United States Environmental Protection Agency

A Breath of Fresh Air for America's Abandoned Mine Lands

ALTERNATIVE ENERGY PROVIDES A SECOND WIND

U.S. Environmental Protection Agency
Office of Superfund Remediation and Technology Innovation (OSRTI)

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A Breath of Fresh Air for America's AMLs- Alternative Energy Provides a Second Wind

This report provides information for communities and other interested stakeholders about the development of wind energy at former mining sites. Local governments, residents and organizations may be interested in creating renewable energy resources and new economic opportunities at these sites. The report describes the mechanics of wind energy, details the various wind technology options, explores wind energy's environmental, economic and social impacts at mining sites, and provides case studies and next steps to help get projects in place.

Introduction

According to the U.S. General Accounting Office, there are between 80,000 and 250,000 abandoned mine lands (AMLs) across the United States. AMLs include abandoned mines and the areas adjacent to or affected by the mines. Because of safety or environmental concerns, the majority of these sites have never been considered for any type of reuse and have remained idle.

Wind energy projects hold the opportunity to change this situation. Wind energy is a renewable energy resource that does not generate pollution and has become an increasingly valuable way to diversify the nation's energy options. Spurred by technological advances, falling costs and rising energy prices, wind energy projects are being developed across the country.[1]

What is an AML

Abandoned Mine Lands (AMLs) are those lands, waters and surrounding watersheds where extraction, beneficiation or processing of ores and minerals has occurred. These lands also include areas where mining or processing activity is temporarily inactive.

AML sites are often located in areas that are ill-suited for more traditional commercial or industrial reuse opportunities. However, these sites can take advantage of local renewable resource attributes to generate electricity or produce power in a manner that increases energy efficiency, reduces the environmental impact of generation, and enhances energy diversity, while at the same time returning these lands to productive use. In addition, EPA has identified renewable energy development at mining sites as a key consideration for the Agency's reuse-related activities at contaminated sites.[2]

AMLs can serve as excellent locations for wind farms, as the requirements for a suitably-placed wind farm and the characteristics of AMLs are often similar to each other. First, wind farms require one critical element: a consistent and sufficient supply of wind. AMLs are often located in mountainous areas that receive consistent wind flows. Second, wind energy projects require access to large, open sites. The size of many AMLs means that large-scale wind turbines can be accommodated in one location. Third, many AMLs are located near existing infrastructure, including roads and power transmission lines. The availability of existing infrastructure can reduce project costs. As a result, while AMLs may be located in areas that are ill-suited for other commercial or industrial reuses, wind farms can be built and operated in these areas.

[1]The U.S. Department of Energy (DOE) estimated that in 2008 American wind plants would generate nearly 50 billion kilowatt-hours of wind energy, over one percent of U.S. electricity. According to the American Wind Energy Association, in 2008 the U.S. wind energy industry installed a record 8,500 megawatts of new generating capacity (capable of servicing more than two million homes). In 2009, according to DOE, the U.S. became the global leader in installed wind energy capacity, exceeding 25,000 megawatts.

[2] Since 2008, EPA has been working with DOE's National Renewable Energy Laboratory, unveiled a GIS-based catalogue of thousands of properties that could potentially host renewable energy production facilities. More information is available at http://www.epa.gov/renewableenergyland/.

What is Wind Energy

Wind is created by the unequal heating of the earth's surface by the sun. Wind's kinetic energy can turn the rotor blades of wind turbines, generating electricity.

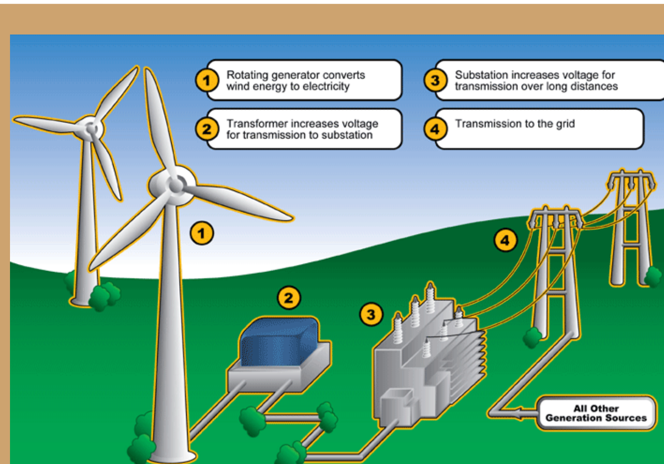
Why is it important

While a majority of the country's current electricity supply is generated from fossil fuels such as coal, oil and natural gas,[3] these traditional energy sources face a number of challenges including volatile prices, security concerns and environmental impacts from extraction and burning. As these non-renewable energy sources are depleted, electricity may become more expensive.

Wind farm in Colorado (source: National Renewable Energy Laboratory)

As communities become more concerned about the environmental impacts of fossil fuels, renewable energy technologies are expected to play a greater role in meeting future electricity demand. Generating electricity through renewable energy sources, like wind, can help reduce dependencies on fossil fuels and lower the amount of pollution associated with predominant power generation methods. According to the American Wind Energy Association (AWEA), wind energy "typically reduces the need for generating electricity from natural gas fired power plants, significantly reducing fuel expenditures and reducing operating costs for utilities and ultimately, lowering rates for their customers. These reduced fuel costs far exceed the incremental costs of adding wind power to their systems over time, including wind integration costs."[4] For communities, wind energy projects on AMLs can facilitate site cleanup activities; large-scale wind projects can generate significant beneficial local economic impacts from construction and operation.

Wind energy is a free, inexhaustible natural resource and a source of clean, non-polluting electricity. AWEA reports that an average sized (1.67 megawatt) wind turbine producing 5,000 megawatt hours of electricity annually could result in an over 3,000 ton reduction in emissions of carbon dioxide, a greenhouse gas that contributes to global warming.



Wind Turbine Components & Energy Transmission

Wind Turbine Components and Technology Trends

Wind turbines have four primary parts: a tower, a rotor, a generator and a nacelle. The turbine's tower extends from its base on the ground into the air and supports the turbine's nacelle and rotor. The nacelle is the streamlined casing that encloses the rotor and generator. The rotor's glass- and carbon fiber-reinforced plastic blades can be more than 100 feet long and are designed like airplane wings, producing lift that causes their rotation. As the rotor is turned by the wind, its shaft turns a generator, producing electricity. Cables carry the electricity generated by the turbine's rotor down the turbine tower to the ground where transmission lines (usually buried) collect and transport the power to a nearby substation or transformer where the electricity is connected to the utility grid.

[3] According to the Energy Information Administration, in 2007 over 70 percent of electricity net generation in the United States came from fossils fuels, nearly 20 percent came from nuclear power, and just over eight percent came from renewable sources, predominantly hydroelectric (six percent) and wind (one percent).
[4] AWEA's Fact Sheets – "Electric Utilities and Wind Power – A Good Mix," at http://www.awea.org/learnabout/publications/upload/Utility-Factsheet_WP11.pdf

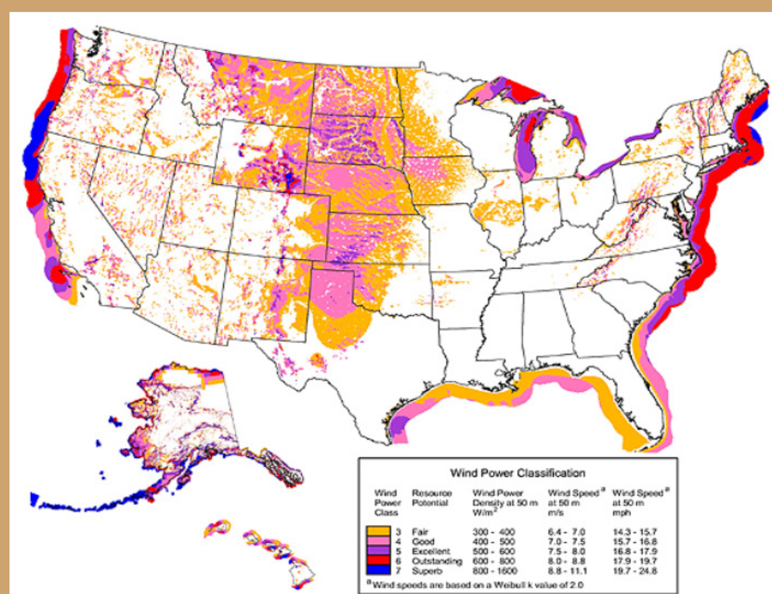
Turbines commonly installed today have three-bladed rotors placed on towers ranging from approximately 200 feet to 330 feet high. Towers approaching 330 feet will likely be an industry standard at marginal wind resource sites within the next few years. The average turbine in the United States in 2006 had a generating capacity of 1.6 megawatts. Typically, the taller the turbine, the greater the amount of electricity it will produce due to the turbine's longer rotor blades and potential exposure to uninterrupted, higher-velocity winds at higher elevations.

