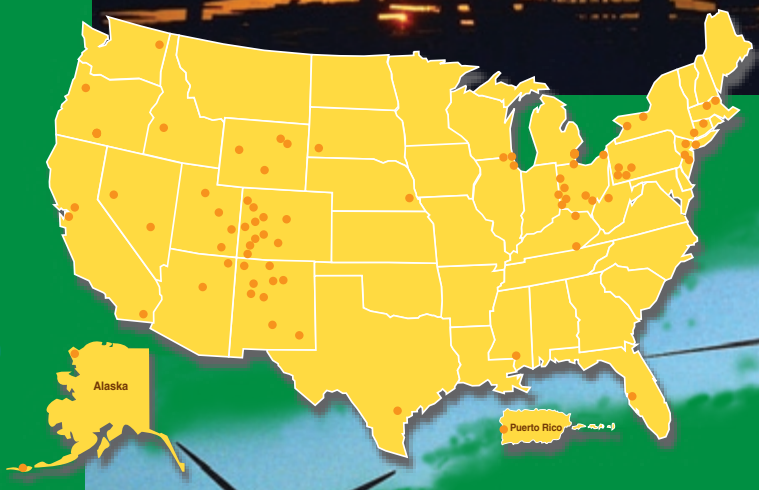
Assessing the Potential for Renewable Energy Development on DOE Legacy Management Lands



Office of Legacy Management

LM

DEPARTMENT OF ENERGY · UNITED STATES OF AMERICA

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Assessing the Potential for Renewable Energy Development on DOE Legacy Management Lands

Authors:
Doug Dahle, Dennis Elliott, Donna Heimiller, Mark Mehos, Robi Robichaud, Marc Schwartz, Byron Stafford, and Andy Walker

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Primary Authors

The NREL team that prepared this report include Doug Dahle, project lead and Andy Walker (Strategic Energy Analysis & Applications Center, Energy Management and Federal Markets Group – FEMP Program); Donna Heimiller (Electric Systems Center (GIS Team Leader) Distributed Energy Resource Center); Mark Mehos (Building and Thermal Systems Center); Byron Stafford, National Center for Photovoltaics; Robi Robichaud, Dennis Elliott, and Marc Schwartz of the National Wind Technology Center.

NREL Contributors to Report

The authors wish to thank the following NREL staff for their time and contributions to this collaborative report:

- Program Support Office – Grace Griego, Raymond David, and Jennifer Josey
- Information Services, Product Production Group – Kathy Rose
- Strategic Energy Analysis & Applications Center – Judy Powers
- External Affairs/Public Relations Team – David Glickson

Voluntary Participants

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- DOE LM, Office of Site Operations
  - Robert Baney, Ray Plieness, Tracy Plessinger, Steve Schiesswoh, Joe Desomeau, Christopher Clayton, Scott Surovchak, and Bill Montana
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  - Brian Connor
- Bureau of Land Management
  - Walt George

- Environmental Protection Agency
  - Joan Fisk, Shahid Mahmud
- Solar Industry
  - Abengoa, Solucar Power, Inc, Hank Price
  - Bright Source Energy, Inc., Doug Divine
  - Irradiance, Inc., Edward Kern
  - SkyFuel, Inc., Randy Gee
  - Solar Millennium, LLC, Jim Augustin
  - United Technologies, Corp., Dale Rogers
- Wind Industry
  - Distributed Generation Systems, Inc., Dale Osborn
  - enXco Inc., Tom Weis

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1.0 Executive Summary

This report represents an initial activity for the Department of Energy's Office of Legacy Management (LM) to identify and evaluate renewable energy resources on LM managed federal lands. Within DOE LM's long-term surveillance and maintenance role, a key function is the establishment of environmentally sound future land uses by evaluating potential land reuse options.

To support consideration of renewable energy power development as a land reuse option task, DOE LM and the Department of Energy's National Renewable Energy Laboratory (NREL) established a partnership to conduct an assessment of renewable energy resources on LM lands in the United States.

The LM/NREL team used Geographic Information System (GIS) data to analyze and assess the potential for concentrating solar power (CSP), photovoltaics (PV), and wind power generation, on LM lands. GIS screening criteria developed with industry from previous studies for the Bureau of Land Management and the US Forest Service were applied to produce tables prioritized by renewable resource potential for all federal lands provided by LM.

In June 2007, DOE LM, NREL, BLM, DOE Office of Energy Efficiency and Renewable Energy, EPA, Solar and Wind Industry representatives met to exchange views and issues on potential renewable energy land reuse options. A principal objective was to gauge the renewable industry's interest in pursuing renewable power development on LM Lands. The industry had concerns about the generally small parcels of LM land available and the additional costs and time for renewable project development on federal lands. Despite the low level of interest in LM, the open discussion identified some opportunities for small wind power projects in the Northeast where renewable energy financial incentives are attractive and an LM site in the Southwest that appears suitable for CSP power development.

This assessment report provides DOE LM with information to consider when assessing alternatives of land reuse options for current and future LM lands.

2.0 Objective

The Department of Energy (DOE) Office of Legacy Management (LM) was established in December 2003. LM maintains control and custody of legacy land, structures, and facilities from private sector and federal nuclear weapons and materials production. LM is responsible for maintaining protectiveness of these lands for their long-term use and containment remedy integrity. Within this long-term surveillance and maintenance role, a key function of LM is the establishment of environmentally sound future land uses by evaluating potential land reuse options. LM has partnered with the National Renewable Energy Laboratory (NREL) to evaluate the potential for development and implementation

of renewable power generation facilities on LM sites. The objectives of this partnership are to:

- Assess the potential for solar and wind resources on LM lands
- Identify LM lands, throughout the United States, with the highest industry development potential for power production facilities based on renewable energy
- Investigate the use of renewable energy technologies to support energy use requirements of DOE land environmental remediation activities.

The information in this report supports efforts to facilitate industry's access to LM lands for renewable energy development.

3.0 Scope

This renewable resource assessment analyzes LM lands and some DOE Environmental Management sites slated to be transferred to LM for long term surveillance and monitoring. The renewable energy sources and technologies addressed in the report include concentrating solar power (CSP), photovoltaics (PV), and wind. The assessment was conducted using proven techniques of Geographical Information System (GIS) screening. See Appendix C: Tables C1 – C3).

4.0 Background

This assessment of the potential for renewable energy power production facilities on LM lands responds to various programs, agendas, initiatives, orders and policies:

- DOE's *Energizing America for a New Century,* based on the President Georg Bush's 2001 Management Agenda and focused government initiatives and actions that benefit citizens, are results oriented and market based.
- The Energy Policy Act of 2005, Section 203, *Federal Purchase Requirement* mandates federal agencies to increase electrical energy consumption from renewable energy sources to 7.5% by 2013.
- Executive Order 13423, *Strengthening Federal Environmental, Energy and Transportation Management,* establishes a goal ensuring that 50% of statutorily required federal renewable energy use is from "new" renewable energy sources and, as feasible, that renewable energy generation projects be implemented on federal lands.
- DOE's Transformational Efficiency Management Initiative, launched by DOE Secretary Samuel W. Bodman in August 2007 focuses on DOE lands and facilities and establishes a Secretary goal to "*Maximize Installation of secure, on-site renewable energy projects at all DOE sites and/or aggregation of DOE sites to optimize affordable purchases of renewable energy generation.*"

The Department of Interior's Bureau of Land Management (BLM) could be considered a model for DOE LM's development of renewable energy on federal lands. BLM set a significant precedent for increasing renewable industry access for renewable development on federal lands. In 2003, BLM partnered with DOE's Office of Energy Efficiency and Renewable Energy (EERE) and DOE's NREL, completing an assessment

of renewable energy potential on BLM public lands in the western U.S. The BLM report titled "*Assessing the Potential for Renewable Energy on Public Lands"* is available at http://www.nrel.gov/docs/fy03osti/33530.pdf

Due to surprising wind industry interest in wind-farm development on federal lands during the drafting of the report, BLM issued the Wind Energy Development Policy in October 2002. The policy guides BLM field offices in processing Right-of-Way (ROW) applications submitted by wind industry developers (http://www.blm.gov/nhp/efoia/wo/fy03/im2003-020.htm). Within two years of the assessment, BLM had received and processed over 70 ROW applications for meteorological towers for wind resource analysis.

The National Environmental Policy Act (NEPA) compliance is required for all projects developed on federal lands, therefore, the cost and time to develop Environmental Impact Statements (EIS) was still a significant barrier. To enhance and attract private sector development on federal lands, BLM developed a Wind Programmatic EIS (Wind PEIS) providing best management practices for mitigation of adverse impacts, applicable to all western U.S. BLM lands. The BLM Wind PEIS allowed wind developers to focus on site specific mitigation measures not addressed in the Wind PEIS. This permitted the development of an Environmental Assessment, which results in much less time and cost for NEPA compliance.

DOE was a cooperating agency supporting the development of the BLM Wind PEIS. Consequently, DOE is pursuing actions to adopt BLM's Wind PEIS, for use with wind development NEPA compliance actions on DOE lands in the Western U.S. As of the publication of this report, DOE's Environmental Office has not completed actions to adopt the BLM Wind PEIS. The BLM Wind PEIS can be found at http://windeis.anl.gov/eis/index.cfm. BLM reissued their Wind Energy Development Policy in August 2006, incorporating Wind PEIS best management practices (http://www.blm.gov/nhp/efoia/wo/fy06/im2006-216.htm).

BLM also issued its Solar Energy Development Policy in October 2004 (http://www.blm.gov/nhp/efoia/wo/fy05/im2005-006.htm) to support increased industry access to BLM lands for solar project development in response to the Western Governor's Association June 2005 goal to develop 30,000 kW of renewable energy on western U.S. lands. During the period of fall 2006 through April 2007, solar project developers have submitted over 40 ROW applications to BLM for solar power generation projects in California, Nevada, and Arizona. As a result, BLM issued a revised Solar Energy Development Policy to support streamlined processing of ROW applications by BLM Field offices. The latest version of BLM's Solar Energy Development Policy is at: http://www.blm.gov/nhp/efoia/wo/fy07/im2007-097.htm.

DOE LM is interested in garnering lessons learned from BLM. LM is interested in evaluating the feasibility of partnering with BLM for renewable energy projects on adjacent lands.

5.0 Descriptions of Renewable Energy Technologies

5.1 Concentrating Solar Power Technologies

5.1.1 Technology Overview

Concentrating solar power plants produce electric power by converting the sun's energy into high-temperature heat using various mirror configurations. The heat is then channeled through a conventional generator. The plants consist of two parts: one part collects solar energy and converts it to heat, and the other converts heat energy to electricity.

CSP systems can be sized for distributed power (10 kW – 25 kW) or grid-connected applications (100's of MW). Some systems use thermal storage during cloudy periods or at night. Others can be combined with natural gas and the resulting hybrid power plants provide high-value, dispatchable power. These attributes, along with high solar-to-electric conversion efficiencies, make CSP an attractive renewable energy option in the southwest United States and other sunbelt regions worldwide.

5.1.2 Parabolic Trough Systems

The sun's energy is concentrated by parabolically curved, trough-shaped reflectors onto a receiver pipe running along the inside of the curved surface. This energy heats oil flowing through the pipe, and the heat energy is then used to generate electricity in a conventional steam generator.

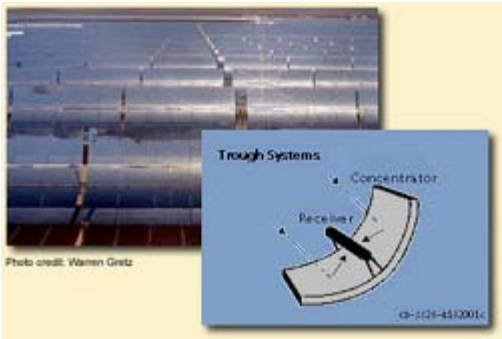


Figure 5.1.1. Parabolic trough solar system.

A collector field comprises many troughs in parallel rows aligned on a north-south axis. This configuration enables the single-axis troughs to track the sun from east to west during the day to ensure that the sun is continuously focused on the receiver pipes. Individual trough systems currently can generate about 80 MWs of electricity; however analysis indicates that individual systems can be built as large as 300 MWs or collocated in power parks constrained only by transmission capacity.

Trough designs can incorporate thermal storage—setting aside the heat transfer fluid in its hot phase—allowing for electricity generation several hours into the evening. Currently, most parabolic trough plants are "hybrids," meaning they use fossil fuel to supplement the solar output during periods of low solar radiation. Typically a natural gas-fired heat or a gas steam boiler/reheater is used; troughs are being considered for integration with existing or new combined cycle or coal-fired plants.
Linear Fresnel Reflector systems are similar to parabolic trough systems in that they focus sunlight along a receiver pipe at the line of focus of a collector system. However, linear Fresnel systems use individually tracking flat or slightly curved mirrors to approximate the shape of a parabolic trough system. While the annual performance of

such systems is significantly lower than that of parabolic troughs, the hope is that installed costs will be reduced sufficiently to achieve similar or lower costs of energy. At this point, no linear Fresnel Reflector systems have generated electricity, so the actual cost and performance of such systems have not been validated.

5.1.3 Power Tower Systems

A power tower converts sunlight into clean electricity for the world's electricity grids. The technology uses many large, sun-tracking mirrors (heliostats) to focus sunlight on a receiver at the top of a tower. A heat-transfer fluid heated in the receiver is used to generate steam, which, in turn, is used in a conventional turbine-generator to produce electricity. Power towers (such as PS10 in Spain) use steam as the heat-transfer fluid. Advanced designs (such as Solar Two) use molten nitrate salt because of its superior heat-transfer and energy-storage capabilities.

Figure 5.1.2. Power tower solar system (Solar Two).

Individual commercial plants will be sized to produce anywhere from 50 MW to 200 MW of electricity. Two large-scale power tower demonstration projects have been deployed in the U.S. The 10-MW Solar One plant near Barstow, CA, demonstrated the viability of power towers, producing over 38 million kWh of electricity during its operation from 1982 to 1988. The Solar Two plant was a retrofit of Solar One to demonstrate the advantages of molten salt for heat transfer and thermal storage. Using its highly efficient molten-salt energy storage system, Solar Two successfully demonstrated efficient collection of solar energy and dispatch of electricity, including the ability to routinely produce electricity during cloudy weather and at night. In one demonstration, it delivered power to the grid 24 hours per day for nearly seven straight days before cloudy weather interrupted operation.

5.1.4 Dish/Engine Systems

A solar dish/engine system is an electric generator that "burns" sunlight instead of gas or coal to produce electricity. The major parts of a system are the solar concentrator and the power conversion unit.

The dish, which is more specifically referred to as a concentrator, is the primary solar component of the system. It collects the solar energy coming directly from the sun and concentrates or focuses it on a small area. The resultant solar beam has all of the power of the sunlight hitting the dish but is concentrated in a small area so that it can be used more efficiently. Glass mirrors reflect about 92% of the sunlight that hits them, are relatively inexpensive, can be cleaned, and last a long time outdoors, making them an excellent choice for the reflective surface of a solar concentrator. The dish structure must track the sun continuously to reflect the beam into the thermal receiver.

Figure 5.1.3. The Stirling Energy Systems 25-kW dish/Stirling system is undergoing operational testing at Sandia National Laboratories in Albuquerque, NM.

The power conversion unit includes the thermal receiver and the engine/generator. The thermal receiver is the interface between the dish and the engine/generator. It absorbs the concentrated beam of solar energy, converts it to heat, and transfers the heat to the engine/generator. A thermal receiver can be a bank of tubes with a cooling fluid, usually hydrogen or helium, which is the heat-transfer medium and also the working fluid for an engine. Alternate thermal receivers are heat pipes wherein the boiling and condensing of an intermediate fluid is used to transfer the heat to the engine.

The engine/generator system is the subsystem that takes the heat from the thermal receiver and uses it to produce electricity. The most common type of heat engine used in dish/engine systems is the Stirling engine. A Stirling engine uses heat provided from an external source (like the sun) to move pistons and make mechanical power, similar to the internal combustion engine in your car. The mechanical work, in the form of the rotation of the engine's crankshaft, is used to drive a generator and produce electrical power.

Based on the following assessment and NREL's judgment of the commercial readiness of CSP technologies, we believe that parabolic trough technology is the only large-scale CSP technology that is available for application in a commercially-financed power project now and in the near future. The remainder of this section thus focuses on parabolic trough technology.

5.1.5 Siting Requirements for Concentrated Solar Power (CSP)

Solar Resource

Parabolic trough solar steam systems require high direct normal insolation (DNI), or beam radiation, for cost-effective operation. The required size of the solar field for a given power plant capacity is, in general, directly proportional to the DNI level. The solar field cost is a significant factor in the economics of a solar power plant. For a Rankine cycle steam power plant with a solar heat resource, the solar field constitutes about 50% of the total cost. Thus, not only do sites with excellent solar radiation offer more attractive levelized electricity prices, but this single factor normally has the most significant impact on solar system costs.

DNI data are either measured directly or constructed by radiation models from measurements of total radiation (which consists of both direct beam and diffuse components). Satellite data are proving to be an important source of these data. Micro-climate effects, sometimes in relatively small regions, can be quite important. Although constructed data are becoming increasingly accurate and valuable, measured DNI data offer the best assurance that the solar field size is chosen accurately.

Ideally, any site under consideration should have one or more years of measured solar resource data to indicate the seasonal and annual variations likely to be experienced at the site. Unfortunately, very few sites have solar monitoring stations, and even when they do, the data are often not of sufficiently high quality. To confirm site solar resource, a solar monitoring station should be installed at high-potential sites by LM or selected solar system developer to calibrate site resource data with satellite data. This assessment uses a new, high-resolution solar resource data set developed using satellite data and correlated to good ground station data. Annual solar DNI estimates are provided on a grid of 0.1 degree in both latitude and longitude (nominally, 10 km). These estimates were created using the Perez irradiance model. [1] As input, the model uses visible cloud images from the NOAA GOES-10 weather satellite (in California), atmospheric water vapor measured from satellites and radiosondes (balloons), total column ozone measured from satellites, and aerosols (dust and haze) estimated from surface and satellite measurements. This is a third-generation model with substantial improvements to handle cloud detection over desert terrain, a critical problem in the western United States.

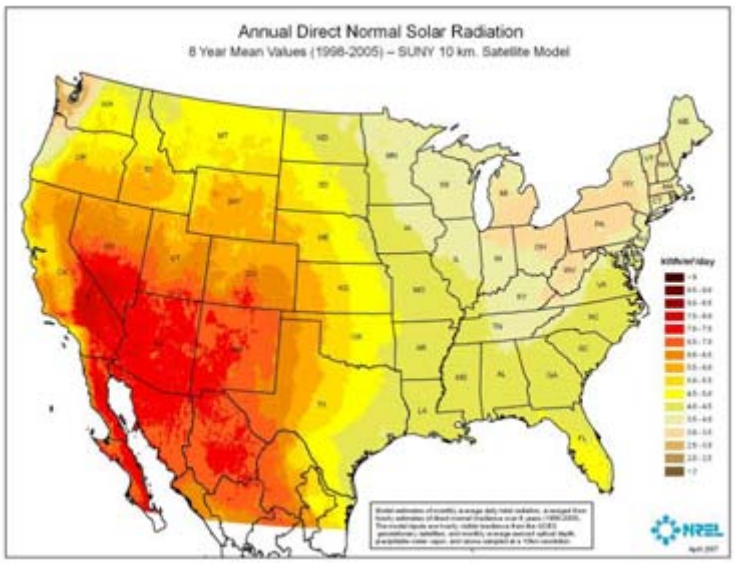


Figure 5.1.4. Solar Resource Map for the U.S.

5.1.6 Solar Resource

The solar resource for generating power from concentrating solar power (CSP) systems is plentiful. The amount of power generated by a CSP plant depends on the amount of direct sunlight. These technologies use only direct-beam sunlight, rather than diffuse solar radiation. The south- western United States potentially offers the best development opportunity for CSP technologies in the world. There is a strong correlation between electric power demand and the solar resource due largely to air conditioning loads in the region.

5.1.7 CSP Plant Development Issues

Land

A parabolic trough solar power plant requires approximately five acres (20,000 m^2) per MW of plant capacity. Plants with thermal storage and higher capacity factors will require proportionally more land per MWe. Siting studies have generally found that land with an overall slope of less than 1% are the most economic to develop. Potential sites should have reasonable land costs, be generally level, and be close to transmission, water, and natural gas. The specific slope and topography of the land will then determine the comparative acceptability of competing sites through their impact on site costs for grading and preparation. Land characteristics are thus most effectively used as screening tools in selecting acceptable sites for further evaluation.

Transmission Access and Interconnection

Transmission line costs can be very high, and access to transmission lines of appropriate capacity is a very important siting factor. Depending on the line voltage level and the length of the transmission line, costs for a 100-MW capacity, for example, can range from $50,000 to $180,000 per mile. Therefore, the proximity of potential solar power plants sites to transmission lines is very important.

Parabolic trough plants use conventional Rankine steam turbine/generator sets, with some performance enhancements such as reheat. The interconnection requirements are similar to those of other steam power plants. The existing 80 MWe trough plants have step-up transformers to supply power at 230 kV and include reactive power control.

Water

The primary water uses at a Rankine steam solar power plant are for the steam cycle, cooling, and washing mirrors. Historically, parabolic trough plants have used wet cooling towers for cooling. The cooling uses approximately 90% of the water. The steam cycle uses approximately 8% and mirror washing uses the remaining 2%. However, availability of water can be a significant issue in the desert. Many of the flat areas in the desert have underground water. Two of the trough sites in operation, since the late 1980's and early 1990's at Kramer Junction, CA, providing electricity to Southern California Edison, use underground water, and one uses aqueduct water.
Annual water consumption at trough plants is approximately 750 acre-feet for a 100 MW plant. If sufficient water is not available at LM sites for cooling, either dry cooling or wet-dry systems are necessary. These options can increase plant electricity costs by 10% or more, indicating the desirability of sites with sufficient aquifer or other water resources. Treatment of raw water is required for plant use.

Natural Gas

Solar thermal power plants have the capacity to provide firm power in a hybrid configuration where fossil fuel, preferably natural gas, can supplement the solar energy resource. This is particularly important during peak demand periods where electricity's value is high. If power firming is a requirement of the power buyer, proximity to natural gas pipelines is a very important factor. It is a significant, though usually not critical, determinant in the viability of hybrid operation. Of course, very large distances can make this option economically unacceptable.

Land Agreements

CSP developers need to work with the land owner(s) to determine the nature of the contractual relationship between land owner and developer. Issues to be agreed upon include: ingress and egress rights, transmission rights, compensation terms, project life, and reclamation provisions at project end. The terms need to include reasonable access for solar resource assessment, construction, operation, maintenance and reclamation activities. Compensation can be in the form of a fixed lease fee per acre, fixed fee per kWh or a percentage of gross revenue attributable to the landowner's parcel.

Permitting

Permitting requirements to construct and operate a CSP plant vary widely depending upon who owns the land and any restrictions on land use. Typically, land use permits and building permits are the minimum required for CSP plants.

Environmental Review

LM sites are federal lands and require environmental studies in compliance with the NEPA. The CSP developer must undertake, at its cost, as required, studies of threatened and endangered species, land disturbance, wetlands and a review of the results with interested local, state or federal officials, or interested citizens or citizen groups. They may also be required to perform historical and archeological studies and visual impact studies. The product of environmental review is an EIS, requiring DOE issuance of a Record of Decision (ROD), or an Environmental Assessment (EA), requiring DOE issuance of a Finding of No Significant Impact (FONSI).

Interconnection and Wheeling

Utilities, private companies or DOE Power Marketing Administrations with transmission systems must allow CSP plants to interconnect to their transmission systems, however the requirements that must be met, the studies to be undertaken, and the interconnection equipment that will be required are determined by the transmission-owning entity, where the costs are usually borne by the CSP developer. tudies such as capacity limitations, load flow analysis, voltage controls and system protection are the norm. Recent legislation has caused the rules and requirements to be re-visited and standards for interconnection equipment and timelines have been developed for two classes of generation (20 MW or less or greater than 20 MW) relevant to solar plants. Moving the CSP generated energy to the purchaser of the energy through the utility or other entity owned transmission system is called wheeling. The fee for this wheeling may be determined through negotiation or defined by a tariff filed by state or federal regulators.

Power Purchase Agreement

The CSP developer must find a buyer for the energy to be generated in order to obtain project financing as the buyer determines the potential revenue stream amount and time frame. The power purchase agreement (PPA) defines the terms for this long term revenue stream. A creditworthy buyer is necessary to ensure a predictable long term cash flow for project financing approval.

Financing

With the PPA in hand, the CSP developer can work with financiers to determine the terms of the loans, due diligence and assignability of documents. The financing is

typically used to provide for the solar collectors, and power generation systems (e.g. turbines) procurement and construction/installation costs though other project costs may also be included.

Operation and Maintenance

The CSP developer must include provisions for O&M for financing because it is critical to the successful long-term operation of the CSP plant. The O&M terms typically specify a CSP plant availability percentage (usually 95% - 98% of the year) and outline the non-performance penalties.

5.2 Photovoltaic Technologies for Power Applications

5.2.1 Technology Overview

This section considers PV technologies in large central generation facilities in the near-term (zero to five years) to mid-term (ten plus years). Historically, the long-term vision has been to develop cost-effective solar technologies for large (100 MWe or greater) central power plant applications. However, it is important to point out that PV is much more competitive when deployed as a distributed resource technology. Unlike many other generation technologies, PV offers considerable flexibility with deployment strategy. PV is a very different technology than traditional utility generation resources, and deployment approaches need to recognize the advantages of PV technology, such as an energy resource for site long-term surveillance and maintenance (LTSM).

PV technologies, also sometimes referred to as solar-electric technologies, are being developed for solar power generation applications. PV technologies use semiconductor materials for the direct conversion of sunlight to electricity. The various PV technologies are categorized by how the sunlight is collected . A major difference is between concentrating and nonconcentrating applications. Nonconcentrating PV systems are typically referred to as flat-plate PV systems.

5.2.2 Flat-plate Nonconcentrating PV Systems

The majority of PV systems installed in the United States and the world are nonconcentrating. They use flat-plate PV modules (panels of solar cells) that have a fixed orientation with respect to the sun, or they track the sun by mechanically changing the orientation of the modules throughout the day.

5.2.3 Fixed, Flat-plate, Nonconcentrating PV Systems

In a fixed flat-plate, nonconcentrating PV system, the solar modules are fixed so that the face of the module is oriented to the south (in the northern hemisphere), and the module is tilted at a fixed angle with respect to the horizontal ground. For maximum year-round energy production, the module tilt will equal the latitude of the site. The module tilt can be reduced if there is a desire to optimize the summer energy production at the expense of the winter production. For large systems, the module tilt is determined when the system is designed and is never changed during the year.

Figure 5.2.1. Arizona Public Service's Prescott Airport Solar System Showing a Tracking Flat-Plate, Nonconcentrating PV System. In the background are concentrating PV systems. (Source: Herb Hayden, Arizona Public Service)

5.2.4 Tracking, Flat-plate, Nonconcentrating PV Systems

By mechanically changing the orientation of the solar modules during the day, we can produce more energy with the same number of solar modules used in the fixed PV system. A typical single-axis tracking system consists of north-south-oriented rows in which the solar modules track the sun in an east-west direction. The solar modules can also track the sun using two-axis (dual-axis tracking). The increase in energy production resulting from dual-axis tracking in comparison to energy production from single-axis tracking systems is marginal, when measured against the incremental cost increase. Most tracking, nonconcentrating PV systems use single-axis tracking as shown in Figure 5.2.1.

5.2.5 Concentrating PV Systems

The fundamental distinction between concentrating and flat-plate PV technologies is the amount of sunlight incident on the solar cells within each system. It is common to refer to the standard solar irradiance at the Earth's surface—1 kW/m^2—as "one sun," which is the amount of sunlight incident on flat-plate systems. Concentrating systems have more than one sun—as much as hundreds of suns—incident on the solar cell. The number of suns is also termed the concentration ratio. The system's array must point toward the sun and follow it throughout the day to maintain the sun's focus on the cell, and good heat-transfer design is needed to limit the cell's temperature. Tracking the sun's movement benefits the concentrating photovoltaic (CPV) system because it produces more than 30% additional energy, measured in kWh/kW, than a non-tracking flat-plate system. If the cost of the CPV system is low enough, an opportunity exists to produce low-cost

electricity from sunlight using relatively high cost/area, high-efficiency solar cells.

Concentrating photovoltaic systems need the highest-efficiency solar cells to improve their effectiveness for producing low-cost electricity. Small-area, high-efficiency solar cells are ideal for CPV systems, such as one using an optical element that focuses sunlight onto a small (e.g., 1-cm x 1-cm) solar cell, much like a magnifying glass that produces a spot of sunlight bright enough and hot enough to burn a piece of paper.

The world's highest-performance solar cells are now made principally from elements in columns III and V of the Periodic Table. These III-V solar cells have conversion efficiencies greater than 28% in production and a world record of more than 36% under concentration. The efficiencies of III-V solar cells are about one-third higher than the efficiencies of the crystalline-silicon solar cells used in today's commercial CPV systems.

Over the years, systems analyses have invariably concluded that higher-efficiency solar cells improve the likelihood that CPV systems will be cost effective. Although the III-V cells are more expensive than silicon cells, the cost has been reduced by mass production to meet the space-satellite market and can be reduced further by developing lower-cost substrates or by further increasing the concentration ratio. The remainder of the concentrating-system cost reduction results from using materials that are much less expensive than the solar cell materials, such as steel and plastic.

There are a variety of concepts for concentrating sunlight onto PV cells. The most common concentrating concepts are linear concentrators and point-focus concentrators. For each of these concepts, solar concentration can employ reflection or refraction (typically using Fresnel lens systems) of the sun's rays. If, for example, the concentration ratio is 300 suns, the system is usually described as a 300x system. Typical linear concentrating systems operate at 10x to 20x, whereas point-focus concepts work at 200x to 1000x or more. The lower-concentration systems have an apparent advantage in that, with minor changes, they can use lower-efficiency, one-sun solar cells, whereas higher-concentration systems use solar cells designed for very high efficiency and highly concentrated sunlight. Systems analyses conducted to date suggest that higher-concentration CPV systems, above 500x, will take more development, but will ultimately produce less-expensive electricity. Concentrating PV systems require two-axis tracking that follow the sun. The higher concentration ratios require greater precision of the tracking mechanism.

The collective configuration of the solar cells, heat-dissipation components, secondary optical components, and electrodes constitutes the "receiver" within a concentrator module. Figures 5.2.2 through 5.2.4 show a point-focus Fresnel lens concentrator system, linear-focus Fresnel lens concentrator, and point-focus dish concentrator, respectively.

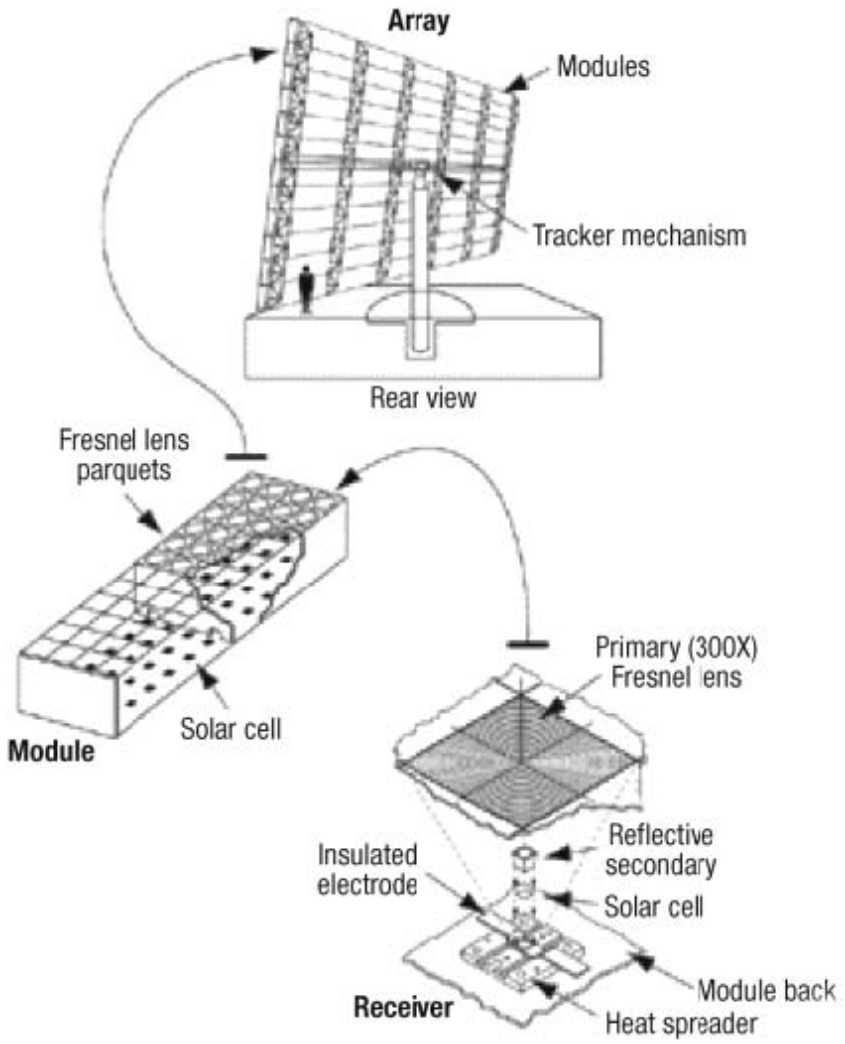


Figure 5.2.2. Schematic of a point-focus Fresnel lens concentrator. Figure 5.2.3. Schematic of a linear-focus Fresnel lens concentrator PV system.

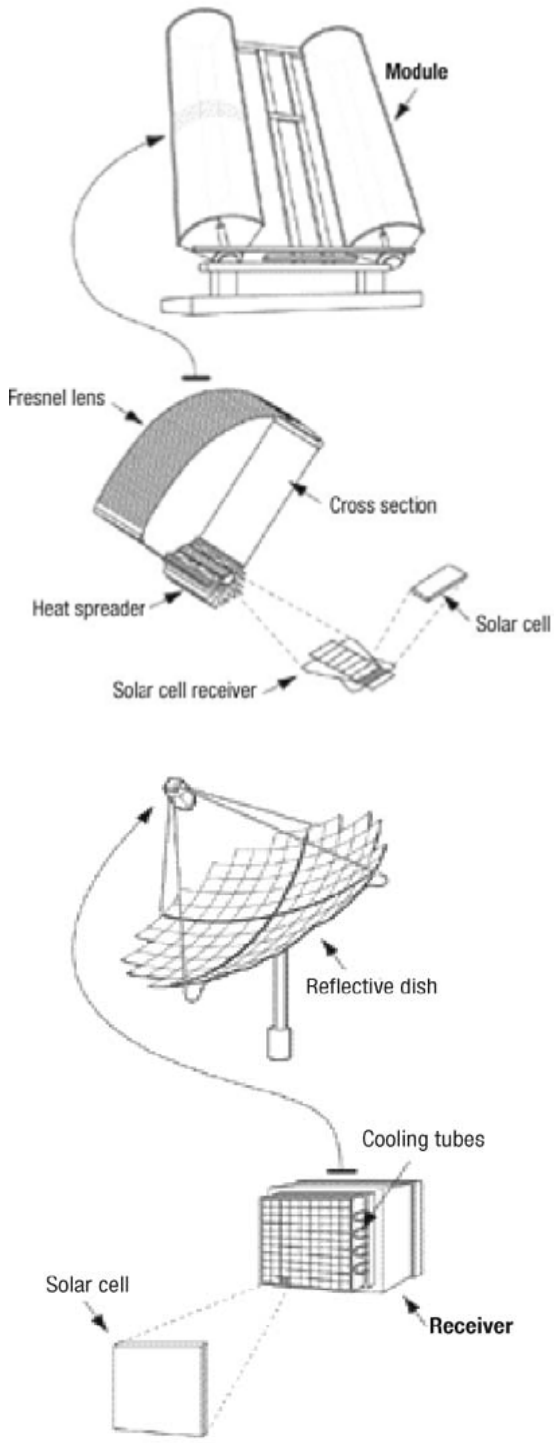


Figure 5.2.4. Schematic of a point-focus dish concentrator PV system.

5.2.6 Recommendation for PV Systems

All the PV technologies mentioned are possible candidates for cost-effective deployment in large power generation stations in the next ten years and beyond. Some of the technologies have had longer experience in the field than others, but all are possibilities in the next ten years depending on the location, competing energy costs, and financing. There is a slightly greater technical risk associated with concentrating PV systems deployed in multi-megawatt applications since we have had less field experience with them. However, overall delivered energy costs from concentrating PV systems could be the same or lower than those of flat-plate, nonconcentrating PV systems—especially in parts of the southwestern U.S.

DOE LM should continue to monitor the technical progress, PV systems cost reductions, and financial incentive program that reduce PV power costs. Throughout the next ten years, there will be applications for utility scale PV plants, such as within states that have implemented Renewable Portfolio Standards (RPS) and offer Renewable Energy Credit (REC) trading (see Appendix D). State utility commissions are increasing the application of RPS solar set aside provisions, requiring utility companies to acquire a specified percentage of solar generation. Additionally. the recent emergence of REC markets has improved economic viability of high-cost renewable energy system development. RECs assign an economic value for the green attributes of renewable power generation systems, which can be applied to reduce the cost of renewable energy electric generation facilities. As an example, a 15 MW PV plant was installed at Nellis Air Force Base in 2007, due to the financial incentive of the PV industry developer's access to RECs (valued at over $0.20/kWh). The cost per kWh of power from this PV plant—provided to this military installation in a 30 year contract—,was well below the current retail rate of electricity, benefitting the military installation and the PV industry.

5.2.7 PV Siting Requirements

Site requirements can have cost impacts and more definitive go/no-go impacts on a project. Most requirements fall into the former category, or shift from one to the other in the limit. For example, a terrain with a 3% slope has potential, but grading costs would be much higher than those of a site with <1% slope, whereas a very high slope or hilly topography would be totally unsuitable. The characteristics considered below have the most significant impacts on costs.

5.2.8 Solar Resource

The solar field cost is a significant factor in the economics of a solar power plant. Concentrating PV systems require high DNI, or beam radiation, for cost-effective operation. Flat-plate, nonconcentrating PV systems use global diffuse solar radiation, which includes the DNI and scattered blue-sky light. Generally, under clear sky conditions, 85% of the sunlight is DNI and 15% is scattered light that comes in at all different angles. The scattered light, which cannot be used by any concentrating system, can be used by flat-plate PV systems. Sites that have a good solar resource for concentrating systems are also great for flat-plate systems, since the global solar resource includes the DNI.

The size of the solar field required for a given power plant capacity in general is directly proportional to the solar resource. Thus, sites with excellent solar radiation offer more attractive levelized electricity prices, and this single factor normally has the most significant impact on solar system costs.

Solar resource data are either measured directly or constructed by radiation models from measurements of total radiation, which has both direct beam and diffuse components. Satellite data are proving to be an important source of such data. Microclimate effects, sometimes in relatively small regions, can be quite important. While constructed data are becoming increasingly accurate and valuable, measured solar resource data offer the best assurance that the size of the solar field is accurate.

Ideally, for any site under consideration there should be more years of measured solar resource data to help us understand the seasonal and annual variations likely to be experienced there. Unfortunately, very few sites have solar monitoring stations, and even when they do, the data are often not high in quality. Therefore, this assessment uses a new high-resolution solar resource data set developed using satellite data and correlated with good ground station data. Annual solar resource estimates are provided on a grid of 0.1 degree in both latitude and longitude (nominally, 10 km). These estimates were created using the Perez irradiance model. [1] The model uses as input: visible cloud images from the National Oceanic and Atmospheric Administration (NOAA) GOES-10 weather satellite (in California), atmospheric water vapor measured from satellites and radiosondes (balloons), total column ozone measured from satellites, and aerosols (dust and haze) estimated from surface and satellite measurements. This is a third-generation model with substantial improvements to handle cloud detection over desert terrain, a critical problem in the western United States.

5.2.9 PV Plant Development Issues

Land

All large PV systems require fairly flat land with slopes of less than 3%. The slope of the land has an impact on construction costs. A screening criterion of less than 3% was used. PV power plants require a large area for their solar collector field. Approximately .02 km^2 (5 acres) are required per MWe of electricity produced in a PV power plant. As a result, the potential for disruption of wildlife habitat may be greater than that for a conventional power plant. In desert regions where a PV power plant would typically be located, protected wildlife such as the desert tortoise and the Mojave ground squirrel could require habitat remediation. For example, the 80-MWe solar thermal power facilities Solar Energy Generating Stations (SEGS) VIII and IX (CSP Trough Systems) have minimized habitat disruption by being built on sites of former agricultural land. SEGS VIII and IX are located near Harper Lake, CA and have been operating successfully in delivering electricity to Southern California Edison since 1991. This strategy of utilizing previously disturbed lands appears to be successful and is the wisest approach, if feasible, in regions of interest. No strategies have yet been identified for PV solar fields that encourage dual use of the land.

Transmission Access and Interconnection

Transmission line costs can be very high, and access to transmission lines of appropriate capacity is a very important siting factor. Therefore, the proximity of potential solar power plant sites to transmission lines is highly important. The interconnection requirements are similar to those of other large power plants.

Water

Water is not required for the normal operation of any PV system. Water is used chiefly for occasional cleaning of the PV modules, Fresnel covers, or the reflective surfaces. The washing interval is determined by local site conditions and an economic analysis of cleaning costs versus increased energy production. Cleaning flat-plate PV systems can be as simple as driving a water truck between the rows and spraying the PV modules. Many installations are not regularly cleaned due to cost, and rely on wind and rain to keep the modules sufficiently clean.

Land Agreements

PV developers need to work with the land owner(s) to determine the nature of the contractual relationship between land owner and developer. Issues to be agreed upon include: ingress and egress rights, transmission rights, compensation terms, project life, and reclamation provisions at project end. The terms need to include reasonable access for solar resource assessment, construction, operation, maintenance and reclamation activities. Compensation can be in the form of a fixed lease fee per acre, fixed fee per kWh or a percentage of gross revenue attributable to the landowner's parcel.

Permitting

Permitting requirements to construct and operate a PV plant vary widely depending upon who owns the land and any restrictions on land use. Typically, land use permits and building permits are the minimum required for PV plants.

Environmental Review

LM sites are federal lands and require environmental studies in compliance with NEPA. The PV developer must undertake, at its cost, as required, studies of threatened and endangered species, land disturbance, wetlands and a review of the results with interested local, state or federal officials, or interested citizens or citizen groups. They may also be required to perform historical and archeological studies and visual impact studies. The product of environmental review is an EIS, requiring DOE issuance of a ROD, or an EA, requiring DOE issuance of a FONSI.

Interconnection and Wheeling

Utilities, private companies or DOE Power Marketing Administrations with transmission systems must allow utility scale PV plants to interconnect to their transmission systems, however the requirements that must be met, the studies to be undertaken, and the interconnection equipment that will be required are determined by the transmission owning entity, where the costs are usually borne by the PV developer. Studies such as capacity limitations, load flow analysis, voltage controls and system protection are the norm. Recent legislation has caused the rules and requirements to be re-visited and standards for interconnection equipment and timelines have been developed for two classes of generation (20 MW or less or greater than 20 MW) relevant to solar plants.

Moving the PV generated energy to the purchaser of the energy through the utility or other entity-owned transmission system is called wheeling. The fee for this wheeling may be determined through negotiation or defined by a tariff filed by state or federal regulators.

Power Purchase Agreement (PPA)

The PV developer must find a buyer for the energy to be generated in order to obtain project financing as the buyer determines the potential revenue stream amount and time frame. The PPA defines the terms for this long term revenue stream. A creditworthy buyer is necessary to ensure a predictable long term cash flow for project financing approval.

Financing

With the PPA in hand, the PV developer can work with financiers to determine the terms of the loans, due diligence and assignability of documents. The financing is typically used to provide for the solar panels, and power conditioning systems (e.g. inverters) procurement and construction/installation costs though other project costs may also be included.

Operation and Maintenance (O&M)

The PV developer must include provisions for O&M for financing because it is critical to the successful long-term operation of the PV plant. The O&M terms typically specify a PV plant availability percentage (usually 95% - 98% of the year) and outline the non-performance penalties.

Wind

The performance and structural design of the concentrating PV solar field are impacted by high winds. The solar field is not designed to operate in winds of more than 35 mph; consequently, high-wind sites limit the performance potential of the concentrating PV plant. Moreover, wind forces dictate the collector structural design. Since the cost of the structure constitutes about 40% of all solar field costs, it is important to optimize this component.

The performance and structural design of a flat-plate nonconcentrating PV solar field is more robust, and it can operate at higher wind speeds. A tracking flat-plate PV system is stowed at a predetermined wind speed to prevent damage to the modules and the support structure. In areas with extremely high winds, the fixed flat-plate PV system will remain operational in wind speeds in excess of 80 mph.

5.3 Wind Power Technologies

5.3.1 Technology Overview

Wind turbines are machines that turn wind into electricity. As indicated in the discussion below about capturing the wind energy, the nature of the wind resource drives two primary trends in the wind industry: move into faster wind speeds with taller towers and capture more wind energy with larger rotors.

The scale of the utility-size wind turbines designed to do this has increased dramatically over the past two decades and continues to do so. Currently, most new wind farm installations use wind turbines in the 1.0 MW to 2.5 MW range. A 1 MW wind turbine will be expected to generate enough electricity for 250 to 300 homes per year. As wind speeds vary year to year, so does the annual energy production of wind turbines – in high wind years they create more kWhs, in low wind years they create fewer kWhs.

Of critical importance for wind turbines is how much of the available wind power can be turned into electricity. The electrical power that a turbine will be able to deliver depends upon the efficiency of the wind turbine in making that conversion. The term C_p represents the limit of the amount of power that can be extracted from the wind and Ng is the efficiency of the generator.

$$P = \frac{1}{2} C_p A \rho N_g V^3$$

Wind turbines use airfoil-shaped blades to convert the kinetic energy of wind into mechanical energy in the form of rotating blades. The rotating blades turn an electric generator behind the rotor completing the transformation of wind energy into electricity. Wind turbine blades exploit the principle of lift, whereby the difference of air pressure causes the blades to move, effectively capturing the energy from the wind. Designed to maximize "lift" rather than "drag", the tips of the blades actually move faster than the wind speed. Modern wind generators have a tip speed ratio range of 6:1 to 8:1. At a ratio of 8:1, if the wind is moving at 10 m/s, the tips of the blades are moving at 80 m/s. Most modern wind turbines have two or three blades.

As relatively small differences in average speed cause significant differences in energy production, it is usually worthwhile examining ways to increase the wind velocity at a particular site. Normally, the easiest way to accomplish this is to increase the height of the tower as wind speeds tend to increase with height above the ground. Because power increases as the cube of wind speed, much of the average power available to a wind turbine comes in short bursts during periods of high wind speed. It is only in high winds that the turbine produces at rated power. To capture such bursts, the wind turbine needs a large enough generator and a strong gearbox that go underutilized most of the time. Just surviving the strongest gusts requires the turbine to use lots of extra material in the tower and blades that for the most part is unnecessary.

5.3.2 Site Selection

There are three basic steps to identifying and characterizing the developable wind resource at a particular site: prospecting, validating, and micrositing. Prospecting often

begins with wind resource and topographical maps. The wind maps are intended to help wind developers decide where to undertake a more detailed investigation of the wind resource. The topographical maps help to identify geographic features that may enhance or dissipate the wind. Also of interest is general proximity to transmission lines, reasonable road access, few environmental concerns, and generally receptive communities.

The wind developer needs to determine what wind data is available for long-term correlation of the site specific data to be gathered. Then a meteorologist will determine where to site the meteorological (MET) tower(s) to best assess and quantify the developable wind resource.

MET towers are used for site specific analysis of the wind resource potential at a particular site. The intent is to obtain high-quality data as close to the expected turbine location and turbine height as possible over a 12-month time frame or longer. This data is then correlated with available long-term wind data to determine if the collected data represents an average, below-average, or above-average wind year.

For utility scale wind farms, 60 m or 80 m MET towers are often used. They will be equipped with anemometers at multiple heights (measuring wind speed and used to calculate wind shear), wind vanes (for direction), temperature and barometric pressure gauges. The collected data will be used to analyze daily and seasonal wind speed, gustiness, and directional patterns. Data is often sampled every second with 10-minute averages recorded that may be combined into hourly averages for analysis. MET towers are often equipped with solar-powered telecommunications capability so that remote data collection and monitoring are possible.

5.3.3 Wind Resource

The extent of the wind resource is a critical variable in determining the economic potential of any wind project. The conventional process in any potential wind project is to install an anemometer and gather one to three years of site specific wind data as close as possible to the proposed wind turbine site. This process involves research and data analysis time, equipment, and money. It is usually time and money well spent because a validated wind resource at the best available location provides realistic energy production and economic performance projections.

Windiness varies with the season and time of day and, of course, weather events. Collected wind data focuses on several primary considerations: average annual wind speed, frequency distribution of the wind at various speeds, and wind shear (the increase in wind speed with elevation and the amount of turbulence in the wind).

The wind speed at any given time determines the amount of power available in the wind. The power available in the wind is given by:

$$P = \frac{1}{2} A \times \rho \times V^3$$

where

P = power of the wind [Watts]
A = windswept area of the rotor (blades) = $\pi D/4 = \pi r^2$ [m^2]
ρ = density of the air [kg/m^3] (at sea level at 15°C)
V = velocity of the wind [m/s]

This equation demonstrates that wind energy is proportional to velocity cubed (V^3). This matters because if velocity is doubled, power increases by a factor of eight ($2^3 = 8$). Consequently, small differences in average speed cause significant differences in energy production. Likewise, being able to precisely characterize the extent of a particular wind resource enables a more accurate projection of expected annual energy output.

5.3.4 Wind Development Process and Issues

The wind development process for a wind farm is a multi-year effort with site selection and continues through financing and construction with numerous steps to be completed in between. Some of the tasks are sequential in nature with the results from one weighing heavily in decisions to be made in the next. As the process develops, more tasks that can be completed in parallel emerge. The following is a condensed summary representative of the types of activities involved in developing a wind farm. The wind development process typically takes two to five years at most sites. Shorter time frames are better for wind developers as capital resources are usually tied up with no revenue until the wind farm begins operating.

Wind Turbine Transportation and Installation Issues

Due to the ever increasing size of wind turbines, such as 80-100 meter hub heights, transporting wind turbines is increasing in cost. Turbine tower sections are large diameter, as long as possible, and extremely heavy for transport by specialized trucking equipment to the site. The same is true for the turbine hub and blades in excess of 70 meters. Trucking equipment require large turning radius, so site access may require road improvement to delivery turbine components. An additional consideration for installation of large wind turbines is the cost and availability of large cranes in the vicinity of the wind farm site.

Land Agreements

Wind developers need to work with the land owner(s) to determine the nature of the contractual relationship between land owner and developer. Issues to be agreed upon include: the wind rights, ingress and egress rights, transmission rights, compensation terms, project life, and reclamation provisions at project end. The terms need to include reasonable access for wind assessment, construction, operation, maintenance and reclamation activities. Compensation can be in the form of a fixed lease fee per acre or per turbine, fixed fee per kWh or a percentage of gross revenue attributable to the landowners' parcel.

Permitting

Permitting requirements to construct and operate a wind farm vary widely depending upon who owns the land and the types of zoning or other restrictions on land use. Typically, land-use permits and building permits are the minimum required for wind farms.

Environmental Review

LM sites are federal lands and require environmental studies in compliance with NEPA. The wind farm developer must undertake, at its cost, as required, studies of threatened and endangered species, land disturbance, wetlands and a review of the results with interested local, state or federal officials, or interested citizens or citizen groups. They may also be required to perform historical and archeological studies and visual impact studies. The product of environmental review is an EIS, requiring DOE issuance of a ROD, or an EA, requiring DOE issuance of a FONSI.

Interconnection and Wheeling

Utilities, private companies or DOE Power Marketing Administrations with transmission systems must allow wind farms to interconnect to their transmission systems, however the requirements that must be met, the studies to be undertaken, and the interconnection equipment that will be required are determined by the transmission-owning entity, where the costs are usually borne by the wind developer. Studies such as capacity limitations, load flow analysis, voltage controls and system protection are the norm. Recent legislation has caused the rules and requirements to be re-visited and standards for interconnection equipment and timelines have been developed for two classes of generation (20 MW or less or greater than 20 MW) relevant to wind farms. Moving the wind-farm generated energy to the purchaser of the energy through the utility or other entity-owned transmission system is called wheeling. The fee for this wheeling may be determined through negotiation or defined by a tariff filed by state or federal regulators.

Power Purchase Agreement

The wind developer must find a buyer for the energy to be generated in order to obtain project financing as the buyer determines the potential revenue stream amount and time frame. The PPA defines the terms for this long term revenue stream. A creditworthy buyer is necessary to ensure a predictable long term cash flow for project financing approval.

Financing

With the PPA in hand, the wind farm developer can work with financiers to determine the terms of the loans, due diligence and assignability of documents. The financing is typically used to provide for the turbine procurement and construction/installation costs though other project costs may also be included.

Operation and Maintenance

The wind farm developer must include provisions for O&M for financing because it is critical to the successful long-term operation of the wind farm. The O&M terms typically specify a turbine availability percentage (usually 95% - 98% of the year) and outline the non-performance penalties.

Table 5.1.1. Comparison of Renewable Technologies for Development on LM Lands*

Development Issue	CSP	PV	WIND
Land Area (Acres)	Minimum: 250 Preferred: >= 500	Minimum: 100 Preferred: >=100	Minimum: 1000 Preferred: >=1000
Land Slope	Maximum: 3% Preferred: 1%	Maximum: 3% Preferred: 1%	Varies
Developer Incurred Costs			
Water Use	Wet Cooled: 750 acre-feet/100 MW Dry Cooled: 75 acre feet /100 MW	Minimal	Minimal
Assess Resource	Radiometer: 1 year	Radiometer: 1 year	Met Towers: 1 year
Land Lease	30 years	30 years	30 years
Power Purchase Agreement	Required for Project Financing	Required for Project Financing	Required for Project Financing
NEPA Compliance · Resource Testing · Plant Development	 Categorical Exclusion EIS EA tiered off EIS	 Categorical Exclusion EIS EA tiered off EIS	 Categorical Exclusion or EA EIS EA tiered off EIS
Transmission Study Required	Yes	Yes	Yes
Interconnection	Compliance with utility requirements	Compliance with utility requirements	Compliance with utility requirements
Construction Permit Operating Permit	Yes Yes	Yes Yes	Yes Yes
Plant O&M	Yes	Yes	Yes

* Potential for renewable power plant development on LM sites is primarily based on land area and water use. All other development issues are costs borne by developer. DOE LM/NRC resources for reuse approval, land lease transactions and documentation of NEPA studies results (ROD or FONSI).

6.0 Approach to Assessing Renewable Energy Potential

All energy sources have a geographic component, but renewable energy sources such as wind and solar are unique in that the fuels cannot be transported. The electricity generation facility must be located at good resource sites. However, this "limitation" makes it easier to assess the renewable energy potential for specific sites such as the DOE LM lands, by extracting the resource information that falls only within the property. All that is required to achieve a good renewable energy estimate is high-quality renewable resource data and the location of the sites to be reviewed.

Over the past decade, NREL has produced the necessary high-quality, region-scale renewable resource data for wind and solar. The wind data is not yet complete

nationally, but has been produced for the majority of states that are likely to have wind resource at levels that would support utility scale generation. The wind resource intensity can change very quickly over a given area, based on the terrain and wind climate. For this reason, extracting the wind resource at a single point within the property may not give an adequate representation of the wind resource potential for a property. In our analysis, if an estimate of the property acreage was given, a circular area equivalent to that acreage was examined to identify likely wind resource levels. Solar resources are more consistent across a geographic area, and so the resource intensity reported for a given point in the property is likely to be representative of the entire property.

The intensity of the wind or solar resource is only one component of understanding a site's renewable development potential. Site conditions such as steep slopes, access to transmission lines, or proximity to environmental or disturbance-sensitive area may impact development opportunities. This analysis provides a first level screening to identify areas that merit further scrutiny for renewable resource development.

6.1 TASK 1—Gather Available Information on DOE lands, and Solar and Wind Renewable Energy Resources

The DOE LM provided a listing of properties of interest to their organization. These properties included parcels currently under LM administration, and properties that are anticipated to be under LM administration once transition details are determined. The property listings included a reference coordinate and the acreage of the property where available. NREL Resource Assessment staff then matched the property information to the available solar and wind resource datasets to identify the level of resource at each site for CSP, PV and wind.

Four sites were identified as having particular interest for CSP and wind development. For those sites (Ambrosia Lake, Blue Water, Highlands, and Bear Creek), additional GIS data were obtained from the Office of Legacy Management's Grand Junction office. This data included more detailed site boundaries, location of the disposal cell, and locations of infrastructure on or near the site. Maps overlaying this data with renewable resource data were produced.

NREL resource data for solar (CSP and PV) and wind energy were deemed suitable for a regional-scale analysis. However, more detailed data are necessary for site-specific applications. Descriptions of the resource data sets used in the analysis are as follows.

6.1.1 Solar

NREL and Dr. Richard Perez of the State University of New York have developed a national solar resource assessment for the United States at a resolution of approximately 10 km by 10 km. This data is produced using a satellite-based model. The estimates are an average of eight years of processed satellite data representing the time period 1998 – 2005. The data will be updated periodically to include additional years of data. The data is processed to represent 14 solar collector configurations that are relevant to different types of solar applications. Appendix B describes the solar data in further detail.

6.1.2 CSP

The CSP analysis used direct normal solar radiation data. These data are pertinent to concentrating systems that track the sun throughout the day, such as trough collectors or dishes.

6.1.3 PV

The PV analysis used flat-plate collector data, with the panel oriented due south at an angle from horizontal equal to the latitude of the collector's location. This is a typical reference point for a photovoltaic application evaluation.

6.1.4 Wind

A low-resolution (25 km by 25 km) U.S. wind resource assessment was produced in 1987. Since then, NREL and other organizations have produced updated higher resolution (200 m to 1 km) wind resource assessments that better reflect the effects of terrain on the potential wind resource. The low-resolution wind data captured continental wind patterns. But the coarse scale meant that the assigned wind resource could apply to as little as 5% of the area if, for example, good resources were on ridge crests. Higher resolution digital terrain data allow the updated wind resource assessments to more accurately depict ridge lines and the effects of blocking on potential wind resources. These data also produce a more accurate overall picture of the resource. However, the updated assessments are model-derived data and not a substitute for on-site measurements before actual site development, even with the large increase in resolution. NREL has completed and validated updated assessments for 34 states, including Hawaii and parts of Alaska. Updated assessments by other organizations have been completed for eight additional states, but those data were not used in this evaluation. Information on updated wind resource assessments is available at http://www.eere.energy.gov/windandhydro/windpoweringamerica/wind_maps.asp. For this analysis, the updated NREL assessments were used where completed, and the 1987 assessment was used for the rest of the area. See Appendix B for more information on data sources.

6.2 TASK 2—Develop Appropriate Screens for GIS Analysis

LM and NREL staff held meetings to discuss the screening, and NREL utilized screening criteria based on past methodology developed for the BLM, United States Department of Agriculture (USDA) Forest Service, DOE Wind Program, and DOE Solar Program. Additional meetings were held June 18th, 2007 to review screening criteria and results of GIS analysis for renewable power production by CSP, PV and wind technologies on each site. One objective of this meeting was to identify any additional criteria that might impact the economic and technical feasibility of renewable power production on LM lands. