# Project Objectives

James Madison University requests $495,235 for a 2-year project to develop and implement a public domain, web-based site feasibility analysis tool for behind-the-meter wind power systems. The tool is designed as a site prescreening/suitability calculator for property owners, and will enable them to assess the technical and economic feasibility of a property for wind power before engaging in costly and time-consuming site characterization and analysis. The tool will first be prototyped for the Commonwealth of Virginia, and then scaled up to include all of the mid-Atlantic states designated as "high priority" (Virginia, North Carolina, Maryland) by the US DOE Wind Powering America program.[1]

# Merit Review Criterion Discussion

## Criterion 1: Market Impact

Our market analysis is based on the collective experiences of the Virginia Wind Energy Collaborative (VWEC—http://vwec.cisat.jmu.edu) and the Center for Energy and Environmental Sustainability (CEES—http://www.cisat.jmu.edu/cees/) at James Madison University. These two centers are responsible for implementation of grants from the US DOE to participate in programs supported by Wind Powering America, from the Commonwealth of Virginia in support of the Virginia Coastal Energy Research Consortium (VSERC—http://vserc.org), and the National Science Foundation. VWEC also implements the Commonwealth of Virginia's State-Based Anemometer Loan Program (SBALP) and state support for feasibility analysis of community and utility scale wind at NASA's Wallops Flight Facility, Oceana Naval Air Station, and on Tangier Island. CEES implements the Virginia Pilot Farm Energy Audit Program (funded by the Virginia Department of Mines, Minerals, and Energy – Energy Division), and conducts agricultural energy research, outreach, and programming in partnership with the Shenandoah Resource Conservation and Development Council, a non-profit association affiliated with USDA's Natural Resources Conservation Service. The directors of VWEC and CEES are the principal investigators for the Virginia Renewables Siting Scoring System ($VRS^3$), a land-use planning method developed for suitability analysis and site prescreening for wind power systems. Extensive public outreach over the past 3-4 years by these programs include multiple small stakeholder meetings, two wind workshops hosted by the Appalachian Regional Commission, over a dozen county land use planning presentations, land owner technical assistance and support, two state annual wind symposia, an on-farm energy savings workshop, and participation in several state and regional clean energy fairs. Our expertise is thus a "collective wisdom" regarding attitudes toward, perceptions of, and needs for wind power in the mid-Atlantic, especially in rural areas.

### Wind Markets in the Mid-Atlantic Region

The high priority mid-Atlantic states have been targeted by DOE because of their abundance of wind resources but relative lack of installed wind capacity, particularly of "large" or utility scale wind. Achieving 20% penetration by 2030 nationally requires that states such as these overcome low wind power adoption rates and accelerate deployment of wind power at all scales: on-site, community, utility,

[1] Larry Flowers, "Wind Energy Update," National Renewable Energy Laboratory, November 2007, http://www.citact.org/pdfs/Synopsis_of_NREL_Presentation.pdf. [Accessed Feb. 2, 2009].

and offshore. We believe that the successful acceleration of installed wind capacity in the mid-Atlantic high priority states will rely heavily on a neglected wind market, which is that for net-metered distributed generation (behind-the-meter) at the residential, farm, commercial, and community scales.

Most wind development initiatives in the mid-Atlantic focus on utility scale wind because of its increasing cost-competitiveness with conventional thermoelectric power production, its high installed capacity (e.g., megawatt scale), the growing emphasis on renewable portfolio standards, and the availability of the Class 4+ wind resources requisite for profitable utility scale installations in this region. However, because the best land-based wind resources are on mountain ridgelines, mid-Atlantic utility scale wind is highly politicized for the same reasons well documented by the University of Massachusetts Wind Energy Center[2] (also a WPA high priority state), and include primarily viewshed, wildlife, and wilderness conservation concerns. Examples of typical utility-scale controversies include siting such a system in Virginia, protection of federal lands and roadless areas in Maryland, and existing legal prohibitions to development along mountain ridges in North Carolina. Unlike other regions, barriers to utility scale wind in the mid-Atlantic are not based on complex regulatory schemes, confusing RPS standards, grid connectivity challenges, or a lack of technical resources and tools, but on community values about landscape, land use planning, and natural resources. Recent initiatives by the Dominion Power-BP partnership in southwestern Virginia suggest that a cautious, transparent, and community-based approach to utility scale wind may be successful over the long run.

In the mean time, much can be accomplished by focusing on deployment of wind in areas with less robust resources and at smaller scales: in Virginia, the ***overwhelming majority*** of the wind resource is Class 1 and 2, and behind-the-meter turbines have an uncontentious presence in the landscape. Because public education, acceptance, and county land use uncertainties are key barriers to the adoption of wind energy at all scales in this region, we believe that focusing on behind-the-meter wind power will enhance adoption rates of small wind and may serve as a pathway to reducing public resistance to utility scale wind as well (a conclusion also drawn by the University of Massachusetts Wind Energy Center, *op. cit.*).

We thus believe that non-utility wind power is a neglected market in the mid-Atlantic region, and acceleration of wind power at all scales must be built on a foundation of public understanding and acceptance where turbines are the most visible, which is literally in the backyard for behind-the-meter systems.

## Six Crucial Barriers to Behind-the-Meter Wind Power in the Mid-Atlantic

In Virginia, net metering law allows 10KW or less connectivity for residences, and 500 KW or less for business and commercial enterprises. In North Carolina, the limit is 20KW for residential, and 100 KW for non-residential applications. In Maryland, the limit is 2 MW. In both Virginia and North Carolina, net-metering caps constrain typical turbine sizes to less than 100 KW nameplate capacity, although Class 3 winds and lower are typically suitable for turbines of roughly 20KW or smaller capacity.

There are many important obstacles that net metering <u>does not face</u>. First, because it is behind-the-meter, grid-tie constraints and Independent Systems Operator (ISO) evaluations are not required. Second, utilities are obligated to connect customers meeting the requirements. Third, because

[2] University of Massachusetts Wind Energy Center, " DOE Wind Powering America: Priority States Wind Energy Outreach Strategy and Implementation—Strategies to Overcome Barriers to the Deployment of Wind Energy in Massachusetts" (Amherst, MA: University of Massachusetts Wind Energy Center, November 2008).

wholesale markets are not involved, life cycle costing and payback analysis are comparatively simple. Fourth, feasibility analysis in this context is relatively straightforward, and involves primarily (a) assessment of the wind resource, (b) evaluation of a few simple site characteristics, (c) selection of turbine sizes and models, and (d) standard life cycle costing. Fifth, it avoids the regulatory problems faced by publicly-owned community or municipal wholesale wind systems. Sixth, because behind-the-meter systems typically involve just one turbine of comparatively low height, special use permitting and zoning is less daunting. Seventh, access to power lines is not an issue or potential fatal flaw in siting. Finally, environmental opposition to small wind is negligible to nonexistent. Nonetheless, barriers to behind-the-meter systems do exist as summarized below.