According to DOE, research is currently underway to improve all aspects of wind energy production, including, the rotor, blades, system controls, gearbox and related components and tower. In particular, focus is being placed on capturing wind opportunities at higher elevations because of the increased wind speed at higher elevations. Research is underway, for example, to build enlarged rotors that sweep larger areas or the same areas more efficiently.

According to AWEA, one megawatt of wind energy can produce about as much electricity as 225 to 300 households use. In a one-year period with average wind speeds of 12 miles per hour, a five megawatt turbine can generate over 15,000,000 kilowatt hours (15,000 megawatts) in a year – sufficient to power more than 1,400 households.

While there are small-scale wind turbines designed to meet the needs of individual homes and businesses, utility-scale (700-kilowatt to three-megawatt) wind turbines are required to support commercially viable wind farms.[5] A wind farm is a collection (anywhere from a few to over 100) of large wind turbines used to produce electricity.

Wind farms need to be located in areas with adequate wind resources, as stronger winds mean more power. Wind resources are characterized by wind-power density classes, ranging from Class 1 (the lowest) to Class 7 (the highest). According to AWEA, sites preferred for large scale wind plants generally have a class rating of 4 or higher, requiring average wind speeds over 15.7 miles per hour at 164 feet. Research efforts are underway, however, to take advantage of areas with less extensive wind resources. In the United States, good wind resources (Class 4 and above), which average over 15.7 miles per hour when the wind is blowing, are found across the country and concentrated heavily through the Great Plains from Texas to North Dakota. Opportunities for wind energy capture at 328 feet are even more widespread across the United States.



In the United States, good wind resources (Class 4 and above), which average over 15.7 miles per hour at 164 feet when the wind is blowing, are found across the country, and concentrated heavily from Texas to North Dakota. (sources: AWEA; DOE)

Areas of the United States with wind resources that can support wind farms include the Pacific coast, the Great Plains and the Appalachian Mountains. These areas are home to significant numbers of former mining sites. Colorado, a state with an extensive coal and hard rock mining history, has more than 1,500 AMLs. The state receives enough energy from Class 4 and higher winds to supply 14 percent of the electricity required by the lower 48 states.

[3] Turbines with up to five megawatt capacity are now being used offshore in the Atlantic and Pacific oceans.

Opportunities for Wind Energy Development on AMLs

There are a small but growing number of wind energy projects in operation at formerly contaminated sites, including mining sites, both in the United States and internationally. These projects include both utility-scale projects to generate electricity for the grid and smaller scale direct-use applications to provide power for the site's remediation and reclamation activities.

Large-Scale Wind Energy Projects

Local communities, government agencies and private developers have been building a range of utility-scale wind energy projects to meet state renewable portfolio standards, to help meet peak power demand, and to help state and local governments diversify their electricity portfolios. Several of these projects are in operation, both in the United States and around the world.

U.S. Wind Farms

Several wind farms located on AMLs and other mining properties in the United States have already moved beyond the planning stages, including the Buffalo Mountain wind farm in Tennessee, the Somerset wind farm in Pennsylvania, and the Glenrock wind farm in Wyoming. Examples of other operating or planned wind projects include:

- In 2006, a mining company operating in Cascade County, Montana completed a six-turbine wind farm to replace its diesel generator sets used for mining operations as well as to provide power to a local utility.

- In 2008, the Casselman Wind Power partially built upon a rehabilitated surface mine in Somerset County, Pennsylvania became operational. The 23 turbines at this wind power project generate 34.5 megawatts of electricity. Eight of the project's 23 wind turbines sit atop a rehabilitated surface mine. To encourage the productive use of this land, the Pennsylvania Energy Development Authority supported the Casselman project with a $500,000 grant to offset increased development costs. In addition, the former mining site will also host the wind farm's operation center, collector transformer and interconnection facility.

- In 2008, ground was broken on a reclaimed strip mine in Cambria County, Pennsylvania for the Highland Wind Project. The wind farm went on line in 2009 will eventually have a combined total nameplate capacity of 62.5 MW.

- The NedPower Mount Storm Wind Project is a 132-turbine wind farm located in part on land honeycombed by former coal and hard rock mining activities. Located along 12 miles of land between the Potomac River, Mount Storm Lake and the Town of Mount Storm in West Virginia's Tucker and Grant counties, the farm will have the capacity to generate up to 264 megawatts of electricity. Ninety-nine percent of the land will continue to be usable for other activities, including farming.

Below, the project highlights and lessons learned from four different wind farms are described in greater detail. Three of the wind farms are located on former mines; the fourth was constructed on a brownfields site.

Case Study #1: Establishing a Wind Project on a Former Strip Mine in the Southeastern United States: The Buffalo Mountain Wind Farm

In October 2000, Anderson County, Tennessee became home to the first commercial wind generation facility in the southeastern United States. The Tennessee Valley Authority (TVA), a federal corporation and the nation's largest public power company, built a three-turbine wind farm on a former strip mine site on Buffalo Mountain, a high ridge located just outside the municipality of Oak Ridge. The 660-kilowatt capacity turbines generate 4,000 megawatt hours of electricity annually, enough to power approximately 400 homes. After expansion in 2004, the wind farm now produces enough electricity to power nearly 4,000 homes.

The Buffalo Mountain wind farm is located on a former strip mine operated during the 1980s by the Coal Creek Mining and Manufacturing Company. When the mine ceased operations in 1990, the company completed reclamation activities, including backfilling and revegetating the strip-mined areas. When TVA approached the Coal Creek Mining Company about the possibility of siting wind turbines on the property, the company was provided an opportunity to explore an innovative reuse and generate revenue from an idle property.

Three wind turbines were installed on Buffalo Mountain in 2000. Part of TVA's Green Switch Program, a program developed to provide customers with access to renewable energy resources, the turbines provide power to residential and business customers through a renewable energy network. As of April 2003, the three turbines had produced 9,500 megawatt hours of electricity. As a result of the wind farm's success, in 2004 TVA added 15 large turbines expanding the wind farm's capacity from two to 29 megawatts. Over a 20-year period, TVA is purchasing the energy generated by the new turbines as part of a $60 million power-purchase agreement made with the turbine developers, Invenergy Wind LLC.

The entrance and wind turbines at the Buffalo Mountain Wind Farm in Anderson County, Tennesee. (source: TVA)

Case Study #2: Establishing Glenrock Wind Farm

In December 2008, Converse County, Wyoming became home to what is considered to be the first commercial wind generation facility located on a reclaimed coal mine in the western United States. PacifiCorp, which serves customers in Wyoming as Rocky Mountain Power, placed into service the first of three wind projects on the former Dave Johnston Coal Mine located about 12 miles north of Glenrock in the central-east portion of the state.

Glenrock wind farm in Wyoming. (source: PacifiCorp)

The Dave Johnston Coal Mine was the second coal mine established in Wyoming's Powder River Basin. Starting production in 1958, the mine served as a fuel source for the Dave Johnston power plant about 16 miles away. Coal production at the mine peaked in 1997, when it generated four million tons of coal. In 1998, a variety of factors resulted in plans for the mine's eventual closure in 2000. Final reclamation work on the nine-mile portion of mining-affected land began in 1999 and was completed in 2005. Reclamation efforts centered on transforming the landscape back to its pre-mining appearance to support grazing and habitat for wildlife and livestock.

