial and industrial borrowers who are installing wind systems on their land, as well as non-profit institutions and local governments within Virginia. The second program developed by DMME is the Virginia Revolving Loan Fund, which seeks to distribute low interest loans to state and local governments, investor owned utilities, electric cooperatives, and municipal utilities. This funding can continually recycle and benefit multiple projects, but the goal of this project is to help establish the pilot project to begin using these revolving loan funds toward DW projects.

The DWAP worked in conjunction with DMME, the CWE, and the JMU capstone students to bring information about distributed wind energy to Virginia landowners in the targeted sectors. The nine target sectors that our team identified as presenting the greatest potential for development of DW are: (i) agricultural lands, facilities, and businesses (ii) rural small businesses (iii) large industrial sites (iv) state facilities and properties (v) abandoned and reclaimed mine lands; (vi) planned urban developments; (vii) remote and/or isolated residential communities (viii) private colleges in Virginia; (x) correctional facilities.

The DWAP aimed to find qualified applicants from the nine target sectors to undertake projects that would successfully utilize this funding and serve as pilot projects for the state of Virginia. By seeking applicants from each of the nine sectors, potential projects would help encourage the growth of distributed wind across a wider variety of landowners. Overall, this program was created to disseminate information about distributed wind and available DMME funding to potential hosts with the objective of selecting one to four potential applicants, the owners of which to continue working directly with DMME and the CWE to install a distributed wind project on their land.

Program Design and Implementation

Targeted Outreach

In order to reach potential site hosts in each of the nine target sectors, all available contact information was collected for winery and brewery owners, school superintendents, environmental non-profits, farming organizations and landowners who had expressed an interest in distributed wind in the past to the CWE.

An informational summary document on distributed wind was developed as well as a cover letter explaining the DWAP program and a brief application document. Two distributed wind case studies were also provided to give potential applicants a general idea of what type of system might be applicable through this program (see Appendix A-E to view these documents). These documents were distributed in a direct e-mailing from the Center for Wind Energy initially on September 21, 2015. This e-mail was circulated to professors at Virginia Tech in the College of Agriculture and Life Sciences who are involved with the Virginia Cooperative Extension. This allowed the application to be forwarded to smaller farm owners associated with this organization. Overall, this initial e-mail was sent to more than 700 landowners in Virginia.

In order to provide more information on the program and answer any basic questions regarding distributed wind, an informational webinar was conducted by the Center for Wind Energy along with DMME and Sustainable Energy Developments Inc. (SED). SED is a solar and wind installer based out of Rochester, New York. The webinar offered basic background information on distributed wind, the DWAP, and the Center for Wind Energy. Representatives from DMME also explained the funding opportunities for distributed wind systems. A representative from SED discussed examples of how businesses, farmers, municipalities, and others use wind to power their facilities as well as the development process associated with installing a wind turbine. The entire presentation from this webinar is available in Appendix F.

In addition to online efforts, a call list was generated for wineries and breweries that had expressed previous interest in pursuing a distributed wind system. The capstone students reached out to all of these organizations to provide more information about the DWAP and the application process. A second round of e-mails was also sent to all potential interested parties prior to the registration end date for the program.

Application Evaluation

Following the outreach efforts conducted by the CWE, eleven fully responsive applications were received for the program. The applications were submitted by organizations represented several of the different key sector areas identified at the beginning of the project, these included vineyards, agricultural producers, rural small businesses, fisheries, K-12 schools, state properties, private residences, and environmental education centers. Additionally, applicant properties were located throughout the Commonwealth, representing ten counties including Carroll County in Southwest Virginia, Prince William County in Northern Virginia, and Accomack County on the Eastern Shore.

It is also important to note that several of the applicants were found to be eligible for REAP funding; this helps to enhance the economic feasibility of these potential DW projects and the potential numbers of projects that could be implemented. Two other applicants, Wintergreen Resort and Chatham Vineyards, were in discussion with the CWE about the program, but decided to not apply. Wintergreen Resort determined that their project would not come to fruition in an appropriate timeframe for this project. Chatham Vineyard was not able to complete an application in time and ultimately decided that this program did not fit with their company goals. Basic information on the official applicants follows.

Table 1. DWAP Applicant Summary

Applicant	Location	Intended Project Use
Abundance Farm	Charlotte County	Power for farm needs
Beegle Landscaping	Floyd County	Power for a residence and two small businesses
Bradford Bay Farms	Accomack County	Power filtration system pumps
Brightwood Vineyard and Farm	Madison County	Power farm and education
Catawba Sustainability Center	Roanoke County	Power facility and education
Chesapeake Bay Foundation	Accomack County	Peak load power and education
Fancy Gap Elementary School	Carroll County	Power school and education
Fidelis Farms and Vineyards	Albemarle County	Power hydroponic greenhouse
Meadowlark Farm	Fluvanna County	Power for farm's water supply
Prince William County Landfill	Prince William County	Power operations and education
Tangier Island Resident	Accomack County	Power home

Abundance Farm is located in Charlotte County and has a projected wind resource of 4.00 m/s at 50 meters. This location would use a DW turbine to power their farm needs. Brightwood Vineyard and Farm in Madison County is a small, sustainable family farm in Virginia's northern piedmont. This site would use a DW turbine for both electricity and educational purposes and has a projected wind resource of 3.32 m/s at 50 m. Bradford Bay Farms also applied to the DWAP program and is located in Quinby on the Eastern Shore of Virginia. This aquaculture farm has a 50-m projected average annual wind speed of 5.52 m/s and would produce energy to power their filtration system pumps that run constantly. Fidelis Farm and Vineyards, located in Crozet, is exploring sustainable farming practices, such as the installation of a hydroponic greenhouse. The wind speed for Fidelis Farm is projected to be 3.69 m/s at 50 m/s.

The Catawba Sustainability Center is a 377-acre property in the Catawba Valley that serves as a living laboratory for research and demonstration of sustainable practices in land management. The Catawba Center has an estimated wind resource of 3.63 m/s at 50 m. The Chesapeake Bay Foundation also submitted an application for their site on Port Isobel to provide peak load relief for Tangier Island and to serve as an environmental education center. This location has a wind resource of approximately 6.90 m/s at 50 m. An application was also received from a resident of Tangier Island on the eastern shore of Virginia. This location has a projected wind speed of 6.90 m/s at 50 m.

Beegle Landscaping is a small business located in Floyd County that has a predicted wind speed of 4.51 m/s at 50 m. The purpose of this project is to provide power for a residence and two small businesses located on the property. This location has a wind speed of 4.51 m/s at 50 m. The Meadowlark Farm School also applied for this program. Meadowlark, located in Fluvanna County, has a predicted wind speed of 3.95 m/s. The purpose of this project is to power the farm, more specifically the farm's power supply. Representatives from the Prince William County landfill also submitted an application to the DWAP program. This land is located near a school, so this project would be intended to power the site and create an educational program for nearby students. The map presented in Figure 5 depicts all sites for which applications were received, and also features Wintergreen Resort and Chatham Vineyards, the two sites for which inquiries were made. These two sites were involved in the DWAP application process but did not complete applications as their project goals did not fit the goals associated with the DWAP.

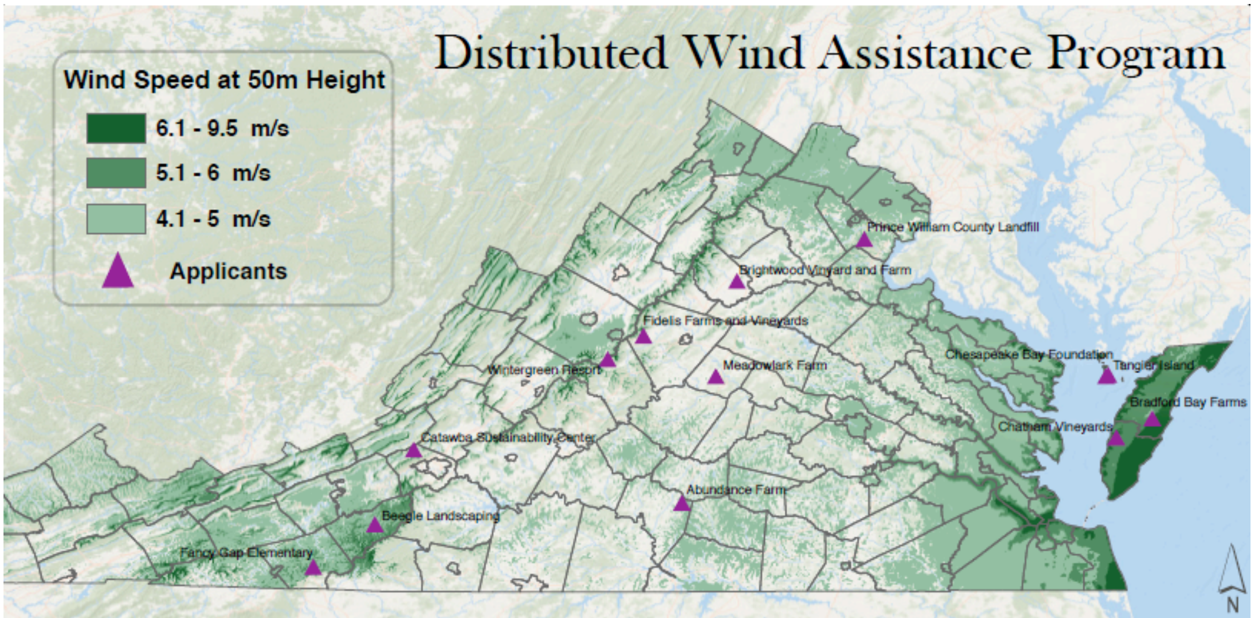

Figure 5. Map of DWAP applicants and 50-meter projected wind speed (Created by Phil Sturm, CWE)

All applicants were evaluated on a specific set of criteria based on the goals of DMME and CWE, as previously defined. First, the application was checked for responsiveness and awarded two points if all elements were complete. Next, the viability of the wind resource was estimated based on review of existing wind maps. This scoring element was determined based on a desktop analysis completed by the Center for Wind Energy that predicted the average annual wind speed at 50 meter elevation at each site. Wind speeds were scored according to the scheme provided in Table 2.

Next, the ordinance for each county from which applications were received were researched. If there was a local wind ordinance that related to the site, the applicant was awarded ten points. The accessibility of each site was also evaluated on a scale of 1 to 8, as determined based upon the site's location relative to a major highway and paved roads. A score of an 8 would be awarded to a site that was located adjacent to a highway while a score of 1 would be awarded to a site that was not accessible by road.

Table 2. DWAP points awarded based on projected average annual wind speed at 50 meters.

50m Wind Speed (m/s)	Points Awarded
7.5 and above	10
6.5-7.49	9
5.5-6.49	8
5.0-5.49	7
4.5-4.99	6
4.0-4.49	5
3.5-3.99	4
3.0-3.49	3
2.5-2.99	2
2.49 and below	1

Sites were also evaluated based on the size of the property and the topography of the area. This scoring element was ranked between 1 and 5, with a 1 representing a small site that contains many hills or is densely populated with trees, and a score of 5 representing a large, open, flat space where a turbine could be readily installed. Applications were also evaluated on the ability for a project to serve as a replicable model in Virginia. This scoring element was ranked on a scale of 1 to 5 as well. A project's value to the community was also evaluated on a scale of 1 to 5. A score of a five would be associated with a project that has an educational component or somehow contributes to the surrounding community, whereas a score of 1 would be assigned to a project that only benefits one individual or business. The visibility of the turbine and project was also evaluated on a scale of 1 to 5. This scoring element was based on the applicant's proximity to a major roadway as well as the applicant's social media presence. Applicants that received a 5 were located in a highly visible area and/or would have a social media presence that would allow the applicant to spread the news about their wind turbine if selected. Finally, all applicants were evaluated based on their willingness to share data and permit visitors. This scoring elements was evaluated between 1 and 5 and considered the use of the site as well as the applicant's answers to questions in the application. The total amount of points an applicant could accumulate was 55 points.