**1. Neglect of the behind-the-meter market by the private sector.—**There is no profit in net metering for commercial ***wind power*** developers. Small wind ***installers*** in the region rely heavily on cold calls from potential customers, and do not have the resources to undertake aggressive marketing. Until the public has enough awareness and knowledge of small wind power systems to initiate contact with wind installers, this will be an underserved market. In addition, our experience suggests that rural clients in particular are extremely suspicious of vendor claims, and often look to a neutral third party or trusted agent for product cost and performance data.

**2. Cheap Electricity.—**In Virginia, retail electricity currently averages about 8-10 cents per kilowatt hour. At these rates, many small wind systems will not pay back over a typical 20-30 year period, even when electricity rate escalators are built into the life cycle model. Our analyses show that very small wind systems (e.g., less than 20 KW) can be profitable within 15-20 year payback periods at low wind speeds, but the length of payback is ***highly sensitive*** to the capacity factor of the turbine.

**3. Lack of Subsidies for Behind-the-Meter Systems.—**The low cost of electricity acts as a significant market barrier to the adoption of small wind systems. Subsidies—such as tax incentives—can lower the effective cost and shorten the payback period for these systems. There are no federal tax credits for net metered wind that are comparable to those that exist for solar energy; the Commonwealth of Virginia does not have any renewable energy tax incentives for net metered energy, but is currently considering several legislative bills that would create a wide array of credits for end-use solar, wind, and other renewable energy systems. One opportunity that can offset the lack of such subsidies is the growing market for certified carbon credits and green power certificates, which opens the door to some creative leveraging of small wind power installations.

**4. Cost and time of site characterization.—**Although the installed costs are considerably lower for behind-the-meter systems compared to utility scale wind power, good site characterization is nonetheless required. At least one year of wind data and an on-site physical assessment is necessary for site and turbine selection as well as accurate life cycle analysis. Our experience with the state anemometer loan program suggests that sites often have wind resources that are a little better or worse than that predicted by the TrueWind maps. Such variability affects turbine capacity factors and ultimately the payback period, which is highly sensitive to the capacity factor of the turbine. One barrier in this category is the comparative shortage of MET towers in the Virginia anemometer loan program, and the associated need to prioritize the most viable sites for use of the MET towers. Another barrier is the commercial cost of private MET tower services, which require an out-of-pocket expense and at least a year's delay in establishing the economic viability of a site for the landowner. A tool that would allow the SBALP program, landowners, and small wind installers to rigorously evaluate the technical and economic feasibility of a site before in-depth characterization proceeds would (a) facilitate more effective use of the MET towers, and (b) help landowners decide whether or not to pursue installation of a small wind system by investing in a complete physical site assessment and economic analysis.

**5. Lack of readily available, accurate cost and payback information.**— Life cycle costing and payback analysis depend on the interaction of both technical (turbine capacity and capacity factors) and economic (installed costs, electricity rates, cost offsets) factors. Typical landowners, however, do not have the ability to prescreen their property for its wind resource, select an appropriate size turbine, and conduct "back of the envelope" life cycle analysis. VWEC, CEES, and the SBALP program receive many residential, commercial, and farm requests for assistance such as the one below:

> "I received your contact information from the Shenandoah Forum. We are interested in receiving some contact information, cost analysis, permit requirements, watt usage, etc. for residential wind turbines. Could you assist us with this please?"

Our experience is that landowners want to know "whether it is worth it" to pursue small wind on their property. What they mean by this can range from whether a system will break even over some period of time to whether they can use a wind turbine for their retirement income. Our experience is also that these requests for help are increasing, suggesting that public acceptance of small wind is poised for take-off. However, VWEC, CEES, and the SBALP program are not staffed in a way that can support a significant increase in requests for technical assistance.

**6. Land use planning/permitting process.—**Virginia's land use planners are relatively open to wind systems less than 10KW, and many counties are in the process of writing ordinances to facilitate special use permitting for these systems. For behind the meter systems both larger and smaller than 10KW, however, a key permitting obstacle is height controversies. Many counties are exploring a variety of height restrictions (because of viewshed) that can inadvertently affect turbine capacity factors for small wind systems. If the permitting process requires landowners to install turbines at technically sub-optimal heights, then the capacity factor of the turbine, and its payback period, will be affected.

In summary, JMU's experience with renewable energy and the public suggests that behind-the-meter small wind systems are gaining in public awareness, acceptance, and interest. Almost all of our public requests for help indicate that there is an explicit desire for payback, although the length of the term can vary considerably. What we are seeing is that net-metered wind is a potentially large but neglected market by the private sector, and that it is challenged by economic disincentives at very low wind speeds. Small wind ***can*** be economically viable in the mid-Atlantic, however (even in Class 1 wind), but the cost and time of site characterization, lack of readily available "back of the envelope" life cycle analysis, and the land use permitting process act as real or emerging barriers to the adoption of behind-the-meter systems. We believe, given the environmental values and rural culture in the mid-Atlantic states, that effective acceleration of net metered systems (residential and commercial) in the region is crucial to greater public knowledge about the role and value of wind power, and can enhance public acceptance of sensitively and appropriately sited utility scale wind.

## Overcoming Selected Barriers With the Next Step Site Suitability Tool

The experience of VWEC, the Virginia Wind Working Group, electric power utilities (especially the rural co-ops), and CEES is that the number of private landowners, farms, commercial facilities, local government officials, and others that are contemplating wind power has reached critical mass. Requests for assistance are escalating, and it is difficult for staff and faculty to keep up with the number of inquiries received for information, especially requests for preliminary site assessments for small-scale, net-metered systems. One critical misperception that often emerges in this process is that landowners radically over-estimate the amount of electricity than can be created by a small wind system and the amount of surplus electricity that will be generated in excess of on-site use. We are therefore proposing to further develop VWEC's existing NextStep life cycle costing Excel spreadsheet program into an online feasibility tool that will:

1. Educate the public about wind power.
2. Estimate site-specific technical feasibility for behind-the-meter systems.
3. Estimate site-specific economic life cycle costs and payback for behind-the-meter systems.
4. Prescreen properties as to their suitability for wholesale/utility wind power systems.
5. Provide guidance to landowners on the "next steps" for further evaluating their properties for behind-the-meter systems or for purchasing green power certificates (in the event their sites are not technically or economically suitable for wind power).
6. Generate a report that can be printed for landowners to keep as a reference document.