Toward the end of the mine's transition period, however, Rocky Mountain Power also determined that wind projects could be sited on a portion of the reclaimed mine land. The area had excellent wind resources, was already owned by the company, and had access to existing transmission facilities Rocky Mountain Power ultimately, chose to construct three wind power projects (Glenrock, Rolling Hills, and Glenrock III) on company lands which included the former mine land. The three projects are collectively referred to as the Glenrock wind farm.

By January 2009, the Glenrock wind farm was fully operational. The wind farm has a combined wind energy generating capability of 237 megawatts with 158, 1.5 megawatt turbines spread across the three projects (Glenrock, Rolling Hills, and Glenrock III). The three projects cost around $500 million in total.

Turbines at the Glenrock wind farm in Wyoming. (source: PacifiCorp)

As part of the company's diverse mix of electricity generating resources, the three projects are estimated to generate sufficient energy to meet the electricity needs of about 66,000 homes annually. In addition, the wind farm is expected to result in considerable incremental property tax revenue for the county and state as well as and about 15 permanent jobs. At the height of wind farm construction, more than 300 people were employed in temporary construction jobs. Rocky Mountain Power is also working with local colleges to expand educational opportunities in wind energy technology.

The development of the Glenrock wind farm by Rocky Mountain Power was unique because it involved locating wind turbines, access roads and an electrical cable system on reclaimed lands within a mine permit boundary. Approximately 47,000 acres of mined land were reclaimed in accordance with regulatory standards administered by the Office of Surface Mining under the Surface Mining Control and Reclamation Act of 1977 (SMCRA). The addition of new wind turbines and associated infrastructure on the reclaimed land required securing a change to the approved post-mining land use from grazing/wildlife to commercial/industrial use pursuant to SMCRA and Wyoming coal mining regulations.

In addition to obtaining all necessary permits to build the Glenrock, Rolling Hills and Glenrock III wind projects, including approval from the state's Industrial Siting Council, land use changes to accommodate the wind farm required a detailed plan describing anticipated impacts to land within the mine permit boundary and a commitment that construction would be completed within a designated timeframe. The process of permitting and constructing the wind projects required a delicate balance of planning and implementing work on approved areas of the reclaimed mine site while avoiding activities on adjacent reclaimed lands where construction was not allowed.

A combination of corporate commitment, positive regulatory interaction and a dedicated workforce allowed the projects to move forward in a way that conscientiously minimized environmental impacts to the reclaimed land. This included avoiding any unnecessary land disturbances and erosion and providing sufficient drainage control, among other considerations. Development and construction of the three wind projects required a very unique, concerted effort by all participants, including company employees and contractors, regulatory agencies and other stakeholders.

Glenrock, Wyoming Wind Farm Site History

- **1958: Dave Johnston Coal Mine begins production**
- **1998: Decision made to close mine**
- **1999: Final mine reclamation activities begin**
- **2000: Mine officially closed**
- **2005: Mine reclamation activities completed**
- **2007: Rocky Mountain Power requests mine permit approval to enable construction of the wind projects.**
- **2008: Turbine installation begins.**
- **Late 2008 – early 2009: All three wind power projects comprising the Glenrock wind farm are completed and operational.**

Case Study #3: Establishing Somerset Wind Farm

Somerset County, Pennsylvania is located in southwestern Pennsylvania's Laurel Highlands. The county's wind resources and high elevations mean that the county is an ideal candidate for wind farm location. While the county's traditional manufacturing, coal mining and agriculture base continues to sustain the area's economy, wind energy has provided a new opportunity for economic diversification and the reclamation and reuse of an AML. In October 2001, Somerset Windpower LLC, a joint venture between power companies Zilkha Renewable Energy (now Horizon Wind Energy) and Atlantic Renewable Energy, began operating six 1.5-megawatt wind turbines on farmland adjacent to the Pennsylvania Turnpike. In 2003, the wind farm was acquired by Florida Power & Light Company (now NextEra™ Energy Resources) and currently generates 25,000 megawatt hours of electricity annually, enough to supply approximately 3,000 homes.

Turbines in the distance at the Somerset Wind Farm. (source: EPA)

The Somerset wind farm site was selected for two reasons: sufficient wind resources and the availability of infrastructure. Prior mining activities meant that roads and power transmission lines were already in place, which reduced project costs.

Once the site for the Somerset wind farm had been selected, several corporations, including Zilkha Renewable Energy, Atlantic Renewable Energy, General Electric, Exelon Powerteam, and Community Energy, Inc., formed working relationships to turn the site into a successful, functioning wind farm. Two power companies, Zilkha Renewable Energy and Atlantic Renewable Energy, entered into a joint venture called Somerset Windpower LLC to design and build the wind farm. General Electric signed on to provide routine operations and maintenance services. Exelon Powerteam, a wholesale power marketing company, signed a 20-year agreement to buy the power produced by the farm. Exelon Powerteam worked with Community Energy, Inc., an energy-sector consulting company, to market the power to universities, corporations and residences under the name "New Wind Energy."

Students visiting Somerset Wind Farm. (source: EPA)

Because of the prior mining activities at the site, additional analysis and remediation were required to ensure that the site's surface was structurally strong enough to support the weight of the six wind turbines. Sixteen-foot perimeter holes were drilled under each of the turbine sites and 15-ton weights (approximating the weight of the turbines) were then inserted into the holes to identify any structural weaknesses. Steel-reinforced concrete foundations were poured for each of the turbines, each containing 180 to 200 cubic yards of concrete and 23,000 to 26,000 pounds of reinforced steel.

Somerset Windpower LLC also developed strategies to address unique on-site situations. One wind turbine, for example, was sited on a tract of land that was formerly deep-mined, potentially compromising the stability of its foundation. The turbine was centered over the mine's stable main heading corridor and concrete was poured into the shaft to stabilize the structure before pouring the turbine's foundation. In addition, a tilt sensor was installed on the turbine to detect subsidence that could compromise the turbine's foundation.

The Somerset wind farm has shown that with careful planning, extensive site research, innovative construction approaches, and effective corporate and community partnership, the power of wind can successfully create clean, usable energy.

Somerset Wind Farm: Turbine Siting Preparation

Step 1: Checking the stability of each proposed turbine location.

Step 2: Building each turbine's steel-reinforced concrete foundation.

Step 3: Checking the stability of each turbine's foundation.

Case Study #4: Establishing Wind Farms on Other Impaired Properties: Steel Winds

Project Location: The Steel Winds wind farm in Lackawanna, New York covers approximately 30 acres of the 1,300-acre Bethlehem Steel industrial site, which borders the eastern shore of Lake Erie about six miles south of Buffalo, New York. The site is situated in a Class 4 wind resource zone and also has existing transmission lines and roads.

Project Development: The City of Lackawanna teamed with two private wind energy developers to plan for the wind farm. The State of New York and EPA also played important roles. The project cost $40 million.

Energy Production: The wind farm includes eight 2.5-megawatt wind turbines capable of powering 9,000 homes per year. The wind power is sold as renewable energy certificates to an electricity supplier that sells to businesses and homes. The wind turbines were manufactured in the United States and, at the time, were considered to be largest and most efficient turbines on the market while also being easy to repair. Additional turbines for the site are being considered.

Local Benefits: Construction of the project resulted in 40 local temporary jobs. Currently, the wind farm employs about five people. The City is expected to receive $100,000 per year for 15 years in lieu of property taxes from one of the private wind developers. As one of the first urban wind farm in the county, the wind farm has also brought the City a great deal of recognition.

Environmental Challenges: The wind farm area was contaminated with industrial waste and steel slag. Cleanup actions in the wind farm area included excavation and removal or recycling of solid waste and grossly contaminated soils over the entire area (except for soil placement of a one-foot vegetated cover on top) and installation of Oxygen Release Compound (ORC) socks in selected monitoring wells to passively expedite bio-degradation of naphthalene and benzene in the southern portion of the site. Although soil contamination remains, the site is considered safe for industrial use.