During this evaluation process, each applicant was sent a copy of the desktop wind speed analysis for his or her site. An informational document was also sent to help provide guidance on how to interpret the results of the analysis (See Appendix G). Figure 2 below shows an analysis representing a wind consultation for Bradford Bay Farms.

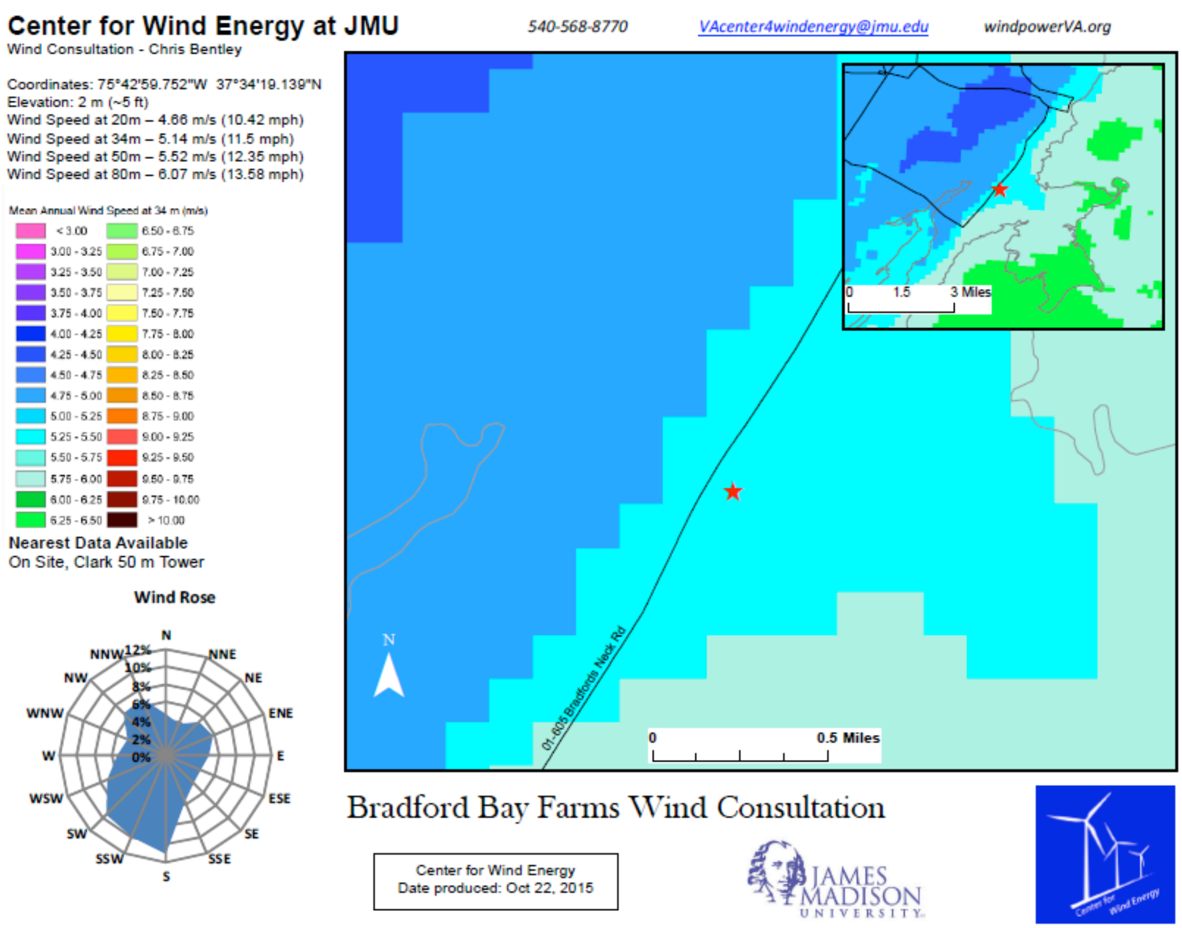

Figure 6. Wind Consultation Map for Bradford Bay Farms (Generated by Phil Strum, CWE)

Participant Selection

After the initial ranking of all applicants was completed, the four highest-scoring applicants were reviewed in greater depth by the Center for Wind Energy as well as DMME. The CWE conducted an initial screening to ensure that all scoring was accurate. One key factor of this evaluation was ensuring that the top candidates had a viable wind speed that would make a project feasible. These four candidates were unique in that each represented a different business sector: an environmental non-profit, an elementary school, a landfill, and an aquaculture site.

The Chesapeake Bay Foundation (CBF), a non-profit organization, has the highest-ranking project applicant. There are several reasons why this site is ideal for installing a pilot distributed wind project. First, renewable energy development aligns closely with the CBF's mission to preserve the environmental quality of the Chesapeake Bay. Additionally, this site also serves an educational facility, which means that the project will receive exposure from the variety of visitors to the site. The project could be incorporated into the CBF's educational mission. Finally, the CBF site had the highest projected wind speed based on preliminary desktop analysis, 6.9 m/s at 50 m. Some potential challenges for the CBF project are related to possible interconnection and accessibility concerns related to the isolated and remote nature of the site.

Fancy Gap Elementary School was the second highest-raking project applicant. This location also has adequate wind speeds to support a distributed wind project. Based on desktop analysis, the site has a projected average annual wind speed of 5.6 m/s at 50 m. Another positive attribute for this applicant is that the Center for Wind Energy already has a relationship with this school, which may aid in some aspects of project development. Additionally, the project is likely to create value for the community as it is an educational facility. Fancy Gap Elementary School is located in a county that does not have a small wind ordinance, which may create potential challenges for project approval. Further, the school board, and school boards, in general, do not typically have excess capital funds for new projects.

Bradford Bay Farms, an aquaculture facility, was the third-ranking project applicant. The Center for Wind Energy already has wind data collected from a meteorological tower that was previously located on this site. Based on desktop analysis, this site projects an annual average wind speed of 5.5 m/s at 50 m. Other positive attributes for this applicant are that the manager of the facility is keenly interested in DWAP and the site is eligible for REAP funding. The primary challenge of this project is that it is in a less visible, remote location; therefore, it may not be as well suited as a pilot distributed wind project. The site is also connected to two-phase power, which will limit the size of the turbine that can be installed. Connection to three-phase power would be costly due to the remote location of the site.

Another promising applicant for DWAP is the Prince William Country Landfill. The county plans to re-purpose the landfill property into an ECO Park and intends to include renewable energy as part of that effort. As a result, a distributed wind projected could be incorporated into the broader development goals of the county. This project site could also serve as an educational facility due to the presence of a school within a safe walking distance. Despite the positive attributes of this site, there is no wind ordinance in Prince William County, and the site has a very modest projected wind resource based on desktop analysis. Prince William County Landfill has begun consulting with an outside developer as well to begin moving forward with their project.

These four applicants were each sent a letter indicating that they would be eligible for consideration for revolving loan funds. The remaining seven applicants were each sent a letter notifying them that they were not eligible for such consideration. This letter also noted that the CWE would be willing to offer further assistance to these applicants if they remained interested in pursuing the possibility of wind energy on their site without DMME support. Examples of these letters may be found in Appendix H.

In-Depth Site Analysis

After receiving notification of their program status, the four highest-scoring applicants responded to the Center for Wind Energy and expressed interest with continuing to move forward with their respective projects. Each project has begun to advance at a different rate, with Prince William County Landfill and Bradford Bay Farms each reaching out to development companies to begin examining options. Of these two, Bradford Bay has made the most progress and was selected as the site that would receive a separate in-depth site analysis. This analysis involved an on-site visit and the development of a case summary that can be distributed to landowners who may be interested in pursuing a distributed wind system.

This in-depth analysis considered the potential cost and payback period for either a 100-kW or 50-kW DW system at Bradford Bay Farms. This specific analysis was conducted by SED using their payback models and cost estimates for each system. The on-site visit allowed the true energy load of the site to be determined and provided a clearer understanding of the environmental and energy goals the applicant is working to achieve.

Bradford Bay Farms Case Summary

Bradford Bay Farms is a fishery located in Quinby on the eastern shore of Virginia. Dr. Clark Norton, a medical doctor from California who wanted to create a sustainable fish farm to raise high quality sea bass, developed this fishery. Bradford Bay currently is implementing several sustainable energy solutions, such as the use of geothermal cooling and solar hot water heating. The building that contains the fishery and the solar collectors is seen in the image below. Chris Bentley, the current manager for the fishery, is committed to decreasing the environmental impact of the farm and in order to do so, he has collaborated with the Center for Wind Energy through the Distributed Wind Assistance Program.

Figure 7. Bradford Bay Farms Site and Solar Collectors

In 2009, Bradford Bay installed a meteorological tower to investigate the feasibility of installing a wind turbine on the site. The tower collected wind data for 3.6 years and showed that the mean wind speed at 50 meters on the site was 5.86 m/s with a standard deviation of 2.52 m/s. The full summary of the data collected from this tower may be found in Appendix I. At the time of this evaluation, there were very few turbines available that would be cost effective to install in this wind resource. As a result, the notion of installing a turbine was temporarily set aside.

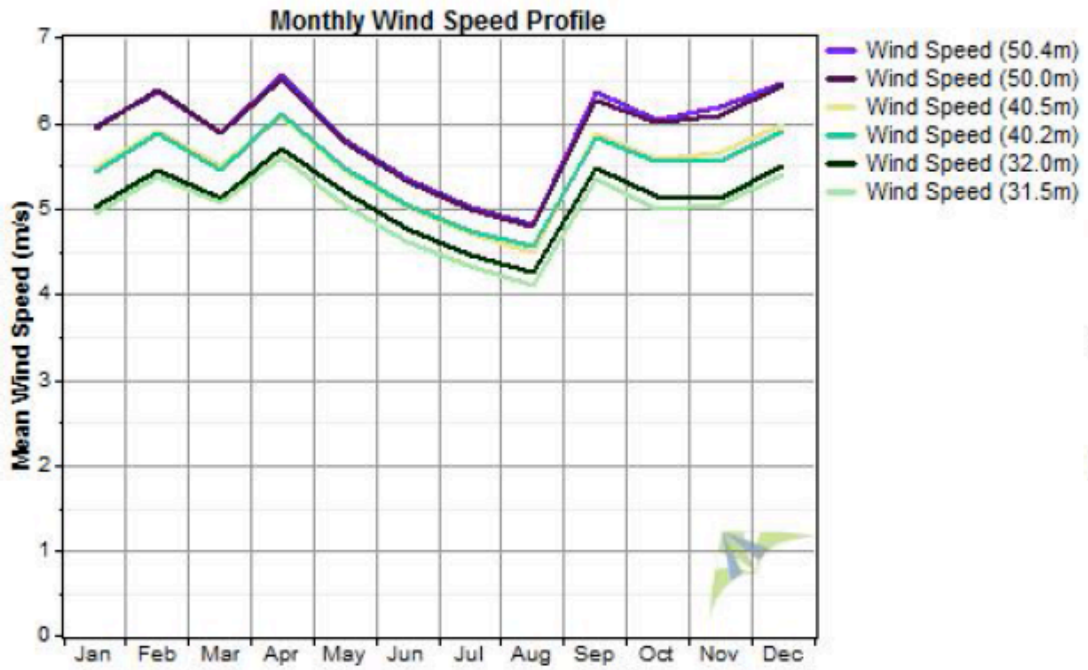

Figure 8. Monthly Wind Speed of Bradford Bay Farms

In order to continue to work toward their goal of being carbon neutral and as energy independent as possible, Bradford Bay revisited the idea of installing a turbine after receiving the information regarding the DWAP opportunity. Given recent technology improvements and available tax credits, they determined that it might now be possible to pursue the installation of a 100-kW turbine. After completing their DWAP application, the site was evaluated based on the scoring criteria previously described. The site earned a total of 42 points out of a possible 55 points. One potential challenge with this site is its remote location, which is a two-fold problem due to its poor visibility as a potential pilot project as well as accessibility challenges. The site is located in Accomack County, which does have a local wind ordinance and is expected to be generally accepting of a wind project given the precedent of a wind turbine in the neighborhood already being installed. The average annual wind speed, although not ideal, was determined to be sufficient to proceed with a project.