**The Existing NextStep.—**The existing NextStep was developed by VWEC and is a spreadsheet-based economic calculator designed to be used by technical support staff, small wind installers, and sophisticated landowners. USDOE funded its development through the Virginia Department of Mines, Minerals, and Energy—Energy Division. NextStep is useful for pre-project development and turbine selection, and provides detailed comparisons and evaluations of small wind turbines with respect to their technical characteristics, performance parameters, and life cycle costs/payback performance (figure 1). Life cycle costing is thorough and includes dozens of economic parameters, including the potential for renewable energy credits. NextStep's primary utility as a spreadsheet calculator is the optimization of turbine selection through the evaluation of technical and economic performance criteria.

NextStep readily lends itself to automation, and when automated in an appropriate format, it can be used as a site suitability and pre-screening tool by landowners themselves, even those almost completely unschooled in wind power concepts. Our project will thus take the NextStep spreadsheet calculator and convert it to an interactive web-based tool that will 1) educate landowners about wind power and its potential power outputs under different circumstances, 2) enable landowners to prescreen their properties using a variety of criteria, and 3) advise them as to next steps for wind development or green power purchases.

Our experience has consistently shown that economic payback, no matter how robustly it is calculated, is only one factor impacting the decision-making process of a landowner who is considering a behind-the-meter wind power system. In many instances, payback is actually secondary to other landowner concerns, such as energy independence and security, stability and/or reliability of local electric power distribution, and environmental impacts. The online NextStep tool will incorporate these informational features.

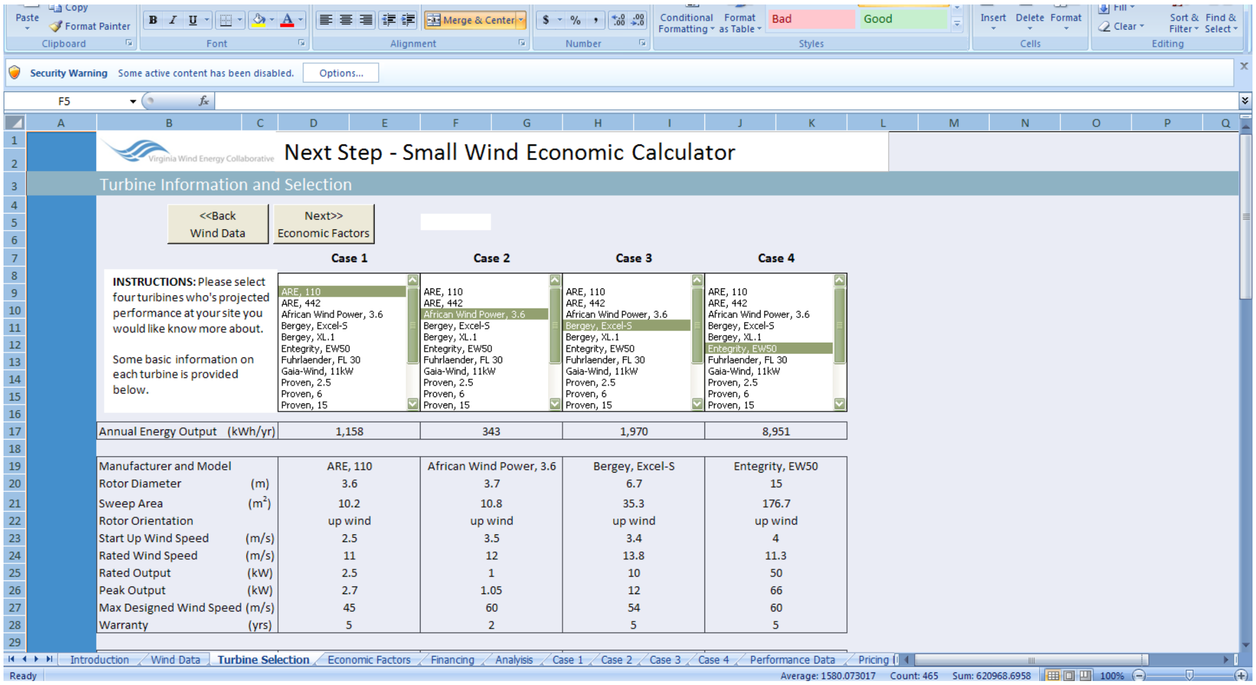


**Figure 1. Screenshot of the NextStep Turbine Selection Worksheet**

**NextStep Online.—**There are dozens of existing online wind feasibility calculators, each with drawbacks. First, many are **too technical or complicated** for the typical landowner (e.g., the *Wind Turbine Power Calculator* of the Danish Wind Industry Association, the *Wind Turbine Economic Feasibility Calculator Protocol and Household Electricity Use Estimation Sheet* of the Center for Rural Pennsylvania). Second, others **exclude behind-the-meter systems** (such as Windustry's *Wind Project Calculator*, a cash flow modeling calculator for community scale wind). Third, still others are **over simplistic, both technically and economically** (such as the *Wind Turbine Power System Sizing Calculator* offered by Energy Efficient Choices; the *Simple Wind Turbine Investment Payback Calculator* used by Midwest Energy, Inc.). Fourth, others have **output that is overly general**, such as the Swift *Residential Wind Estimator*).

The proposed online version of NextStep will overcome the drawbacks of existing online wind calculators. It will be highly interactive, automated, use non-technical language, and generate customized output for individual users. The flow of logical steps is presented in table 1.