Small-Scale, Direct-Use Wind Energy Projects

As part of EPA's green remediation agenda and activities,[6] the use of wind energy for site cleanup and remediation is increasingly being implemented at contaminated sites, including brownfields, National Priorities List and mining sites, as a means to help increase the environmental, economic, and social benefits of contaminated site cleanup. The following examples are not AMLs, but highlight how wind energy is being used to power site cleanup.

Apache Powder Company

At the Apache Powder Superfund site in Arizona, a windmill was installed to generate electricity for powering pumps needed to de-water a perched ground water zone underlying soil-capped areas. The windmill meets the full demand of electricity.

Former Ferdula Landfill

At the Former Ferdula Landfill, a Resource Conservation and Recovery Act site in New York, a single windmill (with 12-foot blades) is used to extract volatile organic compounds for aboveground carbon treatment.

Former Nebraska Ordnance Plan

At the Former Nebraska Ordnance Plant Federal Facility Superfund site in Nebraska, a 10 kilowatt wind turbine is used to power ground water circulation wells for air stripping and ultraviolet treatment.

Massachusetts Military Reservation

Military Reservation Federal Facility Superfund site, a 1.5 mw wind turbine was sinstalled to reduce the energy costs of powering eight ground water treatment systems on the site. As of June 2009, the Massachusetts National Guard plans to develop a wind farm at the site with up to 17 turbines.

[6] EPA defines green remediation as the practice of considering all environmental effects of remedy implementation and incorporating options to maximize net environmental benefit of cleanup. EPA is working with private and public partners to foster the use of best management practices for green remediation at contaminated sites across the United States.

Potential Impacts of Wind Energy Development

All of these wind energy examples illustrate how the reuse of contaminated sites for wind energy development can occur to meet a range of challenges and interests and provide opportunities for communities to return formerly contaminated sites to productive reuse. The following section highlights environmental and economic impacts resulting from the reuse of contaminated properties for wind energy projects. This section also showcases site-specific ways in which wind energy projects can generate beneficial impacts.

Ecological Impacts

Potential ecological impacts and benefits of wind energy production on AMLs include reduced emissions, reduced fossil fuel consumption, greenhouse gas emission benefits, site cleanup, and improved water quality.

Construction of wind turbine foundation at Massachusetts Military Reservation (March 2009) (source: Massachusetts Military Reservation Cleanup Team)

Facilitating site cleanup

Plans to put a wind energy project on an AML may increase the priority to clean up the site. Cleanup of abandoned sites may remove or repair buildings, preventing them from becoming "attractive nuisances." As tailing piles are removed from a site to accommodate reuse, source contamination is also removed. Once a site is remediated, local ecosystems can be restored as well.

Reduced emissions

Coal, natural gas and oil extraction and production release significant amounts of greenhouse gases, including carbon dioxide and methane, into the atmosphere. Wind energy plants do not emit criteria pollutants or greenhouse gases, primary contributors to global warming. Consequently, wind energy projects on mining sites could have an impact on future policies related to climate change.

Reduced fossil fuel use

Utilizing wind energy relieves pressure on non-renewable, limited energy resources, such as natural gas, coal and oil. In addition, the process of extracting and refining coal and oil can negatively impact local ecosystems.

Water quality

Discharges from abandoned mines can severely impact streams, creeks, lakes and reservoirs. Cleanup of tailings piles to make a site ready for a wind energy plant can help prevent contamination of drinking water sources. Cleanup of sites along rivers protects aquatic ecosystems from contaminant impacts.

Economic Impacts – Local /State Impacts:

Local economic impacts include bringing jobs to the area, energy cost stability and potential property revitalization impacts. Economic impacts for state and local governments include creating economic development opportunities and potential new revenues.

Job creation

The construction and operation of a large wind energy project can have a positive impact on a local economy. Construction can use local sources or developed materials. Larger wind farms can be labor-intensive during

Wind farm in Montana. (source: National Renewable Energy Laboratory)

both construction and operations, drawing labor from local markets or helping to transition labor from other sectors, such as mining.[7] As shown in the Glenrock case study, these can produce a large number of temporary jobs and a smaller number of permanent jobs.

Increased revenues

A range of players involved in developing a wind project, including energy companies, local employees, new assembling and manufacturing plants and investors, can add to a state's and municipality's tax stream. During the construction of the wind farm, companies and contractors require equipment and support services, while their employees require services like food and lodging. Following construction of a wind farm, companies and contractors and their employees continue to require local goods and services as the farms are maintained, repaired and upgraded over time.[8] For any particular wind project, new revenue will depend on a project's geographic location, the quality of the resource, and access to markets for the sale of electricity and renewable energy credits.

Revitalization of contaminated property

Wind energy production on formerly contaminated lands can generate value to a community in a variety of ways. Utility-scale wind energy projects require a significant amount of land. Putting these formerly contaminated properties to use can take the strain off "greenfields" for this use and shift a negative perception associated with abandoned mining lands to one of a valuable asset to the community.

Local energy security

Due to natural gas price volatility, wind can provide a more stable price per kilowatt hour generation rates over a longer-term than natural gas.

Economic development

Fostering local wind energy production allows communities to meet their growing energy demands while facilitating local economic development opportunities. In addition to jobs directly related to wind production, dollars that remain within a community have an effect on local economies through reinvestment.

Fostering community pride

Wind farms can also serve as local landmarks and sources of community pride. At the Somerset wind farm, for example, the striking silhouette of the wind turbines is a new local point of reference and even attracts tourists passing by on the nearby Pennsylvania Turnpike. Robert Will, the property's landowner, has come to expect a regular flow of visitors on weekends, drawn to look at the turbines. In recent years, more attention has been placed on the role of wind farms in enhancing nearby tourist activity and wind farms both at home and abroad are catering to tourists. Moreover, at the Mountaineer Wind Energy Center in West Virginia, a kiosk was constructed by the roadside because of the high number of people stopping alongside the road to take pictures and watch the turbines.

[7] Additional tax revenues are generated from increased local spending on goods and services during the construction and operation of a wind farm.
[8] Studies that have assessed the scale of local economic benefits provided by wind farms have reached different conclusions. One study for a wind developer cited by the NWCC concluded that the operation of a 100 megawatt wind farm would generate approximately $500,000 in annual local purchases. A 1995 report from California's Kern County Wind Energy Association, in contrast, concluded that the county's local economy gains $11 million annually from the purchase of goods and services for wind energy projects. The county's total economic gain includes new tax revenues generated by the purchases. Kern County, which contains 4,600 wind turbines with a total generation capacity of 1,400 megawatts, is home to the largest cluster of wind farms in the United States.

Economic Impacts – Private Sector Impacts:

Wind energy at former mine lands has a wide variety of anticipated economic impacts for a site owner, including revenues from leasing land and leveraging resources for site cleanup. Additionally, wind energy projects can provide impacts for utilities and energy service companies, including stabilizing energy transmission infrastructure and meeting renewable energy portfolio requirements.

Wind farm in California. (source: National Renewable Energy Laboratory)

Leveraged funding for site cleanup

Where the potential benefits of reclaiming and reusing land exceed the costs of cleanup and redevelopment, state and local governments, industry, land developers, environmental groups, or private citizens may help to fund site cleanup activities (Note: additional funding may still be needed).

Revenue from land lease agreements

Compensation to a landowner for a site that will host a wind energy installation can be in the form of a fixed lease fee per acre, fixed fee per megawatt hour generated, or a percentage of gross revenue attributable to the number of turbines and amount of electricity sold. Wind turbines provide an additional source of revenue, particularly at sites like AMLs where the land is either not in use or is in agricultural use. Wind farms can be integrated with existing agricultural uses. For example, at the Somerset wind farm, property owner Robert Will receives two percent of the turbines' production revenue as payment for allowing the turbines to be sited on his land. In total, each turbine generates $3,000 to $3,500 each year in revenue for the property owner, while Mr. Will retains the ability to farm most of his property. Landowners are also paid if their land is used for transmission lines, underground collection systems, project substations and road access to wind farms.