While the DWAP application process was still in progress, Bradford Bay began working with Sustainable Energy Developments, Inc. (SED), an alternative energy development company based in upstate New York that was serving as an advisor through the DWAP project. Bradford Bay worked directly with SED to begin developing a design for a project on their site. Initially, SED proposed a 100-kW Northern Power Systems NorthWind 100 wind turbine to meet a portion of the energy load at the site (See Appendix E for a case study on the NorthWind 100 turbine). However, in order to install a 100-kW turbine, electrical service at the site would need to be upgraded from two-phase to three-phase. Bradford Bay Farms began working with their electricity provider, A&N Cooperative, to discuss the feasibility of making this upgrade. It was estimated that the power company would need to connect to three-phase service that was more than 1.5 miles away. The site and A&N investigated the Rural Economic Development Loan & Grant Program (REDLG) as a way to connect to three-phase power through funding from this program. Unfortunately, it was determined that because the three-phase connection would only benefit one user rather than a community, the project was not applicable for REDLG funding. As a result, the site would have to pay approximately $200,000 out of pocket to upgrade to three-phase power.

Bradford Bay Farms determined that the upgrade to three-phase power was not a possibility due to the high cost and is now exploring a new option with SED. The site is investigating a combined system that utilizes a 50-kW Endurance wind turbine coupled with between 50 and 100 kW of solar PV. This system could effectively operate using two-phase power and offer the benefit of a hybrid system that could generate more wind energy in the winter months and more solar in the summer months. The full project proposal from SED may be found in Appendix I.

The energy load for Bradford Bay is consistent due to the nature of their systems and insulating methods. Bradford Bay uses a recirculating aquaculture system that uses a significant portion of the site's energy to run the pumps, filtration systems, and water and heating cooling systems. The recirculating system allows the several different fish holding tanks to have water continuously pumped through each tank but in such a way that the water can be treated and recycled through the system. Pictured below is one of the more energy-intensive filtration devices. This device is a motorized 55-µm drum filter that receives water from the fish holding tanks. The device operates for approximately 15 seconds at a time and turns on every minute.

Figure 9. Motorized Drum Filter

Bradford Bay Farms has already taken several steps to reduce on-site energy use. All of the tanks must be maintained at a certain temperature, and in order to help do so the tanks are stored in insulated rooms made from R-13 Fiberglass Insulation with a moisture control layer on top to keep the insulation from breaking down. Some of the newer rooms used to raise ornamental fish were created from sheets of insulation expected to have an R-value on the order of 15. This insulation is recycled from old Walmart building roofs. The image below shows the inside of one of these insulated rooms. Each room has two large tanks and there are currently four rooms in total, but not all are in use at present.

Figure 10. Insulated live tank room

In 2009, the annual energy usage on the site was 242.22 MWh, resulting in a cost of approximately $23,537. With a 50-kW wind turbine installed, it is expected that the farm could save on the order of $9,259 in energy savings for the farm from the first year alone. Based on SED's model, this site could expect to see a payback period of approximately 8.9 years with a 5-year average energy escalation or 10.63 years with a 10-year average energy escalation rate. This distributed wind effort, combined with the continued energy reduction efforts on site, would help increase the revenue for the site and allow a sustainable program to be developed. Bradford Bay Farms has also collaborated with the Virginia Seafood Agricultural Research and Extension Center (Virginia Seafood AREC) for nearly 12 years in order to maintain their facility, learn about new technologies, and solve any problems that may arise. The Virginia Seafood AREC would provide a useful resource to help establish Bradford Bay Farms as a successful distributed wind pilot project. The Virginia Seafood AREC works with many other fisheries and aquaculture facilities in the state, and internationally. This organization could thus serve as a resource to help educate other companies in this field about the benefits of distributed wind. Overall, Bradford Bay Farms is a forward thinking organization that is already taking steps to decrease their carbon footprint and utilize alternative energy sources. The company intends to begin installation of a 50-kW turbine on their site prior to the end of 2016, upon completion the site will serve as an excellent model for how distributed wind can be implemented in Virginia.

Conclusions

Successes

The primary objective of this project was to create interest in DW throughout the Commonwealth and to select a high caliber applicant to receive funding for the project through DMME's revolving loan program. The program was successful in meeting the stated objective as indicated by the number of applicants to the DWAP program and the diversity of locations of these applicants throughout the Commonwealth. The selected applicants represent several of nine key development sectors identified as having strong potential for DW development. Each of these sites, Chesapeake Bay Foundation, Fancy Gap Elementary School, Bradford Bay Farms, and Prince William County Landfill, offers a unique and important opportunity to advance DW development in Virginia. Furthermore, Bradford Bay Farms appears to be an excellent candidate for a pilot distributed wind project in Virginia due to the company's dedication to energy efficiency and renewable energy technologies, excitement about distributed wind energy development, and willingness to work with the CWE, SED, and DMME to move forward in the development process.

Limitations

While DWAP was a strong initial program to identify a pilot project to advance DW in Virginia, implementation of the program highlighted three limitations that restricted the overall effectiveness of the program. These limitations relate to the program's limited marketing, the large number of target sectors selected as priorities for the program to reach, and the short time frame over which the program could be implemented.

First, the limited marketing campaign conducted for the DWAP may have systematically excluded some highly eligible properties for inclusion in the program. This is particularly the case for the target sectors of agricultural lands, rural small businesses, abandoned and reclaimed mine sites, planned urban developments, and isolated or remote residential communities. With respect to agricultural lands, applications for the DWAP were only disseminated to a small selection of landowners throughout the state. Abandoned and reclaimed mine sites and planned urban developments were not explicitly included in the DWAP outreach efforts. Similarly, due to the large number of target sites identified by the project and the large number of targets sites actively pursued by the project in the advertising effort, the advertising materials were not specific to each sector. This could have influenced the decision of landowners in certain sectors to apply. Also, since the program was tailored to reach as many potential applicants as possible, no prior screening for wind resource availability was done before the application materials were distributed. As a result, several applicants who applied to the program had sites that did not have adequate wind speeds to support DW development. Despite having a poor wind resource, these sites may have potential for solar development or a smaller scale wind project.

The third limitation associated with this program is the selective preference for project applicants most prepared and willing to move forward with the project development process. The project was time-sensitive due to the desire of DMME to offer loan funding and execute a pilot project quickly. Future efforts to advance DW in Virginia may benefit from a longer advertising effort and longer project development time in order to include high caliber applicants with strong wind speeds interested in DW.

Future work

Over the course of the past year, the development and implementation of the DWAP has laid the foundation for the advancement of DW in Virginia. Future work on this project will include a continued partnership with the CWE and Bradford Bay Farms as the landowners move forward in developing the installing their DW system. Additionally, the CWE will continue to work closely with the other selected applicants as they continue to explore the possibility of installing a DW system on their property.

While the project was successful in identifying four potential projects to receive loan funding from DMME, the project was not without its shortcomings. Most notably, future work on this project will include developing and implementing a larger-scale DWAP with a multi-tiered marketing approach. Additionally, this future effort will be aimed specifically at rural wind energy development. This strategy will first help ensure that a greater number of applicants with strong wind resources are reached. Target marketing materials will be sent to the agricultural, rural small business, and rural community sectors. Further, the specific focus on rural wind energy development will enable the state to most effectively leverage REAP funding for DW project development.

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JAMES MADISON UNIVERSITY

September 21, 2015

To Whom It May Concern:

The Center for Wind Energy at James Madison University in cooperation with the Virginia Department of Mines, Minerals, and Energy (DMME) is inviting applications for technical support and a low-interest loan for installation of an intermediate-sized, distributed wind turbine. A distributed wind (DW) turbine can range in size/capacity from 5 kilowatts (kW) turbine at a residential or agricultural site to a megawatt-capacity system at a commercial facility. The U.S. Department of Energy classifies wind systems as distributed according to two factors: proximity to end-use and point of interconnection. Distributed wind systems are installed at or near the point of end-use and are connected to the customer side of the electric meter. More information on the classification of DW can be found in supporting documents provided with this letter.

Distributed wind has been successfully implemented and utilized in a variety of settings including homes, schools, farms, businesses, communities, and remote locations. One example can be seen in Linden, Iowa at a hog farm where a 50 kW turbine operates. As utility prices have increased in the area, this turbine has provided more stable and predictable energy costs for the farm. In Cascade, Wisconsin, the local municipal wastewater treatment facility has installed two 100 kW turbines. This system generates enough electricity to power 28 homes, which is more than the demand of the plant. With the current generation levels, the facility estimates that the turbines will have a 12 year payback period. Full case studies on these two programs are also included in this packet.

In order to advance the DW market in Virginia, the DMME is offering loan(s) with very generous terms for the purchase and installation of DW system(s) at appropriate sites. In order to receive technical assistance and to be considered for this loan, interested parties must complete and submit **by October 9, 2016**. For more information, please contact Dr. Jonathan Miles at 540.568.8770. Thank you for your consideration and for your interest in advancing clean, renewable energy in Virginia.

Sincerely,
Jonathan J. Miles, Ph.D

Jonathan Miles, Ph.D.

Director

Remy Pangle

Associate Director,

Curriculum Coordinator

Phil Sturm

Project Facilitator

540.568.8770 (office)

540.568.8795 (fax)

http://wind.jmu.edu

VAcenter4windenergy@jmu.edu

1401 Technology Drive

Suite 120

Rooms 1161–1173

Virginia Center For Wind Energy
at JAMES MADISON UNIVERSITY

Is Distributed Wind Right For Me?

Why Wind?

In 2014 the Commonwealth of Virginia published a new Energy Plan through the Department of Mines, Minerals, and Energy (DMME). This plan outlines the future development of Virginia's energy sector. A major component of the plan is the development of renewable energy infrastructure, which includes wind energy. It is estimated that Virginia has an onshore wind resource potential of 1,793 MW.[1] The development of distributed wind (DW) energy systems will play a role in achieving the Energy Plan goals and in providing clean, reliable, and cost-effective electricity production across the Commonwealth.

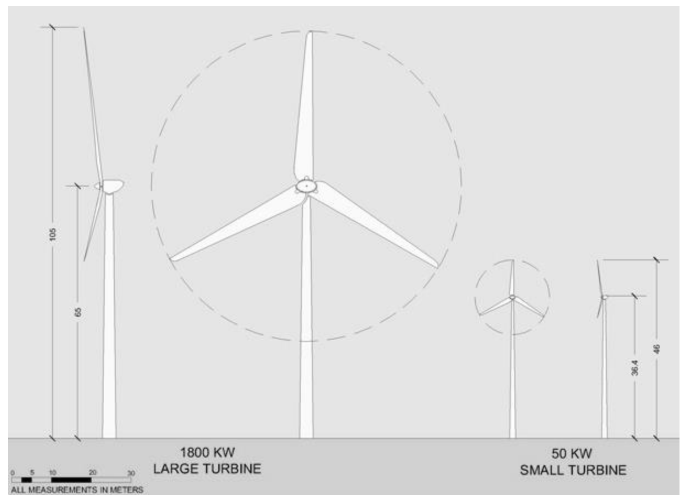
What is Distributed Wind?

Distributed generation describes the phenomenon of electrical power generation occurring in close proximity to where the power is consumed. Distributed generation systems are typically smaller than centralized power plants and offer several advantages, including decreased energy loss during transmission and reduced load on utility transmission and distribution lines. Distributed wind (DW) is a type of distributed generation.