**Table 1. Logical Sequence of the NextStep Online Feasibility Tool**

| | |
|---|---|
| **1. Introduction to the Next Step Tool** | • Overviews the NextStep tool and how/why it can be used. |
| **2. Overview of Wind Power** | • Introduction to wind power systems, scales of wind power, details on behind-the-meter and net metering |
| **3. Locating Site and Associated Wind Resource** | • Users enter street address; GIS programming obtains TrueWind data for that location<br>• Queries available acreage<br>• Queries simple topographical features and potential obstructions |

| | |
|---|---|
| **4. Type of User and Possible Uses** | • Differentiates users by residential, farm, commercial/industrial, and government/ school/other non-profit.<br>• Queries decision criteria (environment, security, payback, etc.)<br>• Queries stand alone v. net-metered<br>• Queries receptiveness to community and utility scale if acreage/wind class support it<br>• Queries annual electricity use at site |
| **5. Turbine Configuration and Power Output** | • Based on wind resources and user profiles, decision criteria, NextStep generates a range of "generic" turbine sizes that could be operated at a site. NextStep uses land use planning parameters to generate site options.<br>• NextStep produces several estimates of annual power output based on turbine size, a range of capacity factors, a range of installed heights.<br>• Annual power output expressed in simple layman's terms<br>• Users do not select turbines; this is automated by NextStep as generic options appropriate to the site. |
| **6. Life Cycle Costing and Payback Analysis** | • The most complicated set of estimates and queries, LCC and payback will be based on the interactions of about 25 different factors ranging from escalation rates to the availability of subsidies and incentives.<br>• Turbine costs not brand-specific, but an automated "generic average" cost for specific sizes in the region (e.g., average estimate for a 3.7-kW turbine) |
| **7. Outputs, Interpretation, Next Steps** | • A series of screens that generate, summarize, and interpret NextStep output, including technical feasibility, economic feasibility, environmental impacts, and site energy security<br>• Plain English uncertainty analysis included.<br>• Queries user about level of interest after reviewing results (a) no longer interested in wind, (b) not interested at my site but want to support wind, (c) yes, interested. Guides user to next steps based on response (e.g., how to purchase green power at local utility, contact list for installers, etc.) |
| **8. Summary Report** | • Users have the option of generating a PDF report to save or print. Report will provide a summary of site characterization, results of NextStep analysis, degree of uncertainty, guidance for next steps, and list of contacts for further information. |

Critical features of the online tool will:

- Substantially simplify the characterization of wind resources at a landowner's site by using GIS tools. Users simply enter a street address.
- Differentiate by type of user. The four classes of users that we will use to both automate and customize information are (a) residential, (b) farm, (c) commercial/industrial, and (d) government, school, and other non-profit. Interactivity of the tool and analysis will be driven accordingly.

- Allow users to specify their decision criteria for the wind power system: economic, environmental, and energy security/stability/independence. Interactivity of the tool and analysis will be driven accordingly.
- Obtain acreage/land area available at a site to prescreen the feasibility for community and utility scale wind power systems if the appropriate wind resource is available.
- Incorporate land use planning and zoning parameters, which will allow the tool to generate specific narrative about the local permitting process and any restrictions (such as tower height) for the landowner.
- Allow users to specify whether they want their system to be stand-alone (with batteries) or net-metered, and provide appropriate analysis for both systems.
- Query users for simple input on topographic features and possible obstructions that would affect the TrueWind resource estimate for a site. This allows for more precise statements about uncertainty in the analysis.
- Provide, in clear lay terms, the expected annual output of a wind power system and its equivalent in commonly understood context. For example, a wind power system might generate enough electricity to "power a refrigerator for a year" or "a neighborhood of several homes for a year." The reduction in carbon emissions and criteria pollutants will also be reported for all users, but analyzed narratively for users who indicate that environmental benefits are a decision criterion.
- Use a series of simple queries to select appropriate discount rates for different types of users.
- Conduct sensitivity analysis as part of the life cycle costing/payback analysis, in particular for turbine height, discount rate, electricity rates, and financial incentives.
- Summarize, in simple language, the nature of the uncertainty in the NextStep analysis.
- Report the range of economic payback that landowners may experience at a specific site, which will allow them to decide whether or not to move forward with site characterization.

Although payback analysis is technically site- and equipment-specific, in our experience it can be reliably done as a "back of the envelope" exercise for site suitability and prescreening analysis, and to guide landowners to the next steps for exploring wind power options.

The most important outcome from the development of the NextStep web-based site feasibility tool for behind-the-meter wind power systems will be the empowerment of the public: they will be provided the resources to self-inform and conduct personal assessments without the inevitable delay associated with waiting for staff assistance at VWEC or CEES. Further, users will obtain assessments that reflect a number of combinations of turbine, site, zoning, economic, and other factors, enhancing public knowledge about the sensitivities associated with the various factors in a wind power analysis. We believe that the knowledge acquired by landowners as they engage directly with the analysis will impact their ability not only to make better decisions on their own behalf, but also to participate in the public forum as decisions are considered regarding the creation and implementation of siting ordinances, planning for community-scale/distributed wind systems, and larger utility-scale facilities.

By highly automating and widely marketing the NextStep tool, this project will reduce a significant barrier to more rapid expansion of small wind systems in Virginia and in neighboring states—limited time and staffing resources in wind and other outreach organizations, which prevents large scale and timely suitability analysis and prescreening of potential wind power sites.

## Reaching 20x30 With NextStep: Overcoming Barriers and Market Acceleration

Our goal is to accelerate site feasibility assessment for and installation of behind-the-meter wind power systems. The NextStep tool is being protyped and designed with the high priority mid-Atlantic states in mind, but is fundamentally adaptable to, and replicable in, other states. As described previously and as is commonly understood throughout the wind policy community, acceptance of large scale wind power is likely to be driven through public comfort and familiarity with the presence of small wind in the landscape. The added benefit of the tool is that it facilitates prescreening of large/utility wind systems as well. Several features of the NextStep tool enhance the acceleration process:

- As a user-friendly, web-based tool, it is accessible to **thousands** of landowners and does not depend on the availability of technical staff in wind outreach programs or small wind installers. NextStep overcomes neglect of the behind-the-meter market by the private sector as well as staffing limitations in public programs.
- It automates key site characterization tasks, allowing landowners, public programs, and private installers to more rapidly identify and prioritize those sites in need of a MET tower and fuller site characterization.
- NextStep's life cycle costing and payback estimation provides a range of customized economic outcomes based on typical turbine system configurations, electric power rates, cost subsidies, and a range of capacity factors and discount rates. This will allow landowners to readily determine whether their economic requirements are likely to be met by a small wind system on their property, thus filtering out small wind inquiries that are unlikely to progress to a system installation. Market acceleration is achieved by creating a higher volume and proportion of landowner inquiries to installers and public programs that have already met a basic threshold of performance requirements (technical and economic).

Two types of metrics are readily available to guide and assess the market performance of the NextStep tool and associated outreach and dissemination efforts. First, electric power utilities have very good records of the number of net metered customers by type and size of installation (e.g., solar versus wind, and by kilowatt nameplate capacity) and by type of landowner (e.g., residential, farm, commercial). This will allow us to track the market penetration rates of behind-the-meter wind systems over time and by end-use sector.