Buffalo Mountain Wind Farm: Benefiting from Site Remediation and Nearby Infrastructure

The Tennessee Valley Authority (TVA) was able to move rapidly from design to implementation of the Buffalo Mountain wind farm in little more than a year for two reasons. Prior remediation work completed by the Coal Creek Mining and Manufacturing Company, which included capping open mine shafts and using vegetation to reduce soil erosion, meant that TVA did not need to pursue additional cleanup activities. Second, the site's close, two-mile proximity to existing infrastructure, including roads and power transmission lines, meant that site preparation costs for the Buffalo Mountain wind farm were reduced.

Meeting state renewable portfolio requirements

Purchasing wind energy allows utility companies to meet state renewable energy requirements. Many states now have Renewable Energy Portfolios in place, which require that a certain percentage of a state's energy come fom renewable sources. In coming years, the federal government may develop greenhouse gas emission standards or a National Renewable Portfolio Standard, which would be expected to place more pressure on utilities to rely on renewable energy sources.

Potential Challenges for Wind Energy Development at Mining Sites

The cleanup and reuse of former mines for on-site renewable energy generation can be complicated by the technical challenges presented by a site, potential regulatory obstacles, the intermittent nature of wind energy, high upfront capital costs and permitting challenges.

Environmental challenges

The environmental challenges associated with wind farms, both at abandoned mine lands and in general, revolve around the turbines' potential threat to wildlife, primarily bats and local and migratory bird populations. In particular, it is important to take steps to avoid turbine placement along migratory bird pathways. In some states, companies considering new locations for wind farms must also submit environmental impact statements before proceeding with projects. At the Buffalo Mountain Wind Farm, an environmental assessment was conducted to ensure that the wind farm would not negatively impact the natural environment.

Transmission access

Access to nearby transmission lines is imperative to developing large-scale wind power projects. An interconnection study can help to assess the impact of a project and its electrical characteristics on a regional power grid; assess if modifications or upgrades are necessary; and identify the technical and financial requirements to do so.

High up-front costs

Even though the cost of generating wind energy has decreased dramatically in the past 10 years, the technology does require a higher initial investment than fossil-fueled generators. Roughly 80 percent of a wind farm's startup cost is its machinery, with the balance being the site's preparation and installation. However, if wind farm systems are compared with fossil-fueled systems on a "life-cycle" cost basis (counting fuel and operating expenses for the life of the generator), wind costs are much more competitive with other generating technologies because there is no fuel to purchase and minimal operating expenses. The construction and operating costs associated with wind energy will also continue to decrease over time.

Buffalo Mountain Wind Farm:
Acquiring Financing and Necessary Technical Expertise

Before the Tennessee Valley Authority (TVA) could build the Buffalo Mountain Wind Farm, the agency first had to work in close coordination with several public and private entities. TVA negotiated with the Coal Creek Mining and Manufacturing Company to be able to lease and site the wind farm on their property, while the energy consulting company, AWS Scientific, was hired to assess potential turbine sites. Lowe Excavating, a construction company, provided road improvement and site clearance services, while Tennessee Communications, a communications company, installed two miles of power lines connecting the wind turbines to the local power grid. Enxco, Inc., an energy company specializing in renewable energy, was hired to develop the farm and provide ongoing operations and maintenance services. Clinton Utility Board, the local power distributor, agreed to maintain the farm's connection to the local power distribution network.

Intermittent power supply

Wind energy's remaining major economic limitation is its status as an intermittent power supply. While the wind is an inexhaustible, renewable natural resource, it does not blow all of the time, and cannot be guaranteed to come online during periods of high energy demand. Organizations like the Tennessee Valley Authority at the Buffalo Mountain wind farm are working to develop energy storage facilities for wind farms that would enable the power generated by wind turbines to be stored and released at times of high energy demand.

Compatibility with remedy

There are several important factors to consider when siting a wind facility on AMLs. At underground mine sites, openings, mine workings, and other subsurface passageways may lead to subsidence or other engineering challenges. Records kept by mining companies on subsurface activities at a site can provide valuable information. In addition, existing infrastructure, including buildings, underground gas pipes and overhead wiring, may need to be removed to make a site suitable for wind technology infrastructure.

Wind project in Idaho. (source: National Renewable Energy Laboratory)

Permitting

Navigating the permitting process required to build a wind facility can pose one of the most challenging obstacles to utility-scale wind energy development. National, state and regional permitting procedures are not typically coordinated and, as a consequence, permitting requirements can vary from state to state and from region to region. The number of agencies and the level of government involvement will depend on a number of factors particular to a project. These factors primarily include: applicable existing laws and regulations, location of the wind turbines and associated facilities or equipment, need for transmission lines and access roads, size of the wind energy project, ownership of a project and ownership of the land. The U.S. Fish and Wildlife Service is in the process of writing a national environmental siting standard for wind facilities.

Concerns over noise

Wind farms can also generate community concerns about the potential noise levels and aesthetics associated with wind turbines. The American Wind Energy Association estimates that a wind turbine located 250 meters from a residence generates about as much noise as a kitchen refrigerator. A wind farm with multiple turbines, however, will generate more sound so appropriate siting of the proposed wind farm in relation to surrounding land uses may need to be considered during the planning and siting process. The trend in recent years has shifted to concerns over low frequency noise from wind farms and its potential effect on humans.

Concerns over aesthetics

Community aesthetic concerns can center on the size, design and visual prominence of the wind turbines, which may significantly alter a community's skyline. Turbine shadow patterns and night-lighting can also create a visual nuisance if sited near residences and businesses. Turbine shadow patterns and night-lighting can be addressed by planting trees or installing screens. Aesthetic concerns, however, can be more difficult to address, as preferences can vary. Some people like the profile of wind turbines, for example, while others find them visually disruptive. Community outreach and education efforts can help ensure that all community members are included in the planning process from the outset. During community meetings, community members can express their concerns, learn about wind energy, and work with other community members and interested parties, including local officials, residents, organizations and energy providers, to ensure that proposed wind farm projects are appropriately designed, appropriately sited, and ultimately successful.

Getting Started with Wind Energy Projects on AMLs

As wind energy projects on AMLs are being planned, three issues will need to be considered extensively: community involvement and support, land ownership issues and site feasibility. These are discussed in more detail below.

Sustained Community Involvement

Active, ***sustained community involvement*** is critically important from the outset of any community planning process and can help determine the extent to which wind power may be able to meet local environmental, economic and social needs. Discussion of community priorities can also help to identify potential community concerns, like noise levels or aesthetics, associated with the location of wind turbines on local AMLs.

Community discussions about potential reuse opportunities at local AMLs need to include a diverse range of stakeholders, reflecting the local and regional impact of former mining sites on economies, communities and ecosystems. Stakeholders in an effective, inclusive process may include local government officials, citizens and organizations; previous site landowners and operators; current or future landowners; potential developers; Tribal interests; and state and federal agencies with potential oversight responsibilities at a site. Additional interested parties may include wind energy corporations and power companies, wildlife organizations and renewable energy organizations. These organizations may be able to provide key technical support and funding resources.

Buffalo Mountain Wind Farm: Engaging the Community

The local community, as well as other agencies and organizations, were significantly involved throughout the development of the Buffalo Mountain Wind Farm. A steering committee composed of Tennessee Valley Authority (TVA) staff, community representatives, environmental organizations and participating power distributors oversaw the project's development, providing input on site design and technical issues, and held a series of public meetings to incorporate community input and share project information. According to Rick Carson, TVA's Renewable Energy Program Manager, community involvement in the project's development led to community support for the Buffalo Mountain wind farm. "The community," he said, "including local residents who had worked in the coal mining industry, was enthusiastic about the reuse of the property."

Understanding of Land Ownership Issues

The community's efforts to evaluate local AMLs as potential locations for wind farms will require close coordination with the owners of these former mining sites. Landowners may be aware of the potential benefits provided by wind energy, or may need to work with the community to determine whether a wind farm represents an opportunity to return their property to successful reuse.