The U.S. Department of Energy (DOE) defines DW systems using two criteria: proximity to end-use and point of interconnection. Wind turbines that are installed at or near the point of end-use and are connected to the customer side of the electric meter or directly to the local grid are considered DW systems.[2] Distributed wind turbines can power homes, schools, farms, or businesses.

How Large are DW Systems?

DW systems can vary in size, depending on the application; DW systems are not defined by turbine size alone. Smaller wind turbines, 5 to 50 kilowatts in capacity, are commonly used to create energy independence for households, farms, and other consumers. Projects up to one megawatt or more can be used to reduce energy costs for agricultural, commercial, or industrial facilities.[3]



Comparison of a 1.8 MW and a 50 kW Turbine.[4]

What Impacts the Success of DW Project?

Distributed wind energy systems can offset energy consumption at homes, schools, farms, or businesses; however, not every location is ideal for wind systems. Wind speed, tower height, and local ordinances are three factors that impact the feasibility of a DW project.

Wind Speed

Wind turbines capture the kinetic energy in wind and convert it into usable electrical energy. Higher wind speeds imply more energy available to be captured by a wind turbine. The greater the power output from the turbine, the better the return on investment.

Turbine Height

As height above the ground increases, wind speeds typically increase because air is less prone to friction forces from the ground and obstructions. Taller towers also allow wind turbines to avoid turbulence generated by ground-level obstructions. Turbines sited in areas of turbulent winds experience decreased performance.

540-568-8770 ***VAcenter4windenergy@jmu.edu*** ***wind.jmu.edu*** ***September 2015***

Local Ordinances

Localities may or may not have a wind ordinance. Without a wind ordinance, it can be challenging to acquire the permits necessary to install a DW system. Wind ordinances outline siting requirements such as those presented below:

- Zoning restrictions
- Height restrictions
- Noise limits
- Setback requirements
- Environmental considerations

Investigating the local zoning and permitting regulations is an important part of determining the success of a DW system.

WHAT FINANCIAL INCENTIVES EXIST FOR DW PROJECTS?

Several policies and programs have been implemented to enhance the development of renewable energy projects throughout the state. These measures include federal and state tax incentives, streamlined permitting processes, and loan and grant programs.

Tax Incentives

- Wind projects that are in service by the end of 2016 will receive a 30% federal tax credit for capital investments.[5]
- The Virginia Department of Mines, Minerals, and Energy offers low-interest loans for DW systems.

Permitting

- In 2010 Virginia introduced a Permit by Rule (PBR) for wind development, to streamline the small wind permitting process and enhance small wind development.[6]

Loans and Grants

- The Rural Energy for America Program (REAP), administered by the USDA, provides guaranteed loans and grants to eligible agricultural producers and small business in rural areas to implement renewable energy or energy efficiency projects. For renewable energy projects, REAP loans, grants, or a loan/grant combinations are available for up to 75% of the total project costs.[7]

ADDITIONAL RESOURCES

For more information about DW systems and wind energy in general, visit the resources below:

Center for Wind Energy at James Madison University

The CWE focuses on research, education, and outreach to advance wind energy deployment. The CWE website has resources from the National Renewable Energy Laboratory, the Department of Energy, the American Wind Energy Association, and the Distributed Wind Energy Association.
http://wind.jmu.edu/index.html

Distributed Wind Energy Association

DWEA is a collaborative group composed of manufacturers, distributors, project developers, dealers, installers, and advocates, whose primary goal is to advance the distributed wind energy industry. The DWEA website offers a variety of resources related to DW systems.
http://distributedwind.org

Office of Energy Efficiency and Renewable Energy

The U.S. Dept. of Energy's EERE website has an interactive graphic to explain how distributed wind works, specifically in relation to application in in the residential sector, the agriculture sector, and for schools.
http://energy.gov/eere/wind/how-distributed-wind-works

CONTACT INFORMATION

Jonathon Miles, Ph.D.
Director and RD&C Coordinator, CWE
540.568.3044 milesjj@jmu.edu

[1] Department of Mines, Minerals, and Energy. (2014). *Virginia Energy Plan.*
[2] Office of Energy Efficiency and Renewable Energy. *Distributed Wind.*
[3] Distributed Wind Energy Association. (2014). *What is Distributed Wind?*
[4] City of Calgary. (2012). *Comparing Different Types of Wind Turbines.*
[5] United States Department of Energy (2015). *Database of State Incentives for Renewable Energy and Efficiency.*
[6] Virginia Department of Environmental Quality. (2015). *Wind PBR Regulation.*
[7] United States Department of Agriculture. (2012). *The Impact of the Rural Energy for America Program on Promoting Energy Efficiency and Renewable Energy.*

DISTRIBUTED WIND ASSISTANCE PROGRAM Application

This program is intended to encourage and enable the installation of Distributed Wind turbines in Virginia. Each application will be evaluated and a preliminary assessment conducted. The most competitive applications will be further evaluated to determine project feasibility and eligibility for state and/or federal funding. Therefore, it is recommended to be as specific as possible when answering the questions in this application. **Applications must be submitted by 5:00 P.M. on October 9, 2015.** Please print and mail this completed application and any attachments to:

Center for Wind Energy
James Madison University
MSC 4905
1401 Technology Drive, Suite 120
Harrisonburg, VA 22807

Contact Information

(Who our office will be working through this process)

Last Name:

First Name:

Mailing Address:

City:

State:

Zip Code:

Home Phone:

Cell Phone:

Work Phone:

Email:

Preferred Method of Communication:

- ○ Email
- ○ Mail
- ○ Phone

Tell Us About Your Project

1. How would a distributed wind system benefit you/your business? What, if any, environmental or energy goals are in place?

2. Describe how the energy produced by a distributed wind system will be used on your site.

3. Please describe your site (amount of open space available, elevation of surrounding areas, obstacles of wind flow, level of development in surrounding area).

For questions, please contact:

Jonathan Miles, Ph.D
Director; Research, Development, & Commercialization Coordinator
James Madison University
MSC 4905
1401 Technology Drive, Suite 120
Harrisonburg, VA 22807
Phone: 540-568-8768
milesjj@jmu.edu

AGRICULTURAL

Rob Manning Installs Two E3120's on His Hog Farms to Lower and Stabilize Energy Costs

KEY HIGHLIGHTS

- Rob Manning operates two hogs farms in Iowa, where he enjoys reduced, stabilized energy costs due to his Endurance wind turbines
- Hog Farmers are large energy consumers because they need to regulate the temperature of their large housing units
- Rob Manning "I would do it all over again if I built another hog farm!"

In any business, let alone farming, a constant battle is waged to reduce fixed costs. Utility costs, specifically, have never been known to decrease; instead, climb forever upward. Next to feed, utilities are the farmer's highest cost.

When he began hog farming four years ago, Rob Manning's business consisted of two facilities, located in the towns of Linden and Dawson in Iowa. Each housed 7,200 hogs. Both facilities are required to maintain a moderate temperature that must be regulated year round so that the hogs can be kept warm during cold months and sheltered from high temperatures in order to prevent death from heat stress in summer months. These controlled tempera-tures help maximize the growth of the hogs; however they result in high electricity costs.

Rob's interest in wind turbines was kindled when he was contacted by

Don Van Howling, local owner of the Van Wall Group, which has as one of its divisions, Van Wall Energy. The Van Wall Group is the Midwest's leading supplier of sales and aftermarket support for agriculture, construction, and home equipment. Rob had been a customer of Don's for over 15 years, making Van Wall the main supplier for all his farming equipment needs. Van Wall had recently introduced the Endurance wind turbines through Van Wall Energy, and recommended these independent energy producers to help Rob offset his high energy costs. Aside from the reduction of energy costs, Rob also appreciated the turbines' ability to provide a measure of predictability and the stabilization of future energy costs in the face of ever-increasing utility prices.

Due to the amount of electricity consumed at Rob's sites, the most appropriate turbine for his applications was the Endurance E3120 50 kW. Jake West, the Wind Specialist from Van Wall Equipment, assisted Rob with everything from site assessment and financing for the project, through to the installation and maintenance of the wind turbines. Upon full completion of the installation, and connection to the utility grid, the turbines were commissioned in December 2010.

"Both wind turbines are working extremely well. They have been producing electricity for over a year, and their performance has been extremely promising. I am happy to say that my electric company is now paying me for the electricity that my wind turbines are producing! Thank you for developing such a wonderful product and for all of your support in getting the process completed. I would certainly encourage other hog owners to consider using this product to lock up their energy costs."

While both turbines are running effectively and providing energy savings, the unit in the Town of Dawson leads the way in energy generation, attaining record production figures twice in October - a daily production total of 1,970 kWh, and a monthly production total of 22,742 kWh. Combined, the two E3120`s have produced over 340,000kWh's in the first year of operation.

"I would do it all over again if I built another hog farm!" says Rob, expressing resounding confidence in the E3120 50 kW wind turbines, two undeniable examples of green energy in action on his properties.

VILLAGE OF CASCADE, WISCONSIN

MUNICIPAL WASTEWATER TREATMENT WIND TURBINE PROJECT

Why was the project initiated?

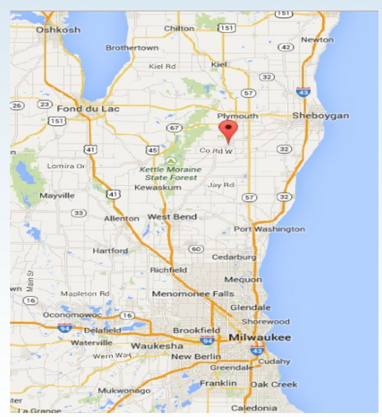
With a population of just over 700, Cascade, WI, doesn't have a great deal of money to spend. Couple this with rising energy costs, and the village was facing strain on their annual budget. The village needed to find a way of cutting annual costs. To do so, they turned to the wastewater treatment plant, the village's largest energy consumer. Costing Cascade approximately $30,000 annually in electricity costs alone, the wastewater treatment plants expenses accounted for a large proportion of the $330,000 annual village budget.

The solution to their problem came in the form of two 100kW NorthWind turbines. The turbines cost the village $906,000, including installation by Kettle View Renewable Energy, LLC. However, of this cost, Cascade paid just over half with the remaining amount supplied by We Energies ($150,000) and Focus on Energy ($250,000). The remaining portion of the turbines were paid by the village through reserves which will be paid back through electrical savings. The turbines installed are capable of generating enough energy to power 28 homes. This amount of electricity is greater than the electricity demand of the plant, allowing the village to sell any additional electricity produced back to the grid through We Energies. With this level of generation the village estimated a 12 year payback period.

What are the other benefits?

The benefits provided by the turbine installation aren't just financial. The project is further helping the community by being integrated into schools curriculum, allowing teachers and students can track the turbines real-time performance, outputs, and environmental offsets.

On top of the educational aspects, the project has also had substantial environmental benefits. With coal dominating the Wisconsin energy mix (62% in 2013), the emission free turbines reduce the villages carbon footprint by an amount equivalent to the emissions from burning 23,000 gallons of gasoline annually.



How is the project doing?

After deciding to install the turbines in 2009, the project came online July 2010, making it Wisconsin's first wastewater treatment plant to be powered by wind. In the four years since its commissioning, the turbine has reduced the city's energy costs by $100,751.

With a projected payback period of 12 Cascade has not performed as well as expected. Since beginning operation, the turbine has produced an average of 212,700kWh annually—84% of the estimated 254,000 kWh. If generation continues at the same rate as the first three years, the payback time is an estimated 18-19 years.

WINDUSTRY

Appendix F. DWAP Informational Webinar Slides

Distributed Wind Assistance Program
Informational Webinar

Center for Wind Energy, JMU

September 30, 2015

Center for Wind Energy

The Center for Wind Energy (CWE) focuses on research, education, and outreach to advance wind energy deployment, through projects that have local, regional, and national implications.