Second, market data are readily available from the state and federal governments. For example, Virginia has the following type and number of properties that are potential sites for small wind:

| Type of Property | Number of Facilities |
|---|---|
| Farms | 47,383 |
| Solid waste facilities | 255 |
| Nursing homes | 279 |
| Hospitals | 130 |
| Racetracks | 36 |
| Wineries | 121 |
| Colleges | 165 |
| Public schools | 2041 |
| Private schools | 684 |

| | |
|---|---|
| Airports | 68 |
| Correctional facilities | 71 |
| Golf courses | 342 |
| **Total** | 51,575 |

Source: Virginia Economic Development Partnership,
USDA Census of Agriculture

Note that this list does not include residential landowners with at least 1 acre of property, or churches, many of which are strong advocates of faith-based environmental stewardship.

In sum, data exist that allow the social and economic marketing of behind-the-meter systems to be highly targeted to specific types of landowners and to track installed systems. It is therefore possible to benchmark the current market penetration of behind-the-meter systems and evaluate its growth over specific increments of time. It is also possible to conduct follow-up surveys with NextStep users to explore reasons why they did/did not pursue a small wind system.

## Criterion 2: Technical Approach and Project Plan

This section will:

- Discuss the viability of NextStep's technical approach and plan to achieve FOA objectives
- Thoroughly outline a plan that is clearly stated, organized, achievable, and technically feasible
- Make a case for the viability, completeness, and timeliness of NextStep's decision points and deliverables in ensuring objective evaluation of progress against the proposed plan

### Development Plan

The following sections will describe the activities and deliverables for the ***analysis, implementation, testing, maintenance, and scaling*** of the NextStep Online Calculator. Analysis, implementation, testing and maintenance will occur during year one of the project and result in a tool focused only on Virginia. Scaling will occur in year two and expand the scope of the tool to cover the Mid-Atlantic region.

#### *Analysis*

The NextStep Online Calculator will be a website. The first deliverable of this project will develop a detailed specification for each page of that website which will include the following:

- A general **description** and narrative **scenarios** outlining the basic role and rationale for the page
- Concrete, specific, measurable **goals** couched in terms of **target visitors** to the site
- A list of the specific **elements** that must make up each page
- The specific **person or people responsible** for maintaining the content on the page
- Normative **definitions of page success** described in terms of the goals defined earlier
- Concrete **metrics** that can be used to determine if success criteria are being met
- An **evaluation schedule** by which metrics will be evaluated
- A **plan for remediating deficiencies** uncovered by the periodic evaluations

In addition, the specification will describe the required hardware, software, database and GIS technology needed to accomplish the solution. The full specification document is likely to be about 50 pages and will serve not only as a guide, but also a means of communication and organization among team members. It can also serve as a blueprint that can be disseminated to other states or regions wishing to implement a similar solution.

This phase of the project is where most of the conceptual work and long-range planning will take place. Participants in this will be Jon Miles, Maria Papadakis, Morgan Benton, James Wilson, and VWEC. Technical consultation will be provided by ESRI. This deliverable will be carried out during the summer and completed by the end of September 2009.

### *Implementation*

A website consists of several components which, using the specification document, can be developed and implemented in parallel:

- **Graphic Design**
  Responsible for providing a usable and aesthetically pleasing look and feel. Design work will be contracted out to JMU's in-house CISAT Creative Services department. Morgan Benton will be responsible for coordinating this effort with Creative Services.
- **HTML Coding**
  Implemented in an appropriate server-side programming language, such as ASP.Net, the HTML for the site provides the informational skeleton for the content. The HTML will be implemented by student employees under the supervision of Morgan Benton and James Wilson.
- **Database Design**
  The database will house the GIS-based wind resource data, economic data (utility rates, incentives, etc.), and turbine data needed to provide consumers with a report. The database will be perhaps the most time and labor intensive components of the project. Database design will be completed by Morgan Benton and James Wilson with consultation from ESRI.
- **Database Population**
  Once designed, the database will need to be populated with the appropriate data. This will be accomplished by student employees under the supervision of Morgan Benton and James Wilson. Over the long term, responsibility for maintaining the currency and accuracy of the data will be shifted to VWEC and/or the Mid-Atlantic regional consortium of partners in this project.
- **CSS Coding**
  Cascading Style Sheets (CSS) are the standard means of converting a graphic design into web form. CSS for this project will be implemented by student employees under the supervision of Morgan Benton.

Implementation is an iterative process, meaning that a first prototype of the site will be built with extremely limited functionality, and that site will be enhanced with features added until all functions in the specified feature set are complete. An early prototype is expected in early fall of 2009. Full functionality for the Virginia-only tool is expected in early spring of 2010. The Mid-Atlantic tool will be functional in spring of 2011.

### *Testing for Usability, and Section 508 Compliance*

Regardless of the quality of information provided by the website, if the site is not usable, the effort is pointless. In 1998, Congress amended the Rehabilitation Act Section 508 to require Federal agencies to make their electronic and information technology accessible to people with disabilities. The NextStep Online Calculator must meet these requirements. Morgan Benton has experience building 508-compliant sites for the Virginia Department of Historical Resources and other clients. In order to complete this phase, a usability lab will be provisioned at JMU and members of the target population for the calculator will be recruited to participate in usability studies. The study participants will also be recruited from populations which exhibit visual, aural, motor and/or cognitive disabilities. These studies will be conducted by student employees under the supervision of Morgan Benton at multiple stages throughout the implementation process. There will be an early, a middle and final usability study. Each study will result in a report on the usability and accessibility deficiencies uncovered and recommended steps for remediating these deficiencies. These should be complete by late spring of 2010.

## *Maintenance*

It is reasonable to predict that the NextStep Online website will exist for at least the next ten years. Given that time frame, over 90% of the lifespan of the tool will be devoted to maintenance. The following are foreseeable dimensions of the maintenance task:

### Keeping Data Up-to-Date

The accuracy of the reports produced by NextStep rely on having accurate

- wind resource data
- maps
- energy rates from utilities
- specifications from turbine manufacturers
- incentive information from local, state, and federal governments
- information related to local zoning ordinances

Monitoring, collecting, and tending to the changes in this data will be a continuous task throughout the life of the tool. VWEC will be the custodian of the website and will be responsible for ensuring that this data is reviewed and updated on a regular basis.

### Changes in the Internet, Browsers, and Usage Patterns

The Internet changes quickly. New standards emerge. Browsers evolve. User behavior evolves. In the next ten years is it is likely that the speed and ubiquity of the Internet will expand greatly. Mobile interfaces are expected to develop rapidly both in adoption and in ease of use. It is reasonable to expect these changes and to make plans for corresponding updates to the tool. After the initial tool development described in this proposal, VWEC, as custodians, will be responsible for contracting with programmers to make any necessary innovations or renovations to the site architecture.