The community may also need to clarify and resolve several ***land ownership issues***. Former mining sites often have multiple owners, including individuals and mining companies. Outstanding mining claims may need to be resolved. Properties may have separate surface and mining rights that are owned by different entities. In each case, the community will need to contact and develop working relationships with the owners of the properties or mining rights at each AML as early as possible in the planning process.

Site Feasibility

The ***technical feasibility*** of locating a wind farm on a local AML depends on the availability of sufficient wind resources, suitable location characteristics and existing infrastructure. Energy resource maps can help the community determine if the site is located in an area that receives sufficient wind resources. Potential wind farm sites at AMLs must also include adequate space for large-scale turbines and open areas located away from buildings, which obstruct wind flow. Finally, the community will need to determine, using local electric power system maps and general area maps, whether AMLs are located in close proximity of existing infrastructure. Some developers require that necessary existing infrastructure be within two miles; others may initiate projects with available infrastructure located much further away (e.g., eight miles). Sites located adjacent to existing roads and power transmission lines mean that wind turbines can be installed and connected to the power grid with reduced cost.

In addition, to these three issues, a series of steps are presented in the text box below to assist in further evaluating wind energy opportunities.

Installation of a 1.5 MW wind turbine at the National Wind Technology Center in Colorado. (source: National Renewable Energy Laboratory)

Evaluating the Potential Reuse of a Local AML for a Wind Energy Project

Communities considering the potential reuse of a local AML as a wind farm can work through the following evaluative steps. For information about wind energy consultants that can provide the services described below, please refer to the American Wind Energy Association (AWEA)'s Web site at www.awea.org.

- ***Identify AML sites and their wind energy potential***, based on the availability of wind resources, site location and existing infrastructure like roads and power transmission lines, which can reduce costs. Wind resource maps such as the Pacific Northwest Laboratory's Wind Energy Resource Atlas (http://rredc.nrel.gov/wind/pubs/atlas/) and data from the National Climatic Data Center (www.ncdc.noaa.gov) can be used to assess local wind resources. Maps of local electric power systems and general area maps can help determine the availability of existing infrastructure.

- ***Secure access to the site***. Work with AML property owners to explore the potential benefits provided by wind energy at each site and determine their level of interest.

- ***Explore and address the social and environmental factors*** that may affect the project, including raptor activity, endangered species in the area, the site's geology, community concerns about noise and aesthetics, cultural and historical factors and local air traffic issues.

- ***Arrange for a professional appraisal of the site's wind resources.*** A professional appraisal of the site's wind resources involves constructing meteorological towers equipped with anemometers, instruments that measure wind force and speed. Based on one-year's worth of data from these instruments, a meteorologist can prepare a site report that describes the area's wind resources. Companies that provide these services can be found on AWEA's Web site, listed above.

- ***Obtain the services of a professional familiar with the regulatory environment surrounding wind power development.*** These services can help ensure that relevant state and federal regulations like environmental impact statements are identified and addressed early in the planning process.

- I***dentify a wind energy developer*** that would be interested in discussing the possibility of locating a wind farm on the site. Attachment B of this report provides a list of wind energy companies and consultants.

- ***Identify a reliable power purchaser*** and secure tentative commitments from one or more buyers for the wind farm's output. Municipal, regional, cooperative and national utilities, as well as other entities, including universities and businesses, are potential purchasers of a wind farm's output. Regional Transmission Organizations (RTOs) will also need to be contacted to ensure access to the area's existing power transmission network.

- ***Establish access to sufficient capital***, approximately $1 million per megawatt, to support the cost of constructing a wind farm National and international lenders, including investment banks, insurance companies and foreign investors, typically supply 50 to 90 percent of wind projects' capital costs, with project sponsors providing the remainder of the project's funding.

- ***Secure an agreement with a company*** to provide operations and maintenance services for the wind turbines. Companies that provide these services can be found on AWEA's Web site.

Incentives and Policies for Wind Energy Development

A number of policies and incentives can be utilized to facilitate the development of renewable energy projects. Energy development incentives include both policy-based incentives (renewable portfolio standards) and financial incentives (tax credits and rebates).

Renewable Energy Policy Tools and Incentives

Federal and state policies have played a major role in creating markets that are favorable for wind energy deployment. Wind energy's cost premium has declined in recent years due to technology improvements and an increase in the cost of fossil fuel based energy generation. At the same time, a growing nationwide public policy focus on carbon-free, renewable energy has created a wide range of financial incentives to lower costs even further. Chief among the state energy policies are renewable portfolio standards (RPS) that require that a specific portion of a state's electricity consumption be met by renewable energy by a certain date.

Wind farm in Colorado. (source: National Renewable Energy Laboratory)

Major financial and policy incentives are highlighted below. In addition, many states offer specific financial incentives for renewable energy development. The rules associated with many of these incentives are complex and it is recommended that a tax lawyer review their applicability to specific projects. Appendix A provides additional information on incentives.

Renewable Energy Production Tax Credit

Authorized in 1992, the renewable energy production tax credit (PTC) is a credit of 2.1 cents per kilowatt-hour of wind power generated. According to AWEA, it has been the wind industry's most important federal incentive. Although the credit has been allowed to lapse three separate times, under the American Recovery and Reinvestment Act (ARRA), the PTC will remain in place through December 31, 2012.

Investment Tax Credit/Grant Program

Instead of the PTC, wind project developers can now obtain a 30 percent investment tax credit (ITC) for wind energy facilities that become operational and placed in service in 2009 and 2010. The ITC is also available for wind energy facilities that became operational prior to 2013 if construction of the facility is started in 2010.

Helpful Hint

Utilities can be reasonably expected to invest in the most financially viable (e.g., least expensive) renewable energy projects. For many states, wind energy projects have been the most financially viable projects to date.

Renewable Portfolio Standards (RPS)

An RPS is a regulatory policy that requires the increased production of renewable energy sources such as wind or solar by a retail seller of electricity (e.g., a utility). A utility can satisfy this obligation by either (a) owning a renewable energy facility and producing its own power or (b) purchasing renewable electricity from someone else's facility. RPS policies are implemented by states, and vary considerably in their requirements with respect to time frames, eligibility, treatment of existing plants, enforcement and penalties, and whether they allow the trading of renewable energy credits.

Renewable Energy Credits (RECs)

RECs are tradable commodities, separate from the electricity produced, that bundle the "attributes" of renewable electricity generation. Because they are unbundled from electricity, RECs are not subject to transmission constraints. RECs have become a dominant mechanism for compliance with renewable portfolio standard (RPS) policies in many states and voluntary green power purchases.

Clean Renewable Energy Bonds (CREBs)

Originally created by the 2005 Energy Tax Incentives Act, CREBs provide a federal tax credit for the bond owner in lieu of interest payments from the issuer. The Emergency Economic Stabilization Act of 2008 authorized $800 million of new renewable energy bonds to finance facilities that generate electricity from renewable resources, including wind. Under the ARRA, that limit was increased to $2.4 billion. The legislation allows state and local governments, public power providers and electric cooperatives to issue CREBs to finance new renewable electric power facilities, including wind installations.

Wind farm in Wyoming. (source: National Renewable Energy Laboratory)

Third Party Financing Models

In the public sector, public entities are moving away from direct ownership of wind energy systems and toward the use of partnering with third-party owners. State and local governments see the third-party ownership model as a potential way to effectively monetize federal tax benefits, avoid paying the high up-front cost of wind, facilitate the use of otherwise marginal lands owned or controlled by a local government, more efficiently allocate public funds, and accelerate the deployment of wind projects. Instead of owning a wind system, a public entity hosts a system that is paid for and owned by a taxable entity. The public entity enters into a long-term contract (power purchaser agreement) with a third party to purchase the electricity generated on its property.

Conclusion

With thousands of potentially viable AMLs near abundant wind resources, the potential impact from wind energy development on these sites is significant. Communities can harness the emerging need for secure and carbon-free energy to promote the remediation and restoration of AMLs and to facilitate economic development.