The CWE is hosted by James Madison University in Harrisonburg, VA and is supported by a director, full-time and part-time staff, and student interns who assist on several a range of projects.

The CWE will provides technical support, informational resources, site evaluations, and financial guidance to those who apply to the DWAP program.

Distributed Wind Basics

Distributed wind is defined by two criteria:

- Proximity to end-use: Installed at or near point of end-use
- Interconnection: Connected to the customer side of electric meter or directly to local grid

Diverse applications

- homes, schools, farms, industrial sites, commercial facilities, other

Not defined by turbine size

- DW wind turbine capacities can range between 50 kW and 1 MW

Taller towers minimize turbulence and expose system to higher wind speeds to maximize performance

The Virginia Energy Plan aims to produce 25% of Virginia's power from alternative sources by 2025

- at present, 5.1% of Virginia's energy is dereived from renewable resources (DMME, 2014)
- Virginia has an estimated wind potential of 1,793 MW at 80-meter hub height

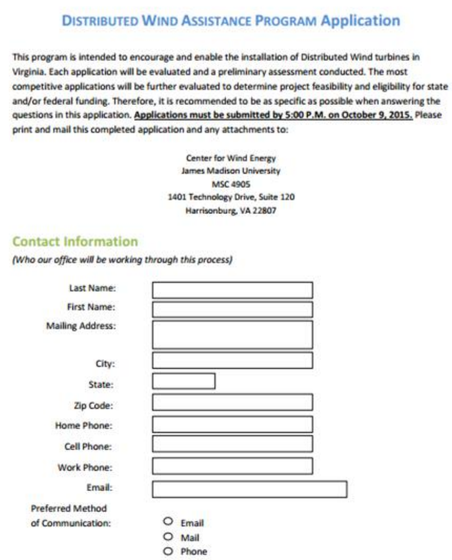
DWAP Application

General questions regarding:

- Contact person
  - Landowner
  - Use of land
  - Project location
    - Site information
    - Physical address

If you are interested in applying for multiple sites, please complete a separate application for each site

To receive the application, please email us at VAcenter4windenergy@jmu.edu.



Distributed Wind Assistance Program Application

This program is intended to encourage and enable the installation of Distributed Wind turbines in Virginia. Each application will be evaluated and a preliminary assessment conducted. The most competitive applications will be further evaluated to determine project feasibility and eligibility for state and/or federal funding. Therefore, it is recommended to be as specific as possible when answering the questions in this application. **Applications must be submitted by 5:00 P.M. on October 9, 2015.** Please print and mail this completed application and any attachments to:

Center for Wind Energy
James Madison University
MSC 4905
1401 Technology Drive, Suite 120
Harrisonburg, VA 22807

Contact Information

(Who our office will be working through this process)

Last Name:
First Name:
Mailing Address:
City:
State:
Zip Code:
Home Phone:
Cell Phone:
Work Phone:
Email:
Preferred Method of Communication:
○ Email
○ Mail
○ Phone

DWAP Estimated Timeline

Fri, October 9:	**Applications Due by 5 PM EDT**
Fri, October 16:	Completion of desktop wind resource analyses
Oct 16 to Nov 6:	Site Visits & Evaluations
November 16:	Applicants notified of selections DMME eligibility
November 16:	Detailed information distributed re: all funding mechanism available
November 30:	DMME Loan Application is due

Grant & Loan Opportunities

Virginia Department of Mines, Minerals, and Energy (DMME) Revolving Loan Program

- DMME is offering low-interest loans for DW systems
- The DWAP application and review process will enable consideration for a DMME Loan

Rural Energy for America Program (REAP)

- Provides guaranteed loans and grants to eligible agricultural producers and small businesses in rural areas
- Loans, grants, or loan/grant combinations are available for up to 75% of project costs

Federal Tax Incentives

- Wind projects that are in service by the end of 2016 will receive a 30% federal tax credit for capital investments

DMME

The primary goal of the Division of Energy is to advance sustainable energy practices and behaviors. To achieve this goal, the Division of Energy, works to:

- increase the use of proven energy conservation practices in Virginia
- foster growth of emerging and sustainable energy industries and infrastructure
- identify applications of new and innovative energy technologies in Virginia
- provide energy education and outreach to Virginians to increase their ability to make informed energy choices

DMME

DMME supports implementation of Commonwealth goals and recommendations in the 2014 Virginia Energy Plan (VEP). The first objective of the VEP is to "Accelerate the Development of Renewable Energy Sources in the Commonwealth to Ensure a Diverse Fuel Mix and Promote Long-Term Economic Health." The first recommendation under this objective is to "Work to ensure the diversity of the Commonwealth's generation fuel mix

- "Diversity in fuel mix will provide a hedge against volatility and spread the risk among varied sources of generation. This diversity must include an increase in the development of zero-emitting renewable sources, as well as on the largely untapped potential of energy efficiency. This path will lead to economic prosperity through increased jobs and environmental health through lower harmful emissions."

DMME

Recommendation 5-C in the VEP calls for the creation of "flexible financing mechanisms to help to put in place key additional energy assets and support priority energy programs." To this end, DMME manages several financing programs, including:

Virginia Saves Green Community Program

Eligible borrowers:

- ✓ Private commercial and industrial
- ✓ Non-profit institutional
- ✓ Local government

Virginia Revolving Loan Fund

Eligible borrowers:

- ✓ State and local government
- ✓ Investor Owned Utilities
- ✓ Electric Cooperatives
- ✓ Municipal Utilities

Sustainable Energy Developments, Inc.

SUSTAINABLE ENERGY DEVELOPMENTS™

- ✓ Examples of how businesses, farmers, municipalities, and others use wind to power themselves
- ✓ The development process

Interpreting Your VCWE Consultation Map *540-568-8770* [*www.windpowerVA.org*](http://www.windpowerVA.org)

Congratulations on receiving a personalized wind map from the Virginia Center for Wind Energy (VCWE) at James Madison University. We provide wind related services to local governments, state agencies, landowners, academia, non-governmental organizations, and businesses throughout the Commonwealth. *This sample map will help you understand the data provided on your map.*

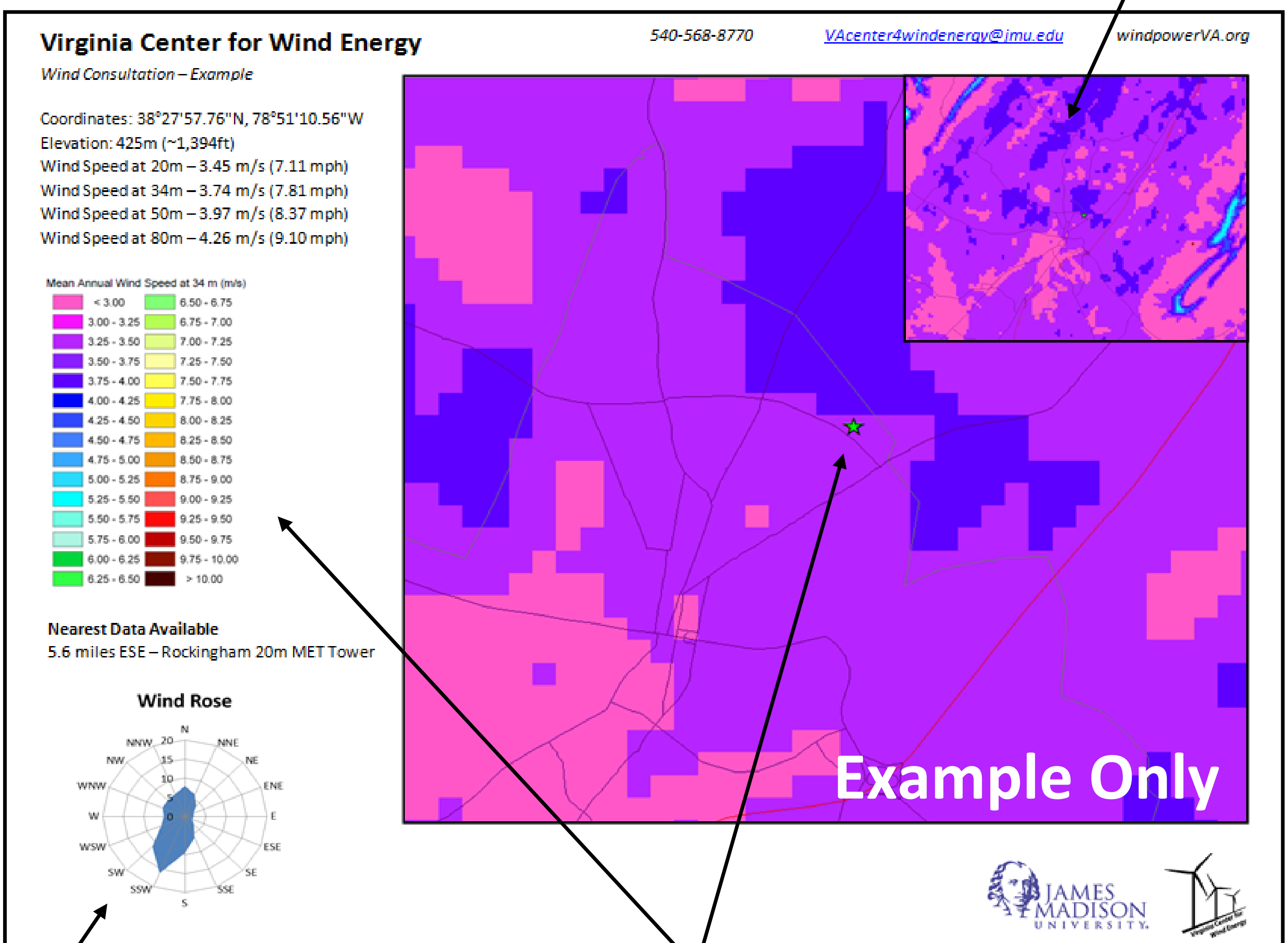
The Data

The star marks the location where we retrieved data from the wind map. The GPS coordinates and elevation for your site are provided. Estimates of your mean annual wind speed are provided in meters per second (m/s) and miles per hour (mph) at 20 meters, 34 meters, 50 meters, and 80 meters. The typical residential scale project would require a height of around 34 meters (~111ft) while 50 meters (~164ft) is more suitable for a utility scale project. You will also see the distance to the nearest data set from your site. Such data sets have been collected through the State-based Anemometer Loan Program and are available upon request.

According to the USDOE publication, Small Wind Electric Systems: A Virginia Consumer's Guide, the minimum average annual wind speed is 4 m/s (9mph) for an off-grid system and 5.4 m/s (12mph) for a grid-connected system.

Inset Map

This map provides a zoomed-out view of your site. Local roads are indicated in black and interstates are indicated in red. Bold black lines indicate County limits.



Wind Rose

A wind rose provides an estimate of your prevailing wind direction. The blue area represents the percentage of time the wind comes from a particular direction.

For this example, approximately 16% of the wind comes from the SSW.

Wind Map

The colors on the map correspond to the mean wind annual wind speed (at 34 meters) legend on the left.

The Virginia wind map was purchased by the VCWE from AWS Truepower.

JAMES MADISON UNIVERSITY

21st January 2016

Ms. Jane Doe
123 Wind Energy Lane

Dear Ms. Doe:

The Center for Wind Energy (CWE) at James Madison University, in cooperation with the Virginia Department of Mines, Minerals, and Energy (DMME), is pleased to announce that you have been selected as a candidate to receive further assistance and technical support and to be considered for a low-interest loan, for installation of an intermediate-sized, distributed wind turbine. Applicants to the Distributed Wind Assistance Program were ranked based upon projected wind resource, status of local wind ordinances, accessibility of the site, size and topography of the site, replicability of the project, value to the community, and willingness of the owners to permit visitors and share data.