### Long Term Sustainability

Maintaining the data and technical infrastructure as described just now is going to require an ongoing source of support over the life of the tool, which may be ten years or more. The specification document that will be produced in the analysis phase of the project, as well as experience with the completed site over the first year of its existence should provide the data needed to estimate a reasonable ongoing budget. It is anticipated, however, that in-house resources at VWEC and CEES could be provided to maintain the tool's database. More significant structural changes due to changes in the Internet, browsers, or web-usage patterns would be funded through future requests for support.

## *Scaling Up from Virginia to the Mid-Atlantic Region and Beyond*

The prior four steps—analysis, implementation, testing, and maintenance—will be completed for a Virginia-specific tool. If successful, the next step for NextStep would be, during year two, to scale it up to cover a larger geographical region. More specifically, it is anticipated that the NextStep tool would be replicated and deployed in the states of Maryland and North Carolina, both of which are DOE priority wind states. From a technological perspective, this means:

- **More Data**
  The wind resource data, economic data, turbine data, installer and vendor data from the additional states must now be incorporated efficiently into databases for those states.
- **More Visitors**
  As the pool of potential site visitors increases, so will the traffic to the website. The server

infrastructure must be able to scale to handle the increased bandwidth and processing capacity that will be necessary to prevent the site from grinding to a halt.

- **More Coordination**
  Necessarily, the number and proximity of the people involved in maintaining the site will increase, and along with that the cost of coordination will rise dramatically. Thought must be given to how this growth will occur.
- **Different Policy Environments**
  The knowledge and attitudes of key stakeholders (state and local governments, legislators, utilities, consumers, etc.) as well as the laws and rules with respect to the small and community wind sectors in the new states is expected to differ substantially from Virginia. This difference is likely to have unexpected consequences for the technical and database design of the systems to be built in those states.

Whereas for the Virginia-based tool the body in charge of maintaining the site has been designated to be VWEC, it is proposed that in this phase of the project a larger organization be developed for the Mid-Atlantic region called the Mid-Atlantic Wind Energy Collaborative, or MAWEC. The creation of MAWEC and the incorporation of the MAWEC data into NextStep would happen as follows.

During spring of 2010 Jon Miles, Maria Papadakis, and other members of VWEC would reach out to their contacts and colleagues in high priority wind states in the Mid-Atlantic region. By this time, the Virginia-based tool will be up and running and available as a demonstration of what is proposed for these states. A partner institution in each state will be identified and then during the early summer of 2010 JMU will host a meeting which representatives from all of the MAWEC states would attend. The representatives would receive training on the technical upkeep required by the tool, and a plan for collecting and integrating the data from the new states will be developed. By late summer, Morgan Benton will have developed a plan and schedule for implementing the MAWEC version of the NextStep tool in those states in conjunction with the partner states.

Beginning in fall of 2010, a new development effort will begin that will essentially repeat the steps of the previous year, this time in the neighboring states. It will be necessary to develop a new graphical design to meet the needs of the new partners. A best case scenario would be that the architecture designed for Virginia easily scales up to handle the extra data brought in by the new states. However, the best case scenario is not likely. A more realistic scenario is that the data gathering and organization practices, the incentives, the cost structure for utilities and other factors will be significantly different in other states, requiring that some functionality for the MAWEC tool be significantly reworked from the VWEC version. As before, this development effort is expected to end in the spring after it was begun, i.e. 2011.

## Deliverables and Decision Points

There are several clear decision points that result from the development process described above:

- **Decision Point #1: VWEC NextStep Tool is Complete**
  This point comes in mid-to-late spring of 2010. Based on the experience building the VWEC version of NextStep, the decision to be made is should we proceed to try to build MAWEC?
- **Decision Point #2: Post-MAWEC Summit**
  After the MAWEC representatives meet in early summer of 2010, a decision needs to be made as to the true scalability and feasibility of creating the regional versions of the tool.

## Criterion 3: Qualifications and Resources

This section will:

- Demonstrate the capabilities, experience, record of success at technical innovation, qualifications, credibility, and credentials of NextStep's team members
- Establish the availability of required equipment, laboratory and demonstration facilities, analytic support, and other necessary resources for bringing NextStep
- Demonstrate support of each team member's participation via letters of commitment

### Critical Competencies and Record of Success

Our team consists of a variety of members that collectively have many years of experience and success in the areas of:

- Developing and deploying wind energy solutions
- Building coalitions and doing outreach and community development with consumers
- Developing and deploying Section 508 compliant web-based applications in the public sector
- Developing and deploying GIS solutions

In particular, this project brings to bear the skills and technical resources of the Virginia Wind Energy Collaborative (VWEC, http://vwec.cisat.jmu.edu) and the Center for Energy and Environmental Sustainability (CEES) at James Madison University. VWEC and CEES together represent substantial expertise on the scientific and technical aspects of wind, public perceptions of and attitudes toward wind power, and energy life cycle costing, payback, and other economic analysis. These two centers are responsible for implementation of grants from the US DOE to participate in programs supported by Wind Powering America, from the Commonwealth of Virginia in support of the Virginia Coastal Energy Research Consortium, and the National Science Foundation. VWEC also implements the Commonwealth of Virginia's State-Based Anemometer Loan Program (SBALP) and state support for feasibility analysis of community and utility scale wind at NASA Wallop's Flight Facility, at the Ocean Naval Air Station, and on Tangier Island. CEES implements the Virginia Pilot Farm Energy Audit Program (funded by the Virginia Department of Mines, Minerals, and Energy—Energy Division), and conducts agricultural energy research, outreach, and programming in partnership with the Shenandoah Resource Conservation and Development Council, a non-profit association affiliated with USDA's Natural Resources Conservation Service. The directors of VWEC (Dr. Jon Miles) and CEES (Dr. Maria Papadakis) are the principal investigators for the Virginia Renewables Siting Scoring System ($VRS^3$), a land-use planning method developed for suitability analysis and site prescreening for wind power systems. Extensive public outreach over the past 3-4 years by these programs include multiple small stakeholder meetings, two wind workshops hosted by the Appalachian Regional Commission, over a dozen county land use planning presentations, land owner technical assistance and support, two state annual wind symposia, an on-farm energy savings workshop, and participation in several state and regional clean energy fairs. The key personnel from JMU on this project will be introduced below.