Uncertainties remain, however. Not all former mining sites will be suitable candidates for wind energy projects. Regional wind energy variation, availability of financing and financial incentives and site-specific conditions will impact the feasibility of developing and exploiting the wind energy resources available at many of these mine lands. With these considerations in mind, public and private organizations are exploring how wind energy development can play an important role in local and regional economic development and community revitalization.

By returning AMLs to productive reuse as wind farms, communities can benefit from the potential cleanup of these vacant, idle properties, as well as from economic benefits that include local job creation, economic growth and diversification, and increased tax revenues. To pursue these benefits, communities will need to evaluate local wind resources and establish strong working relationships with site landowners and wind energy providers. As the Somerset wind farm suggests, these projects will also require sustained community interest and innovative financing and design approaches. The end result: AMLs reclaimed as wind farms that can help communities find new answers to long-standing economic and environmental questions. The opportunities await.

Appendix A: Wind Resources

Wind Energy Organizations and Initiatives

Department of Energy (DOE) Wind and Hydropower Energy Technologies Program	http://www1.eere.energy.gov/wind/index.html
DOE Wind Powering America	http://www.windpoweringamerica.gov
National Renewable Energy Lab (NREL) Wind Research	http://www.nrel.gov/wind
NREL Renewable Energy Resource Maps	http://www.nrel.gov/wind/nwtc.html
Golden Field Office - DOE[9]	http://www.eere.energy.gov/golden
American Wind Energy Association	http://www.awea.org/
Western Governors Association – Clean and Diversified Energy Initiative	http://www.westgov.org/energy
Department of Interior – Bureau of Land Management	http://www.blm.gov/wo/st/en/prog/energy/wind_energy.html
IEA Wind [10]	http://www.ieawind.org
Windustry	http://www.windustry.com
European Wind Energy Association	http://www.ewea.org
Interstate Renewable Energy Council	http://www.irecusa.org
National Wind Coordinating Collaborative	http://www.nationalwind.org

Tools and Information for Undertaking Redevelopment Projects at AMLs and Other Impaired Properties

EPA Renewable Energy Maps	http://www.epa.gov/renewableenergyland
EPA Abandoned Mine lands Team Reference Notebook	http://epa.gov/aml/tech/refntbk.htm
Report: “Identification and Evaluation of Community Involvement Activities in Abandoned Mine Land Communities”	http://www.epa.gov/aml/downloads/aml_comm_involvement.pdf
Mine-Scarred Lands Initiative Tool Kit	http://www.epa.gov/aml/revital/msl/index.htm
Report: “Anatomy of Brownfields Redevelopment”	http://www.epa.gov/brownfields/overview/anat_bf_redev_101106.pdf
Sustainable Management Approaches and Revitalization Tool (SMARTe)	http://www.smarte.org/smarte/home/index.xml
CLU-In Green Remediation Overview	http://www.clu-in.org/greenremediation

[9] The Golden Field Office manages many of DOE’s renewable energy programs.
[10] International Energy Agency (IEA) Implementing Agreement for Co-operation in the Research, Development, and Deployment of Wind Energy Systems

Appendix A: Wind Resources Continued

Tools and Information for Identifying Sites and Assessing Wind Energy Resources

EPA Renewable Energy Maps	http://www.epa.gov/renewableenergyland
DOE Wind Resource Information	http://www.nrel.gov/rredc/wind_resource.html
DOE – Where is Wind Power?	http://www.windpoweringamerica.gov
DOE Wind Resource Assessment Maps	http://www.nrel.gov/wind/resource_assessment.html
NREL GIS and Mapping Resources	http://www.nrel.gov/gis
NREL Renewable Energy Resource Maps	http://www.nrel.gov/renewable_resources
NREL United States Atlas of Renewable Resources	http://maps.nrel.gov/re_atlas
National Oceanic and Atmospheric Administration - National Climatic Data Center	http://www.ncdc.noaa.gov/oa/ncdc.html
AWS Truewind's windNavigator	http://navigator.awstruewind.com
Wind Power: Performance and Economics - Renewable Energy Research Laboratory, University of Massachusetts at Amherst	http://www.ceere.org/rerl/about_wind
Wind Power: Interpreting your Wind Resource Data - Renewable Energy Research Laboratory, University of Massachusetts at Amherst	http://www.ceere.org/rerl/about_wind

Tools and Information for Assessing Project Viability and Impacts

NREL Wind Energy Finance (WEF): An Online Calculator for Economic Analysis of Wind Projects	http://www.windpoweringamerica.gov/economics.asp
NREL Job and Economic Development Impact (JEDI) model	http://www.nrel.gov/analysis/jedi
NREL Wind Farm Area Calculator	http://www.nrel.gov/analysis/power_databook/calc_wind.php
DOE Wind Economic Development Studies	http://www.windpoweringamerica.gov/econ_project_search.asp
DOE Wind Economic Development	http://www.windpoweringamerica.gov/economics.asp
Wind Power: Impacts and Issues - Renewable Energy Research Laboratory, University of Massachusetts at Amherst	http://www.ceere.org/rerl/about_wind

Appendix A: Wind Resources Continued

Tools and Information for Planning Wind Projects

NREL Energy Project Planning Support	http://www.nrel.gov/applying_technologies/project_planning.html
AWEAS's 10 Steps to Building a Wind Farm	http://www.awea.org/learnabout/publications/upload/Ten_Steps.pdf
Community Wind Toolbox	http://www.windustry.com/communitywind
DOE Wind Energy Guide for County Commissioners	http://www.windpoweringamerica.gov/pdfs/wpa/county_commissioners.pdf
AWEA Wind Energy Siting Handbook	http://www.awea.org/sitinghandbook
Wind Power: Siting in Communities - Renewable Energy Research Laboratory, University of Massachusetts at Amherst	http://www.ceere.org/rerl/about_wind
DOE – Siting Considerations in New England	http://www.windpoweringamerica.gov/ne_siting.asp

Tools and Information for Wind Permitting and Related Approvals

Wind Power: Permitting in Your Community - Renewable Energy Research Laboratory, University of Massachusetts at Amherst	http://www.ceere.org/rerl/about_wind
Wind Energy Development Programmatic Environmental Impact Statement (U.S. Department of Interior)	http://windeis.anl.gov/index.cfm

Tools and Information for Wind Project Financing and Related Support

Database of State Incentives for Ren. Energy	http://www.dsireusa.org/
DOE Office of Energy Efficiency and Renewable Energy Financial Opportunities	http://www1.eere.energy.gov/financing/
DOE Green Power Network	http://apps3.eere.energy.gov/greenpower
AWEA Financing Resources	http://archive.awea.org/resources/financing/
DOE Clickable Map of State Wind Activities[12]	http://www.windpoweringamerica.gov/state_activities.asp
Funding Opportunity Announcements for the Department of Energy's Golden Field Office	http://www.eere.energy.gov/golden/Funding.aspx
Native American Anemometer Loan Program	http://www.windpoweringamerica.gov/nativeamericans/anemometer_loan.asp
EPA Guide to Purchasing Green Power	http://www.epa.gov/greenpower/documents/purchasing_guide_for_web.pdf

[12] Activities include: wind working groups, validated wind maps, anemometer loan programs, small wind guides, wind for schools, exhibits, and workshops/Webcasts.