The next step in this process is to confirm your interest in receiving ongoing support, leading to an application to DMME for a low-interest loan as well as for grants from the U.S. Department of Agriculture, assuming eligibility. The CWE will assist by conducting a comprehensive financial modeling to determine economic viability of a project, and will assist in appropriate funding sources. An on-site visit will also be scheduled. Finally, the CWE will introduce you to potential installers, should you wish to pursue project development.

In order to confirm your interest in continuing with this program, kindly respond to this e-mail at your earliest convenience, or contact Mr. Phil Sturm at the CWE by phone, before 5th February 2016. If you have any questions or concerns, please contact Dr. Jonathan Miles at 540.568.3044. We thank you for your patience and cooperation throughout this process. The Center for Wind Energy looks forward to working with you in the future and thanks you for your interest in advancing clean, renewable energy in Virginia.

Sincerely,

Jonathan J. Miles, Ph.D
Professor, Integrated Science and Technology
Director, Center for Wind Energy

Jonathan Miles, Ph.D.
Director

Remy Pangle
Associate Director,
Curriculum Coordinator

Phil Sturm
Project Facilitator
GIS

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540.568.8795 (fax)
http://wind.jmu.edu
VAcenter4windenergy@jmu.edu

1401 Technology Drive
Suite 120
Rooms 1161–1173

Appendix H2. DWAP Rejection Letter

21st January 2016

Mr. Jane Doe
123 Wind Energy Lane

Dear Ms. Jane Doe:

The Center for Wind Energy (CWE) at James Madison University, in cooperation with the Virginia Department of Mines, Minerals, and Energy (DMME), regrets to inform you that your application has not been selected at this time to receive further consideration for technical support and a low-interest loan through the Distributed Wind Assistance Program. Candidates were ranked based upon projected wind resource, status of local wind ordinances, accessibility of the site, size and topography of the site, replicability of the project, value to the community, and the willingness of the owners to permit visitors and share data. We received a large number of qualified applications and we are thankful for your efforts to submit. Thankfully, there is reason for some optimism in terms of providing you further resources, should you remain interested to install a wind turbine. We are exploring the potential for additional financial support that would allow us to assist a greater number of applicants. We are also submitting to the U.S. Department of Agriculture for an assistance grant that would expand the number of parties we are able to assist. We will maintain your file in our database, and contact you at a point in time when we can continue to provide you assistance.

If you wish to receive information regarding potential future programs, please respond to this e-mail at your earliest convenience or contact CWE by phone. If you have any questions or concerns, please contact Dr. Jonathan Miles at 540.568.3044. Thank you for your patience and cooperation throughout this process. The Center for Wind Energy looks forward to working with you in the future and thanks you for your interest in advancing clean, renewable energy in Virginia.

Sincerely,

Jonathan J. Miles, Ph.D
Professor, Integrated Science and Technology
Director, Center for Wind Energy

Jonathan Miles, Ph.D.
Director

Remy Pangle
Associate Director,
Curriculum Coordinator

Phil Sturm
Project Facilitator
GIS

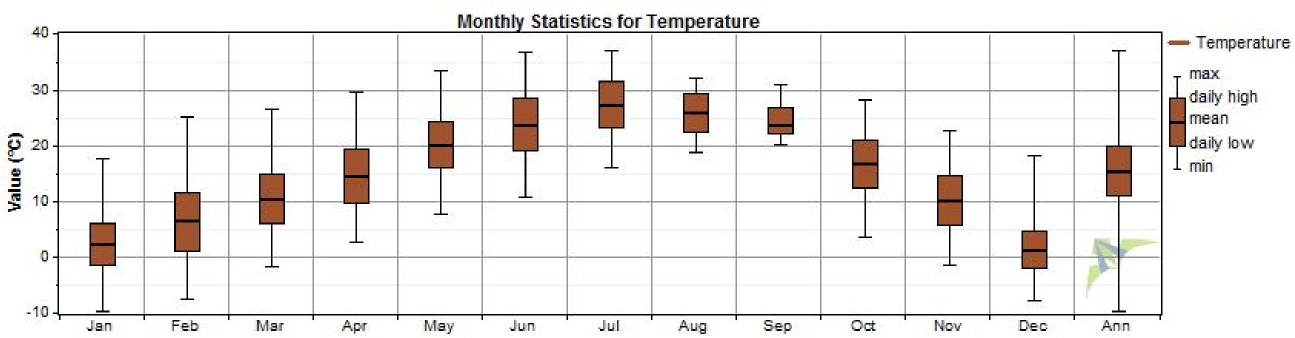
540.568.8770 (office)
540.568.8795 (fax)
http://wind.jmu.edu
VAcenter4windenergy@jmu.edu

1401 Technology Drive
Suite 120
Rooms 1161–1173

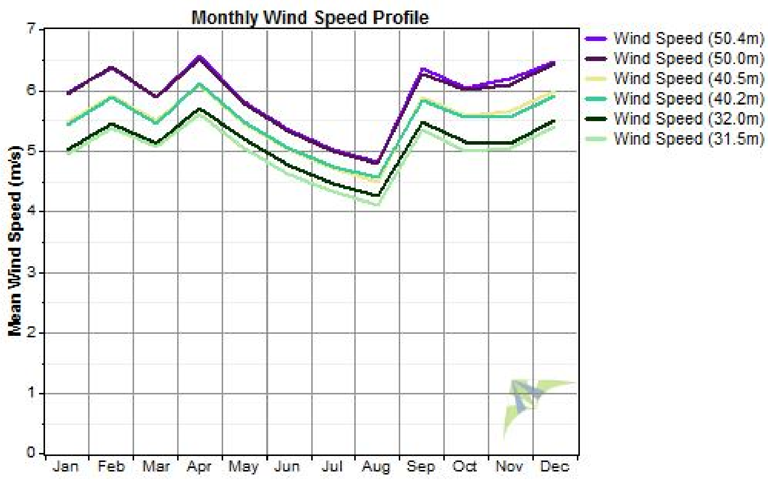
Data Set Properties

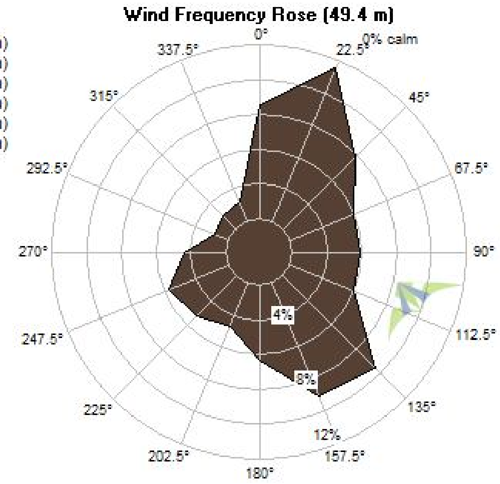
Report Created: 1/18/2013 09:58 using Windographer 2.4.8
Filter Settings: <Unflagged data>

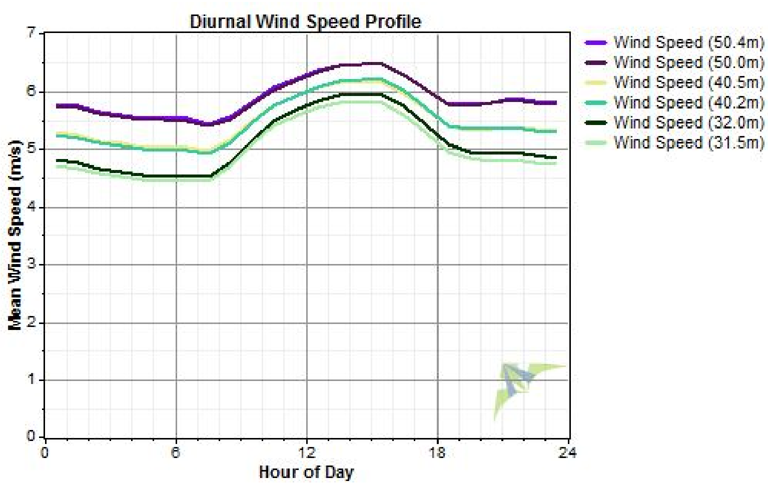
Variable	Value
Latitude	N 37° 34' 18.060"
Longitude	W 75° 42' 59.460"
Elevation	5 m
Start date	1/26/2009 00:00
End date	8/22/2012 08:00
Duration	3.6 years
Length of time step	10 minutes
Calm threshold	0.4 m/s
Mean temperature	15.4 °C
Mean pressure	101.2 kPa
Mean air density	1.223 kg/m³
Power density at 50m	204 W/m²
Wind power class	2 (Marginal)
Power law exponent	0.333
Surface roughness	1.98 m
Roughness class	4.48
Roughness description	Suburban