Dr. Jonathan Miles is a professor in the Department of Integrated Science and Technology at James Madison University and a founding member of CEES at JMU within which he directs the Wind Power Applications and Technologies Team (WPATT). The WPATT is staffed full time and supports the efforts of both the Virginia Wind Energy Collaborative and the Virginia Coastal Energy Research Consortium. Dr. Miles also leads his department's flagship study-abroad program in Malta, and recently secured approvals for a new dual-degree international master's degree program in Sustainable Environmental Resources Management to be offered jointly by JMU and the University of Malta that will open in August 2009. Dr. Miles formerly served on an IPA assignment at the U.S. Department of Energy (DOE) where he supported the DOE's Wind Powering America (WPA) program with emphasis on mid-Atlantic and southeastern states and to the Regional Wind Energy Institute (RWEI) at the Southern Alliance for Clean Energy (SACE). Dr. Miles also supports the Wind for Schools (WfS) program being developed by the National Renewable Energy Laboratory (NREL) and piloted with six western state universities and for which his emphasis is on curriculum development.

Dr. Miles has received numerous grants since 2001 from the U.S. Department of Energy, the Virginia Department of Mines, Minerals, and Energy – Energy Division, from the National Science Foundation, and from industry to examine a range of problems and issues pertaining to wind energy. He founded the Virginia State-Based Anemometer Loan Program in 2002 and was a co-founder of Virginia's Wind Working Group in 2003. He has since developed a suite of tools and resources to in support of wind deployment and conducted a comprehensive feasibility study for large wind at NASA's Wallops Flight Facility. Among the awards and accolades he has received are the 2007 Wind Powering America Eastern Regional Wind Advocacy Award, a 2005 Provost's nomination for the State Council of Higher Education for Virginia Outstanding Faculty Award, and 2004 Innovation Award from the Interstate Renewable Energy Council.

Dr. Maria Papadakis is professor of Integrated Science and Technology at JMU and Director of the Center for Energy and Environmental Sustainability. Dr. Papadakis has cross-disciplinary expertise and 25 years of professional work experience in the federal government and university sectors. She has regularly taught courses in environmental policy and regulation, energy economics, energy policy and regulation, instrumentation and measurement, mathematical modeling, and energy management. Her current professional work focuses on greenhouse gas mitigation, building and facility energy management, energy efficiency and conservation in agriculture, and small-scale renewable energy systems. Dr. Papadakis' research has been funded by the Social Science Research Council, the National Science Foundation, the US Department of Energy, the Virginia Department of Mines, Minerals, and Energy, and the US Department of Housing and Urban Development. Maria is a council member of the Shenandoah RC&D and a member of the Soil and Water Conservation Society. She is currently completing her credential as a Certified Energy Manager with the Association of Energy Engineers.

In addition, the principal investigator for this project, Dr. Morgan Benton, has substantial experience developing and deploying Section 508 compliant web-based applications in the public sector. Dr. Benton has eleven years of experience building and deploying web sites and web applications, designing databases, and managing network server resources. He is the founder and principal at Morphatic, a consulting firm providing website solutions to small and medium sized clients. He has built Section 508 compliant websites for the Virginia Department of Historical Resources, such as the Historical Highway Marker Search Engine that was launched in time for the 2007 quadrennial celebration of the founding of Jamestown. He has also launched large scale projects, such as the website for the Public Performance and Reporting Network, an online community of elected officials, public servants, academics, and citizens consisting of over 2000 people and organizing a large database of community resources designed to make government more effective and efficient.

Relatedly, Dr. James Wilson has 25 years of experience with developing and supporting information technology solutions including nearly 20 years of working with Geographic Information Systems. He was formerly the Geospatial Application Integration Manager for the Virginia Geographic Information Network (VGIN) and is currently the State University Representative on the Virginia Geographic Information Network Advisory Board (a 5-year gubernatorial appointment). James has been teaching a course on Internet GIS since 2002 and has been the PI, Co-PI, and senior personnel on projects worth approximately $300,000 with funding coming from the Federal Geographic Data Committee, the U.S. Geological Survey, the U.S. Forest Service, several U.S. Department of Defense contractors, and the National Endowment for the Humanities, among others.

Key support on this project will also be supported through a sub-contract with ESRI. Since 1969, ESRI has given customers around the world the power to think and plan geographically. The market leader in GIS, ESRI software is used in more than 300,000 organizations worldwide including each of the 200 largest cities in the United States, most national governments, more than two-thirds of Fortune 500 companies, and more than 7,000 colleges and universities. As a closely held, privately owned corporation, ESRI continues to grow. All revenue is directly related to GIS. Over the past thirty years, ESRI has conducted more than 2,000 GIS projects throughout the United States and the world. Throughout our past projects, ESRI has discovered that cost, risk, functionality, and time are key factors in the success of any project. ESRI is continually selected as the GIS vendor of choice for companies because of their ability to satisfy customers.

### Equipment, Labs, Facilities, Staff, and Other Support

James Madison University will provide the housing and infrastructure necessary to complete this project including office space, usability lab space, network resources including server housing, facilities for meetings, and administrative support. The Virginia Wind Energy Collaborative will provide staff support on the order of 20% of one staff member's time to aid in managing the tool development and organizing the communication efforts between the target audiences.

### Letters of Support and Commitment

See attached letter of commitment from ESRI.

## Criterion 4: Results Dissemination

Disseminating the NextStep tool to the target user audience involves (1) marketing the tool to landowners within the 3-state region, and (2) informing electric power utilities, the wind industry, and the planning community about the calculator in order to facilitate their marketing of the tool to landowners as well. JMU will collaborate with the Maryland and North Carolina Wind Working Groups (with whom we already have a good working relationship) to determine the best "institutional home" of NextStep for those states. This project will provide start-up marketing materials for dissemination in Maryland and North Carolina, comprehensive marketing materials and initiatives in Virginia, and participation in many regional, mid-Atlantic events. Marketing techniques will include both social marketing (e.g., to enhance public understanding of wind power) and product marketing (e.g., the NextStep tool). By way of illustration, marketing techniques include, but are not limited to:

- Direct mailing to all counties in the region and planning district commissions.
- Direct mailing to targeted end users, such as golf courses, hospitals, wastewater treatment plants, and so forth.
- Outreach and demonstration booths at appropriate regional events, such as annual agricultural expos, energy fairs, southeast region annual Resource Conservation and Development Council conferences, and electric utility workshops.
- NextStep workshops held specifically for small wind installers.
- Press releases through James Madison University and other Wind Working Groups.
- Presentations to electric utilities (cooperative, investor-owned, and municipal) in the region.
- Outreach through the USDA cooperative extension service.
- Direct mailing to all of the USDA Resource Conservation and Development Councils in the region.

