



# WIND ENERGY ASSESSMENT AND DEVELOPMENT

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Visit us on the web at:

[www.armgroup.net](http://www.armgroup.net)



**ARM Group Inc.**

Earth Resource Engineers  
and Consultants

Pennsylvania is currently the leading producer of wind power east of the Mississippi River. Despite being the wind energy leader in the east, Pennsylvania is currently only generating approximately 250 megawatts of an estimated more than 5,000 megawatts of untapped wind power in the state. The growth potential for wind energy production in the state is immense, and the PADEP estimates that nearly half of all the homes in Pennsylvania could be supplied by wind-generated electricity if this potential is strategically exploited. With federal tax credits in place and generous government grants for wind energy development available, now is an opportune time to meet rising energy demands by evaluating the potential for wind energy production at your site.

ARM can coordinate all aspects of wind energy development beginning with a preliminary feasibility assessment and culminating with completed installed capacity. ARM's services include:

- Initial Project Feasibility Evaluation
- Economic and Financial Viability Analysis
- Wind Resource Assessment
- Land Development Planning, Zoning Approval, and Permitting
- Environmental Impact Study including:
  - Sensitivity Receptors
  - Visibility Study
  - Ecological Effects
  - Avian Impacts
  - Noise Assessment
  - Erosion and Sedimentation Control
- Public Inquiry Coordination and Outreach and Liaison with Planning Officials
- GIS Mapping and Visualizations
- Landowner Agreements
- Wind Turbine Layout Design and Optimization
- Civil Infrastructure Engineering and Micro-siting Evaluation
- Geotechnical Investigation and Recommendations
- Project Management
- Grid Connection Issues and Utility Purchasing Agreements

From individual windmills for on-site electrical supply (small wind) to 50-megawatt wind farms for retail electrical production, ARM has the experience and resources to successfully harness the energy producing potential of the wind blowing over your site. Let ARM assist you in assessing and developing your site's wind energy resource, and you will not only realize long-term cost savings and profit potential, but you will also be contributing to the growing movement toward energy independence and a cleaner environment for future generations.



# WIND ENERGY ADVISORY SERVICES

Commercially viable wind turbine sites are a valuable natural resource. The Pennsylvania wind map indicates that only about 4% of the area of the State has the wind speeds needed to support a commercial wind energy project. As much as half of this land is located within state gamelands, state forests or parks where commercial development potential may be restricted by competing land uses or conservation regulations. Additionally, the large distance to existing electric transmission lines may preclude development of some of the remaining areas.

ARM Group can assist Owners of potentially suitable wind energy property in:

- ◆ evaluating the viability of their property for a commercial scale wind project;
- ◆ assessing the potential total development value of the property;
- ◆ advising how to structure agreements to maximize the total development value.

ARM's advisory and consulting services generally include, but are not limited to, the following:

## SITE SUITABILITY SCREENING

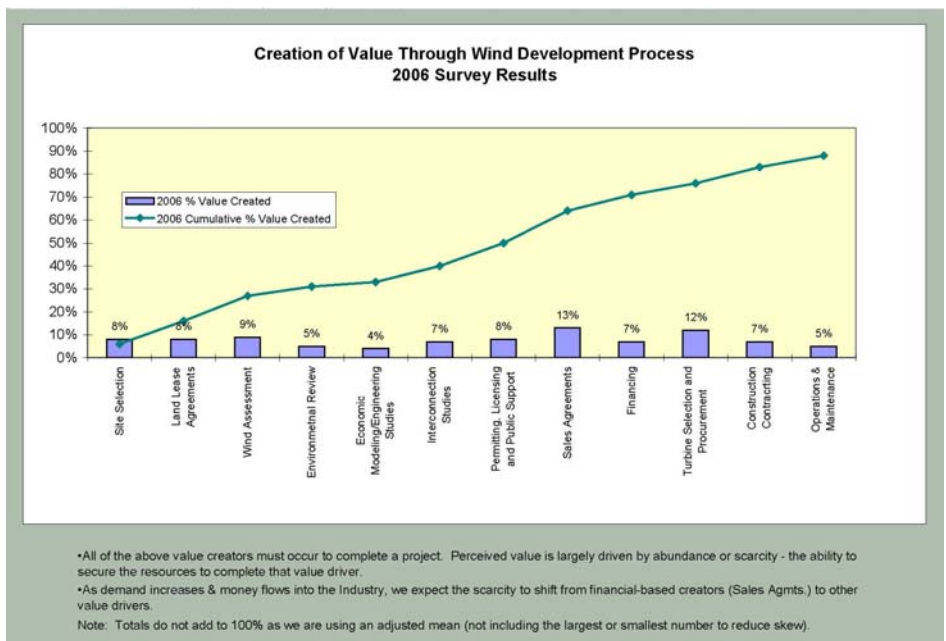
Using a desktop analysis approach, ARM can evaluate the available land area, exposure to the wind, existing land uses, proximity to residences and property boundaries, and possible electrical interconnection points for the plant to identify areas that appear suitable for utility scale wind energy development. Using available wind mapping, ARM can develop a preliminary financial analysis to determine whether a wind project may be financially viable and attractive.