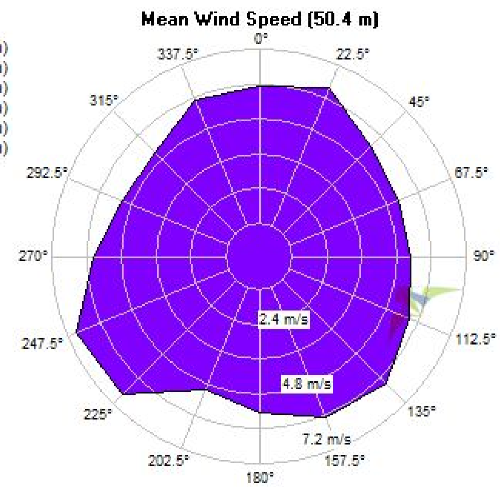


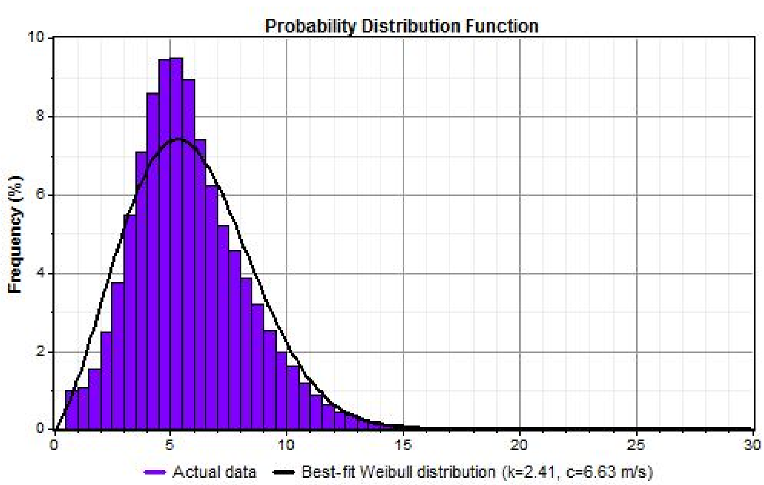
Wind Speed and Direction

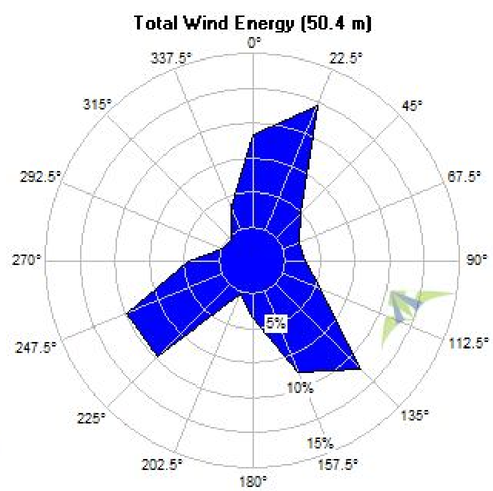




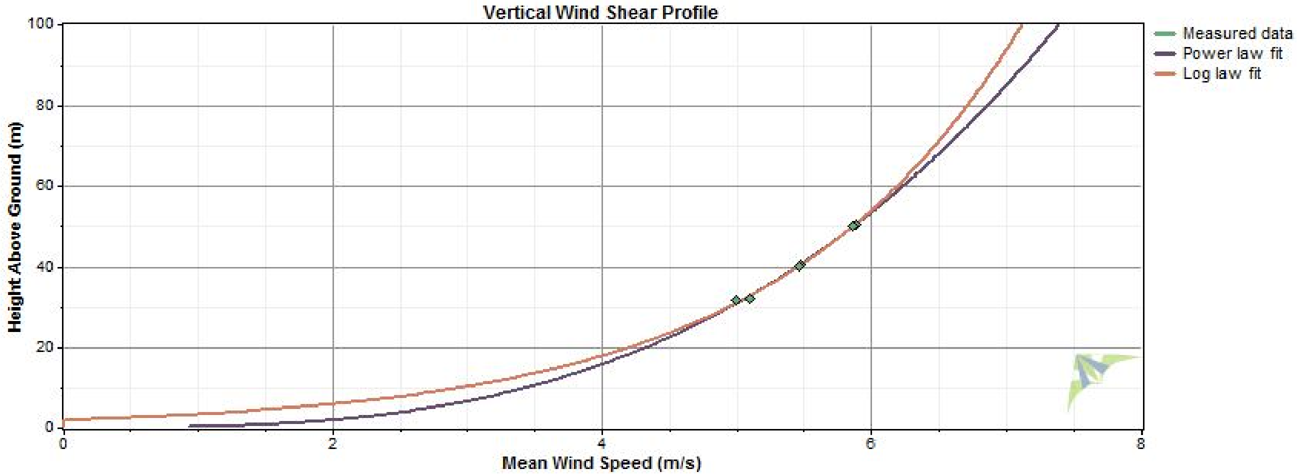


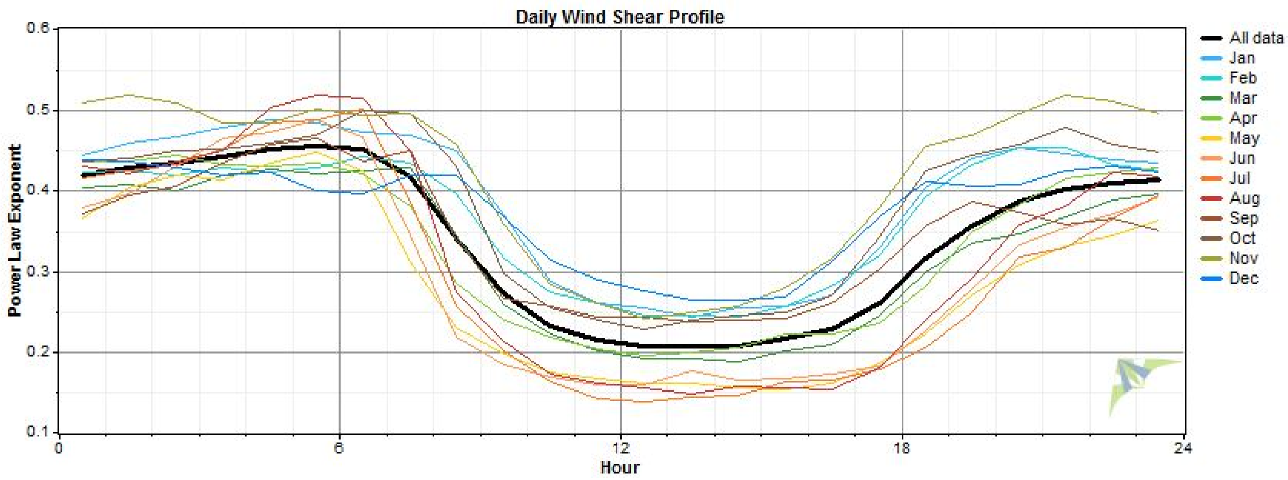


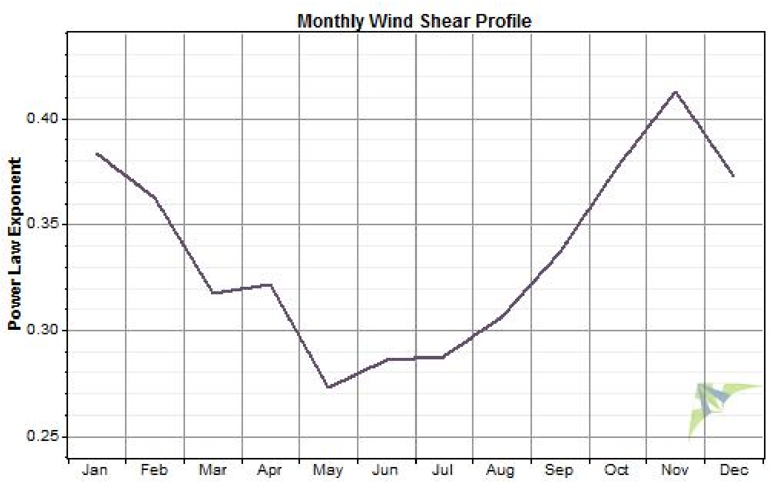


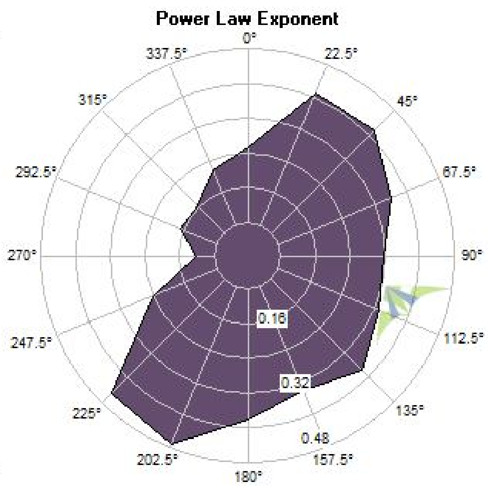


Wind Shear

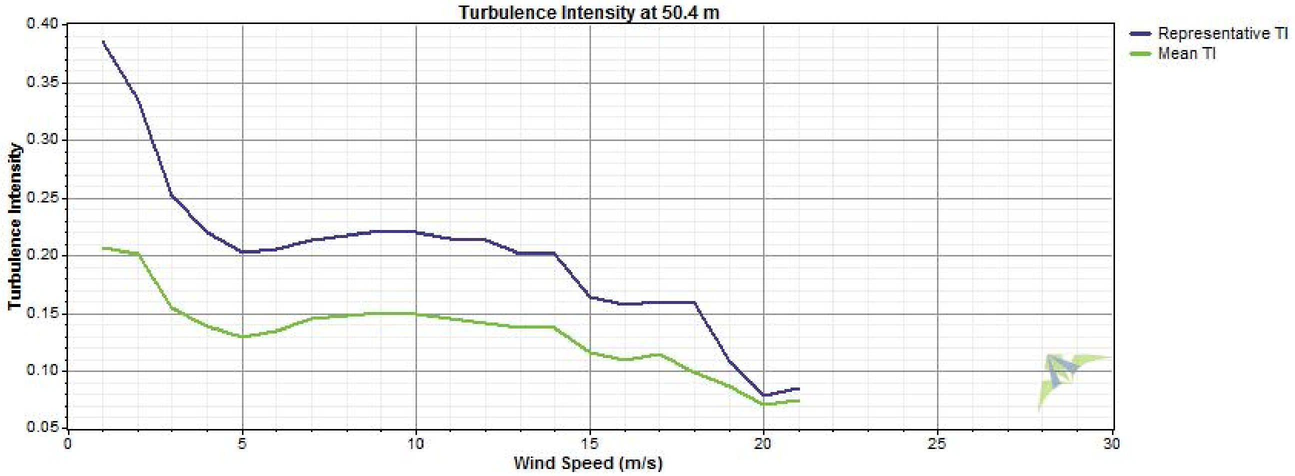

Vertical Wind Shear Profile
Height Above Ground (m)
Mean Wind Speed (m/s)
Measured data
Power law fit
Log law fit
0
20
40
60
80
100
2
4
6
8

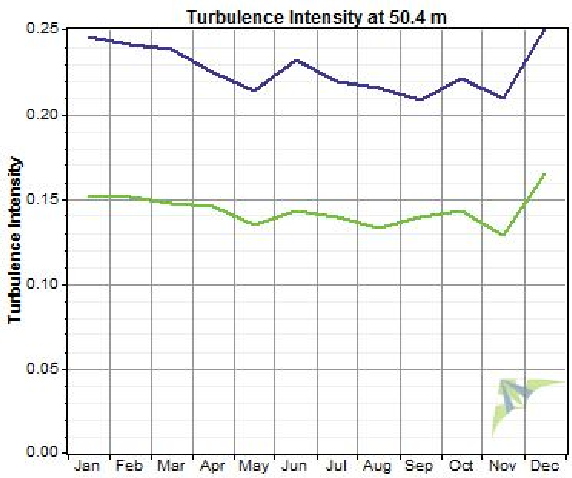

Daily Wind Shear Profile
Power Law Exponent
Hour
All data
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
0.1
0.2
0.3
0.4
0.5
0.6
0
6
12
18
24

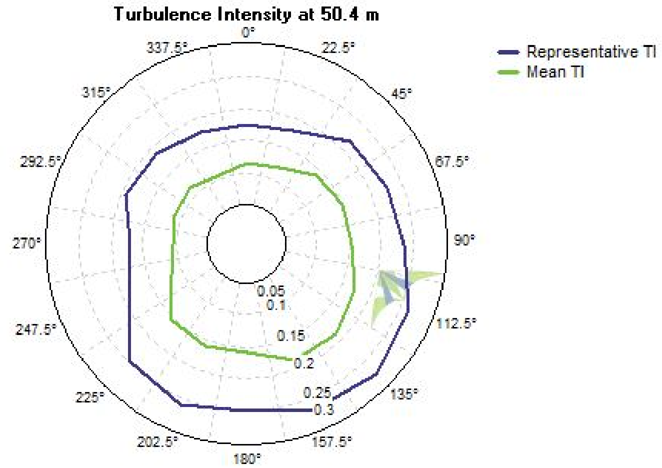

Monthly Wind Shear Profile
Power Law Exponent
0.25
0.30
0.35
0.40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

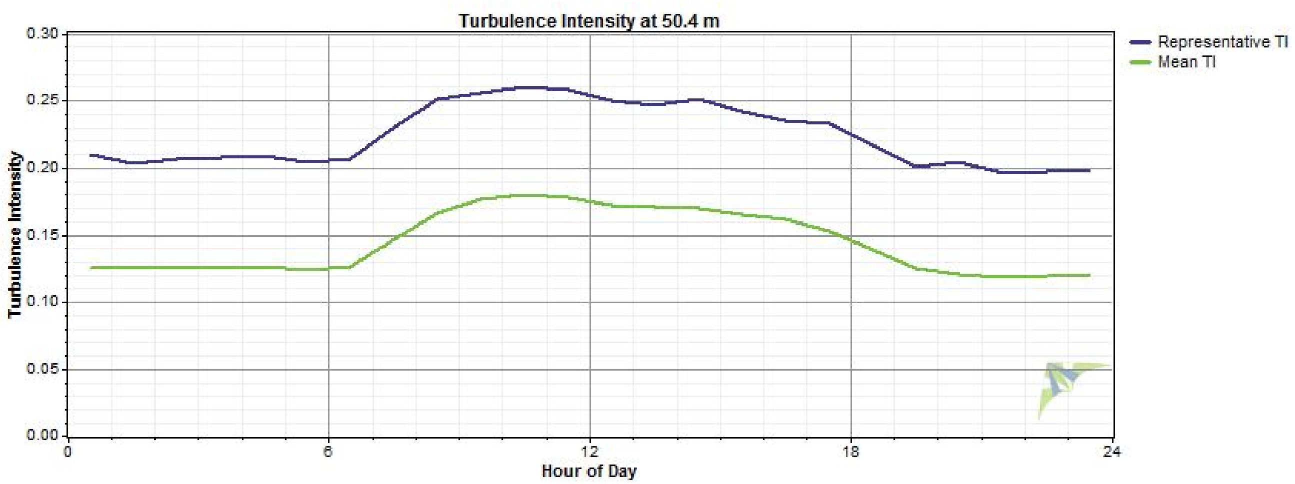

Power Law Exponent
0°
22.5°
45°
67.5°
90°
112.5°
135°
157.5°
180°
202.5°
225°
247.5°
270°
292.5°
315°
337.5°
0.16
0.32
0.48

Turbulence Intensity









Data Column Properties

Number	Label	Units	Height	Possible Records	Valid Records	Recovery Rate (%)	Mean	Min	Max	Std. Dev
1	Wind Speed (50.4m)	m/s	50.4 m	187,824	135,534	72.16	5.89	0.78	27.78	2.55
2	CH1SD	m/s	50.4 m	187,824	74,507	39.67	0.826	0.000	6.600	0.495
3	CH1Max	m/s	50.4 m	187,824	74,507	39.67	7.49	0.40	27.60	3.40
4	CH1Min	m/s	50.4 m	187,824	74,507	39.67	3.31	0.40	17.00	1.67
5	Wind Speed (50.0m)	m/s	50 m	187,824	135,534	72.16	5.86	0.76	27.76	2.52
6	CH2SD	m/s	50 m	187,824	74,507	39.67	0.819	0.000	6.600	0.496
7	CH2Max	m/s	50 m	187,824	74,507	39.67	7.49	0.40	28.40	3.40
8	CH2Min	m/s	50 m	187,824	74,507	39.67	3.34	0.40	17.40	1.70
9	Wind Speed (40.5m)	m/s	40.5 m	187,824	135,534	72.16	5.47	0.78	26.68	2.37
10	CH3SD	m/s	40.5 m	187,824	74,507	39.67	0.841	0.000	5.800	0.489
11	CH3Max	m/s	40.5 m	187,824	74,507	39.67	7.18	0.40	26.10	3.29
12	CH3Min	m/s	40.5 m	187,824	74,507	39.67	2.92	0.40	16.20	1.51
13	Wind Speed (40.2m)	m/s	40.2 m	187,824	135,534	72.16	5.46	0.78	26.38	2.37
14	CH4SD	m/s	40.2 m	187,824	74,507	39.67	0.842	0.000	6.100	0.490
15	CH4Max	m/s	40.2 m	187,824	74,507	39.67	7.17	0.40	27.70	3.30
16	CH4Min	m/s	40.2 m	187,824	74,507	39.67	2.92	0.40	16.70	1.56
17	Wind Speed (31.5m)	m/s	31.5 m	187,824	135,534	72.16	4.99	0.77	25.37	2.23
18	CH5SD	m/s	31.5 m	187,824	74,507	39.67	0.860	0.000	5.300	0.478
19	CH5Max	m/s	31.5 m	187,824	74,507	39.67	6.81	0.40	25.30	3.22
20	CH5Min	m/s	31.5 m	187,824	74,507	39.67	2.47	0.40	15.50	1.40
21	Wind Speed (32.0m)	m/s	32 m	187,824	135,534	72.16	5.10	0.80	25.20	2.25
22	CH6SD	m/s	32 m	187,824	74,507	39.67	0.850	0.000	5.300	0.473
23	CH6Max	m/s	32 m	187,824	74,507	39.67	6.85	0.40	27.70	3.22
24	CH6Min	m/s	32 m	187,824	74,507	39.67	2.55	0.40	15.50	1.43
25	Wind Direction (49.4m)	°	49.4 m	187,824	135,534	72.16	89.7	1.0	360.0	101.4
26	CH7SD	°	49.4 m	187,824	74,507	39.67	9.7	0.0	133.0	6.5
27	CH7Max	°	49.4 m	187,824	74,507	39.67	201.3	0.0	359.0	99.5
28	CH7Min	°	49.4 m	187,824	74,507	39.67	180	180	180	0
29	Wind Direction (39.6m)	°	10 m	187,824	135,534	72.16	100.1	1.0	360.0	99.0
30	CH8SD	°	10 m	187,824	74,507	39.67	10.5	0.0	127.0	6.5
31	CH8Max	°	10 m	187,824	74,507	39.67	204	0	359	100
32	CH8Min	°	10 m	187,824	74,507	39.67	185	185	185	0
33	Temperature	°C		187,824	74,507	39.67	15.40	-9.70	36.90	9.56
34	CH9SD			187,824	74,507	39.67	0.022	0.000	3.400	0.067
35	CH9Max			187,824	74,507	39.67	15.65	-9.60	36.90	9.58
36	CH9Min			187,824	74,507	39.67	15.24	-9.80	36.60	9.57
37	Air Density	kg/m³		187,824	187,824	100.00	1.223	1.137	1.339	0.026
38	Wind Speed (50.4m) TI			187,824	74,507	39.67	0.144	0.000	0.787	0.066
39	Wind Speed (50.0m) TI			187,824	74,507	39.67	0.144	0.000	1.119	0.070
40	Wind Speed (40.5m) TI			187,824	74,507	39.67	0.156	0.000	0.859	0.067
41	Wind Speed (40.2m) TI			187,824	74,507	39.67	0.158	0.000	0.878	0.071
42	Wind Speed (32.0m) TI			187,824	74,507	39.67	0.170	0.000	0.846	0.070
43	Wind Speed (31.5m) TI			187,824	74,507	39.67	0.176	0.000	0.866	0.072
44	Wind Speed (50.4m) WPD	W/m²		187,824	135,534	72.16	206	0	13,120	361
45	Wind Speed (50.0m) WPD	W/m²		187,824	135,534	72.16	201	0	13,092	341
46	Wind Speed (40.5m) WPD	W/m²		187,824	135,534	72.16	166	0	11,622	294
47	Wind Speed (40.2m) WPD	W/m²		187,824	135,534	72.16	164	0	11,235	278
48	Wind Speed (32.0m) WPD	W/m²		187,824	135,534	72.16	135	0	9,794	234
49	Wind Speed (31.5m) WPD	W/m²		187,824	135,534	72.16	129	0	9,993	231

SUSTAINABLE ENERGY DEVELOPMENTS™

BRADFORD BAY FARMS

WIND ENERGY DEVELOPMENT

PRELIMINARY ANALYSIS

Sustainable Energy Developments, Inc. (SED) has performed a preliminary analysis for an on-site wind turbine to offset energy usage at Bradford Bay Farms in Quinby, VA. The analysis demonstrates the technical and economic feasibility of installing a small-to-medium scale wind turbine at the Farm.

Wind Resource – SED has determined the wind speed to be **5.3 m/s (12 mph)** at a height of 37m based on a review of publicly available wind resource data for the region.

Site Characteristics –The Bradford Bay site appears to possess adequate setbacks from residences and other public ways for the wind turbine envisioned although further evaluation of the site will be necessary through a feasibility study or fatal flaw analysis.

Wind Turbine Recommendation –SED has performed the analysis based around the installation of a single **Endurance E3120 50kW wind turbine**, which would be the most appropriate wind turbine for the site based on site characteristics and the energy needs of the Farm. This is a Class III wind turbine which is designed for areas with moderate wind speeds such as this.

Electricity Profile and Interconnection Structure – All electricity generated by the wind turbine would be used to offset electricity consumption at the facility and any excess generation would be eligible to be net metered and credited back to Bradford Bay. The average retail electricity rate at this facility is **$0.08/kWh.**

Grants and Incentives – The project could be eligible for funding from the **Virginia Department of Mine and Minerals (DMME)**, as well as the USDA Rural Energy for America Program. For the purposes of this analysis, we have assumed that we would be able to obtain $260,000 in grants that between these two programs.

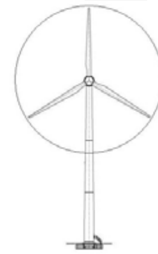
SED has also assumed the Farm would be able to make use of the 30% federal Investment Tax Credit and has assumed that construction would start before January 1st, 2017.

HEADQUARTERS
877 WIND NRG
585 265 1148
317 Route 104
Ontario, NY 14519

MASSACHUSETTS OFFICE
978 422 7744
978 422 7744
1 Bean Road
Sterling, Massachusetts 01564

Wind Energy Analysis Bradford Bay Farms

Recommended Wind Turbine:	Endurance E-3120
Rated Capacity	50 kW
Rotor Diameter	19.2 m
Hub Height	42 m
Tower Type	Self-Supporting Lattice



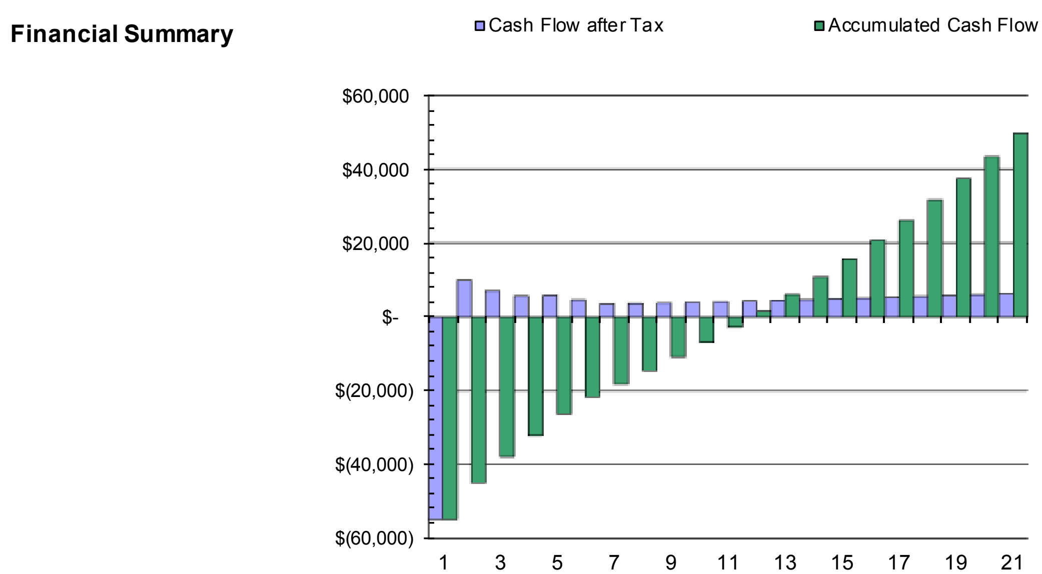
Project Inputs and Assumptions

Wind Speed	5.51 m/s	12.3 mph
Average Electricity Rate	$0.08 per kWh	
Total Installed Cost	$490,000	
Federal Grants and Incentives	30% Investment Tax Credit to be applied against all income	
State Grants and Incentives	$260,000 State and Federal Grants	
Warranty Term	5 Years	
Maintenance and Insurance	Year 1 Maintenance	$2,500 Per Year
	Post Warranty Maintenance	$2,199 Per Year
	Capital Reserve	$2,000 Per Year
	Insurance	$750 Per Year

Analysis Results

Wind Turbine Annual Production	115,741 kWh
Net Installed Cost after Grants and Tax Credit	$230,000
First Year Energy Savings	$9,259

	Escalation Rate	IRR	Payback
10 Year Average Energy Escalation	3.00%	7.59%	10.63 Years
5 Year Average Energy Escalation	5.00%	11.18%	8.93 Years



Sustainable Energy Developments, Inc. (SED) is a leader in the development and deployment of community-scale wind and solar installations in the northeast. SED is focused on the development of high quality, economically beneficial decentralized wind projects with particular focus in the northeast. Our work includes technical feasibility assessments, permitting, design engineering, construction and operations and maintenance management for wind and solar projects ranging in size from 5 kilowatts to several megawatts. SED has over ten years of professional development experience and operations and maintenance management of wind and solar projects with nearly 17 megawatts of installed capacity. SED has been recognized as a pioneer of this market that focuses on providing local benefits through wind energy and have demonstrated the vast potential that exists through projects installed and currently under development.

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