- Email listservs.
- Feature articles and advertisements in regional magazines such as *Cooperative Living*, which is sent to all customers of the Old Dominion Electric Cooperative (serving Virginia and Maryland).
- Outreach to specific agricultural trade groups, such as the Virginia Poultry Federation.

Marketing and outreach to the agricultural sector will take place primarily through CEES/Dr. Papadakis; VWEC/Dr. Miles and CEES will jointly work with the electric power utilities. VWEC will be responsible for all other marketing initiatives to target market segments.

Although this project develops the NextStep tool specifically for the high priority mid-Atlantic region, it is readily adaptable to all other states. As a consequence, we will make publicly available the underlying programming of NextStep, and develop an "instruction manual" with guidance on how to adapt it to other state contexts. NextStep will also thus be disseminated/marketed nationally through presentations at AWEA events, direct mailings and phone calls to state energy offices, and other state wind organizations.

Other dissemination and outreach initiatives include:

- **The NextStep Website**
  The tool itself will be a publicly available website. The site will be designed with search-engine-friendliness in mind. In a sense the tool will disseminate itself.
- **MAWEC Summit**
  This will be a meeting during year two of the key players in the mid-Atlantic states that will be participating in the scaled up version of the tool.
- **Conference Presentations**
  Team members plan to present results at the following conferences and venues:
  - American Wind Energy Association Annual Conference (AWEA—national)
  - American Planning Association Annual Conference (APA—national)
  - Old Dominion Electric Cooperative annual conference and workshop (Virginia)
  - Association of American Geographers Annual Meeting (AAG—national)
  - ESRI Educational User Conference (national)
  - Virginia GIS Conference (Virginia)
  - International Conference on Information Systems (ICIS—international)
- **Journals and Magazines**
  Target venues for this work include but are not limited to:
  - *Planning Commissioner's Journal*
  - *Cooperative Living*
  - *Newsletter of the Rural Electricity Resource Council*
  - *International Journal of GIS*
  - *Transactions in GIS*
  - *Professional Geographer*
  - *ArcNews*
  - *The Virginia Geospatial Newsletter*

## Other Selection Factors

### Geographic Diversity

As discussed earlier, our tool is designed as a site prescreening/suitability calculator for property owners, and will enable them to assess the technical and economic feasibility of a property for wind power before engaging in costly and time-consuming site characterization and analysis. The tool will be suitable for use by, and indeed target people in regions not only with more substantial class 3+ wind (ridge lines and coastal regions), but also in rural areas where the class of wind is lower, but which are underserved by the current market and which offer the opportunity to accelerate the "mindshare" of a population wary of the impacts of larger scale wind projects that may come in the future. Although the emphasis of our efforts will be on DOE WPA priority states in the mid-Atlantic region, through the dissemination of reports of our experiences, and also the specifications of our system at national conferences we expect our tool to have a national impact.

### Technological Diversity

NextStep will be a web-based application that incorporates a geospatial database to provide educational content and thorough reports to a diverse set of stakeholders. Ensuring section 508 compliance will mean that the site will be accessible in some form to site visitors regardless of visual, aural, motor, or cognitive disability status. In addition, search engine friendliness will ensure that the tool over time will earn higher rankings from search engines, thereby increasing its impact.

## Project Timetable

| Time Period | Activities |
|---|---|
| **Summer 2009**<br>01 Jul 2009 – 30 Sep 2009 | • Complete full website analysis and specification |
| **Fall 2009**<br>01 Oct 2009 – 01 Dec 2009 | • Iterative development of site prototypes<br>• Incremental usability testing and section 508 compliance analysis |
| **Winter 2009-2010**<br>01 Dec 2009 – 01 Feb 2010 | • Launch of public beta<br>• Continued user testing based on public beta feedback |
| **Spring 2010**<br>01 Feb 2010 – 01 Jun 2010 | • Final testing and usability analysis of tool<br>• Public launch<br>• Build partnerships in mid-Atlantic<br>• Market the VA tool to target constituencies within VA |
| **Summer 2010**<br>01 Jun 2010 – 01 Sep 2010 | • Host meeting/ workshop for partners<br>• Complete analysis to upscale tool to cover mid-Atlantic states |
| **Fall 2010**<br>01 Sep 2010 – 01 Dec 2010 | • Implementation of tools for partner states |
| **Winter 2010-2011**<br>01 Dec 2010 – 01 Feb 2011 | • Beta launch of tool in partner states<br>• Usability testing of partner tools |
| **Spring 2011**<br>01 Feb 2011 – 01 Jun 2011 | • Marketing efforts to encourage use of the NextStep tool in the mid-Atlantic partner states |

| | |
|---|---|
| | • Final testing and usability analysis of upscaled tool<br>• Official launch of tools in partner states |
| Post-Project / Ongoing<br>**Through 2030** | • Periodic maintenance of data in the database<br>• Site enhancements to account for changes in Internet infrastructure |

## Project Narrative Appendix:

Letter of Commitment from subrecipient, ESRI, next page.

February 26, 2009

Mr. John D. Hulvey
Director
Office of Sponsored Programs
James Madison University
MSC 5728
Harrisonburg, VA 22807

Reference: Letter of Commitment from ESRI for 20% Wind by 2030: Overcoming the Challenges Topic Area 2C - Distributed Wind Technologies (DWT) Site Analysis Tool

Dear Mr. Hulvey:

ESRI is available to provide geospatial consulting support for the development of an ArcGIS Server-enabled geodatabase design and associated data development that will support the 2D and 3D visualization environment for the Distributed Wind Technology Site Analysis Tool. ESRI will also provide the necessary system architecture consulting support to assist James Madison University in the configuration and tuning of the ArcGIS Server and ArcSDE implementations.

ESRI will provide this consulting to James Madison University in support of the project "20% Wind by 2030: Overcoming the Challenges Topic Area 2C - Distributed Wind Technologies (DWT) Site Analysis Tool" to the U.S. Department of Energy. I'm pleased to offer the support of ESRI to this project, under the leadership of Dr. Morgan Benton at James Madison University.

If a grant is awarded by the sponsor to support the proposed program, ESRI will perform the work as outlined in the project narrative and in accordance with the ESRI -approved budget. The appropriate ESRI officials have administratively approved this proposal.

For additional assistance or questions regarding ESRI's intent to participate in this activity, please contact John Perry at the following:

John D. Perry
Contracts Manager
ESRI-Professional Services Division
380 New York Street
Redlands, CA 92373-8100
Ph 909-793-2853, ext. 1133
Fx 909-307-3034

We look forward to collaborating with James Madison University and anticipate a successful project. Signature below indicates ESRI approval for commitment of resources.

Sincerely,

Laura Dangermond
Vice President