The Chart below illustrates how each of the elements (events/milestones) of a commercial scale wind energy project feasibility/economic viability study contributes to the net increase in the total development value of a given property. Each of the events/milestones listed on this Chart, and able to be executed by ARM, plays an important role in ensuring that Owners maximize the value of their asset.

ARM is well-positioned and has the experience to provide financial, scientific, and technical guidance throughout the entire commercial wind energy development process. Whether the project involves only advisory service including the assessment of a property's potential value through the completion of a desktop study and preliminary financial modeling, or whether it involves a formal wind resource assessment, zoning/permitting, environmental surveys, foundation studies, wind turbine selection/procurement, and PPA negotiations, ARM is prepared to maximize the value of your asset and provide high quality, cost-effective, client-focused professional consulting and engineering services.



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## 1 — LEASE/ROYALTY APPROACH

The simplest approach to develop the project is to offer the property for lease to a wind power developer. This would require no investment on the Owner's part, but would result in the minimum potential value for the property.

There are essentially three types (any combination) of payment arrangements that Owners can make with wind developers on lease agreements. Each type of payment has its own risk, which is proportional to the risk taken.

- ◆ First is a single up front payment. As the value of wind is expected to increase over time this type may not be the best form of lease.
- ◆ Second is a fixed annual payment. This is less risky for the landowner but it may result in a smaller share of the turbine revenue.
- ◆ Third is a percent of the revenue from the energy sales. This type of lease carries the most risk, as the income will vary depending on the output of the wind turbines, but has the potential for a high return to the Owner.

A combination of any of the first three lease types could be utilized. One possibility may include a fixed payment per acre along with a share of the revenue from each turbine. To date the most common lease payment method has been a fixed annual lease payment. A developer would typically offer about \$2,000 to \$4,000 a year for each wind turbine location as a lease payment or royalty. The return to the Owner would thus depend on the developer's estimate of the number of turbines that could be placed on the site, the value of the wind resource and the cost of development. Site-specific information provided by the Owner to support the viability of the site would be useful in negotiating a higher lease or royalty arrangement.

## 2 — OWNER DEVELOPMENT

The second option available to the Owner is to undertake the development of the property on their own. Under this scenario, the Owner would fund the site-specific studies required to prove the value of the wind resource and the feasibility and cost of project development. Once the resource is proven, a long-term Power Purchase Agreement (PPA) would be sought with a utility or with a green energy marketer. With a PPA, financing of the construction of the project could be arranged. Or alternatively, the property/project could be sold to a developer at a much greater value to the Owner based on the financial benefits of a proven project.

## 3 — EQUITY PARTNERSHIP WITH DEVELOPER

A third option is to participate as an equity partner in the development of the project. This option has the potential to dramatically increase the Owner's return on the property while managing risk by partnering with an experienced developer and sharing the investment. There are a number of developers that may be willing to discuss an equity partnership arrangement.

# HARRISBURG AUTHORITY

## WIND ENERGY FEASIBILITY STUDY

### HARRISBURG, PA

ARM has completed a comprehensive feasibility study and wind resource assessment for the City of Harrisburg, PA that evaluated the potential for locating a 30-megawatt wind farm on the ridgeline above the DeHart Reservoir in Dauphin County. The study was funded through a grant from the Pennsylvania Energy Development Authority (PEDA). The year-long study concluded that the project could generate in excess of 60,000,000 kilowatt-hours per year, which could meet the electrical needs of 4,000 homes. ARM, with its subconsultant AWS Truewind, completed the following components of the feasibility study:

#### Wind Resource Assessment

A 50m meteorological tower with multiple wind anemometers was installed on the ridge top above the DeHart Reservoir to collect wind speed measurements and other meteorological data over a 12-month period to evaluate the energy producing potential of the wind at the site.

#### Environmental Studies

ARM completed a preliminary environmental impact assessment, which involved the following evaluations:

- Habitat Survey
- Bird and Bat Survey with Risk Assessments
- Wetlands identification
- Noise Assessment
- Comprehensive Visibility Study with Scaled Renderings of the Proposed Wind Farm



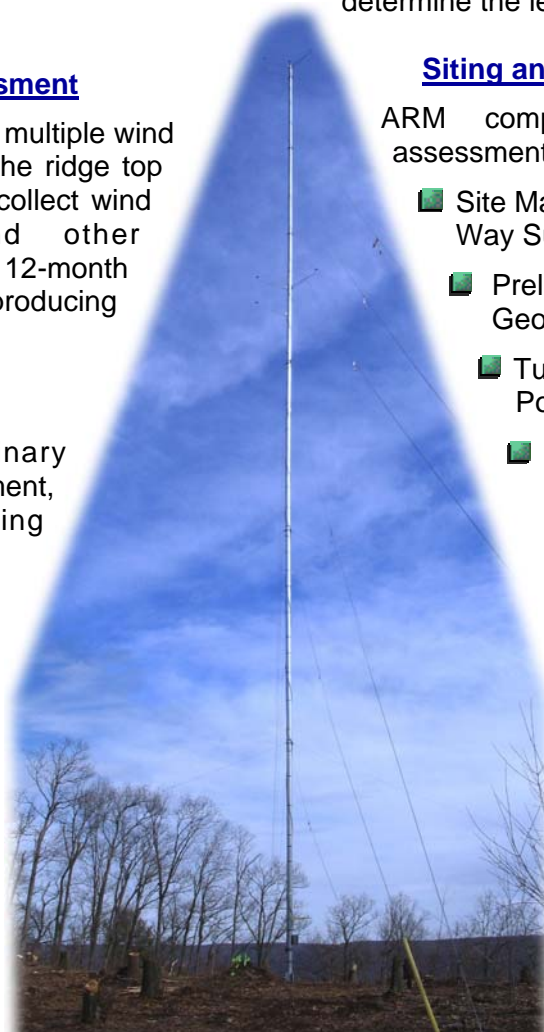
#### Community Outreach/Impact Studies

ARM conducted a study to assess the potential impact to the surrounding community and to determine the level of local support for the project.

#### Siting and Facility Layout Evaluation

ARM completed the following studies/assessments:

- Site Mapping and Easement/Right-of-Way Surveying
- Preliminary Civil Infrastructure and Geotechnical Feasibility Evaluation
- Turbine Size, Number, and Strategic Positioning
- Conceptual Site Design including Transmission Line and Access Road Layouts
- Interconnection Studies
- Cost Estimate and Detailed Cash Flow Modeling



# CHESTER COUNTY SOLID WASTE AUTHORITY SMALL WIND TURBINE CHESTER COUNTY, PA

The Chester County Solid Waste Authority (CCSWA) received a Pennsylvania Economic Development Authority (PEDA) grant to install a windmill on their landfill to generate electricity. CCSWA hired ARM Group Inc. to coordinate the permitting and to prepare a foundation system for the placement of a 1.8 kW small wind turbine on top of a geosynthetic-capped municipal solid waste landfill. On behalf of CCSWA, ARM attained building and zoning permits for the proposed project.

Based on the unique subsurface conditions at the proposed windmill site, ARM developed a foundation scheme to essentially “float” the loads imposed by the tower on the constantly settling surface of the landfill. ARM worked with a structural engineer to design a custom-fabricated steel foundation that would provide stability and the ability to relocate the windmill in the

future. Additionally, ARM’s engineers developed customized geotechnical foundation specifications for the structural fill pad underlying the steel foundation. ARM directed the construction of the foundation pad and tested the compacted soil with a nuclear density gauge to ensure that adequate compaction was achieved.

The selected windmill, a *Skystream* 1.8 kW model fabricated by Southwest Windpower, was erected at the site in May, 2007. The windmill is approximately 41 feet tall when a single blade is in the vertical position. The entire assembly weighs approximately 200 lbs. ARM also provided construction quality assurance services on behalf of the owner, which included soil and steel connection (subcontracted) inspections to ensure that the windmill was installed and connected in accordance with the project specifications.



# LANCASTER COUNTY SOLID WASTE MANAGEMENT AUTHORITY WIND RESOURCE ASSESSMENT LANCASTER COUNTY, PA



ARM performed a preliminary feasibility study for the Lancaster County Solid Waste Management Authority (LCSWMA) to assess the wind energy generation potential of their Landfill Site along the Susquehanna River in Lancaster County, Pennsylvania. Based on the results of this preliminary study, ARM was authorized to proceed with a 12-month wind resource assessment. A 60m meteorological tower equipped with six calibrated anemometers and two wind vanes was installed at the site in June, 2007. ARM, in connection with a specialty subconsultant, has been receiving and reviewing meteorological data transmitted from the tower to evaluate the site's potential for commercial scale wind energy production. Following the 12-month data collection period, ARM will assist in the development of a long term wind speed projection. Assuming the long term wind speed projection appears favorable for commercial-scale wind energy production, ARM will proceed with the following project tasks:

- Wind Turbine Layout Design and Optimization
- Economic and Financial Viability Analysis
- Land Development Planning, Zoning Approval, and Permitting
- Environmental Impact Study including:
  - ☞ Sensitivity Receptors
  - ☞ Visibility Study
  - ☞ Ecological Effects
  - ☞ Avian Impacts
  - ☞ Noise Assessment
  - ☞ Erosion and Sedimentation Control
- Public Inquiry Coordination and Outreach and Liaison with Planning Officials
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