Appendix B: References and Information Sources

Information for this report was gathered from various reports, papers and online sources, categorized below:

General Wind Energy Information

- U.S. Department of Energy's Wind Energy Program website, at http://www1.eere.energy.gov/wind/index.html.
- 1995 book Wind Energy Comes of Age by Paul Gipe.
- 1995 book Renewables Are Ready by Nancy Cole and P.J. Skerret.
- Appalachian Mountain Club's 1996 General Policy on Windpower, at www.nationalwind.org.
- U.S. Department of Energy's 2000 fact sheet Wind Powering America: Clean Energy for the 21st Century.
- March 2000 Smithsonian article "A Second Wind."
- August 2002 Time article "The Winds of Change."
- August 16, 2002 USA Today article "Wind Energy Generates Income."
- August 20, 2002 Washington Post article "Windmills on the Water Create Storm on Cape Cod."
- American Wind Energy Association's website, at www.awea.org.
- National Wind Coordinating Committee's wind energy fact sheets, at www.nationalwind.org.
- U.S. Department of Energy's December 2008 report 20% Wind Energy by 2030, at http://www1.eere.energy.gov/wind/index.html.
- American Wind Energy Association's Market Update Fact Sheet for 2008, at http://www.awea.org/.
- U.S. Department of Energy's December 2009 report Wind Power Today, at www1.eere.energy.gov/windandhydro
- American Wind Energy Association's Resources Wind Web Tutorial, at http://archive.awea.org/faq/wwt_basics.html.
- American Wind Energy Association's Resources Basic Principles of Wind Resource Evaluation, at http://archive.awea.org/faq/basicwr.html.
- Energy Information Administration Energy Information Sheets – Electricity Generation (last updated May 2009), at http://www.eia.gov/energyexplained/index.cfm?page=electricity_in_the_united_states.
- American Wind Energy Association's Fact Sheets – Electric Utilities and Wind Power – A Good Mix, at http://www.awea.org/learnabout/publications/upload/Utility-Factsheet_WP11.pdf
- American Wind Energy Association's Wind Power and Climate Change Fact Sheet, at http://www.awea.org/.
- Windustry's webpage "Introduction to Wind Development", at http://www.windustry.com/wind-basics/.

Glenrock Wind Farm

- October 2009, personal communications with PacifiCorp /Rocky Mountain Power representative Jeff Hymas.
- Rocky Mount Power August 15, 2008 press release "Dave Johnston Power Plan 50th Anniversary and Glenrock Wind Farm Community Celebration", at www.rockymountainpower.net.
- Rocky Mountain Power Summer 2008 Insights newsletter, "Renewable energy growing strong in Wyoming", at www.rockymountainpower.net.
- Rocky Mountain Power Fall 2007 Renewable Energy Update Forecast, at www.rockymountainpower.net.
- PacifiCorp Renewable Energy web page, at www.pacificorp.com
- July 23, 2009 CNET News online article "From coal mine to wind farm", at http://news.cnet.com
- September 7, 2008 Billings Gazette article "Wind power brings jobs to Glenrock", at www.billingsgazette.com.

Somerset Wind Farm

- August 2002 Progressive Engineer article "A New Crop Takes Root", at www.progressiveengineer.com.
- October 2002 and January 2003 interviews with Gary Verkleeren, Zilkha Renewable Energy.

- October 2002 interview with Robert Will, Somerset wind farm landowner.
- Pennsylvania Department of Environmental Protection website, at www.dep.state.pa.us.
- NextEra Energy online article "Somerset Wind Energy Center", at www.nexteraenergyresources.com.
- Exelon online article "Somerset Wind Farm", at www.exeloncorp.com.

Buffalo Mountain Wind Farm

- December 4, 2001 Elizabethton Star article "Windmills on the Mountain? TVA Project Could Boost Tourism."
- Oak Ridge Nuclear Laboratory's website, at www.ornl.gov.
- Tennessee Valley Authority's Green Power Switch and Public Power Institute programs websites, at www.tva.gov/greenpowerswitch/index.htm.
- Powering the South organization's website, at www.poweringthesouth.org. [no longer available online]

Steel Winds Project

- First Wind online article "Welcome to Steel Winds", at http://www.firstwind.com/sites/default/files/SteelWind_factsheet July 21 2011.pdf
- September 2009, personal communication with U.S. Windforce representative.
- U.S. Environmental Protection Agency Office of Solid Waste and Emergency Response's Steel Winds fact sheet, at www.epa.gov/oswercpa.
- New York State Department of Environmental Conservation Steel Winds- Brownfields Cleanup Program fact sheet, at www.dec.ny.gov.
- July 2009 Power Engineering online article "Steel Winds Overcomes Installation Problems", at http://pepei.pennnet.com.

Other U.S. Wind Farm Projects

- December 28, 2001 online article "Grant Wind Farm Will Be Largest in East", at http://web.uswindforce.com.
- Mlive.com online article "Wind farm and wood-to-ethanol plant proposed for Muskegon brownfield", at www.mlive.com.
- Iberdola Renewables online article "Casselman Wind Power Project", at www.iberdrolarenewables.us/pdf/casselman-fact-sheet.pdf.
- April 22, 2008 Energy Daily online article "PA Building New Energy Economy With Cambria County Wind Farm", at www.energy-daily.com.
- September 9, 2008 Montana Standard article "Wind Farm Planned for Golden Sunlight Mine Land", at www.istockanalyst.com.
- June 19, 2006 S&C Electric Company article "Mining Company Gets Clean Power Source", at www.sandc.com/webzine.
- Casselman Wind Power Project Fact Sheet. http://www.iberdrolarenewables.us/pdf/casselman-fact-sheet.pdf

Information on Small-Scale Wind Projects on Impaired Properties

- CLU-In Green Remediation Focus web page on Apache Powder, at www.clu-in.org/greenremediation.
- CLU-In Green Remediation Focus web page on Ferdula Landfill, at www.clu-in.org/greenremediation.
- CLU-In Green Remediation Focus web page on Former Nebraska Ordnance Plant, at www.clu-in.org/greenremediation.
- Massachusetts Military Reservation News Release 2007-09 "Contract Awarded for Wind Turbine", at www.mmr.org
- Massachusetts Military Reservation Cleanup Team July 8, 2009 presentation "AFCEE Wind Turbine Project", at www.mmr.org.
- June 11, 2009 Boston Globe article "Wind farm proposed for Cape military reservation", at www.boston.com.

Environmental, Economic, and Social Impact Assessment Information

- Fall 1995 Land and Progress article “Wind Energy Creates Jobs, Power in East Kern.”
- 1997 European Wind Energy Association report Wind Energy in Europe - The Facts.
- U.S. Department of Energy’s 2000 fact sheet Wind Powering America: Clean Energy for the 21st Century.
- August 2001 National Wind Coordinating Committee report Avian Collisions with Wind Turbines: A Summary of Existing Studies and Comparisons to Other Sources of Avian Collision Mortality in the United States, at www.nationalwind.org.
- October 2001 AgJournal article “Wind Energy Investment Benefits Landowners.”
- October 2001 Penn Almanac article “Wind Energy to Power Penn,” at www.upenn.edu.
- November 2001 Renewable Energy Policy Project report The Work That Goes Into Renewable Energy, at www.repp.org/repp.
- December 2002 Grist article “Tilting at Windmills: Activists Are Split on Proposed Project Off Cape Cod,” at www.gristmagazine.com.
- February 2, 2002 Patriot News article, at www.pennlive.com/patriotnews.
- American Wind Energy Association’s website, at www.awea.org.
- U.S. Department of Energy’s Wind Energy Program website, at http://www1.eere.energy.gov/wind/index.html.
- Pennsylvania Department of Environmental Protection’s Wind Farming fact sheet, at www.dep.state.pa.us.
- Office of Surface Mining, Reclamation, and Enforcement website, at www.osmre.gov.
- January 26, 2006 Atlantic City Weekly article “Could Atlantic City’s new Wind Farm be the resort’s next tourist attraction?”, at www.atlanticcityweekly.com.
- Atlantic County Utilities Authority website, at www.acua.com.

Wind Energy Development Incentives and Policies Information

- American Wind Energy Association’s Update – “What is the Current State of the Production Tax Credit?”, at http://www.awea.org/issues/federal_policy/index.cfm
- American Wind Energy Association’s Legislative Affairs Web page, at http://archive.awea.org/legislative/
- Windustry’s Community Wind Toolbox – “Tax Incentives”, at www.windustry.org/CommunityWindToolbox.

A Breath of Fresh Air for America's Abandoned Mine Lands

ALTERNATIVE ENERGY PROVIDES A SECOND WIND

United States
Environmental Protection
Agency

OSRTI
Abandoned Minelands Team

March 2012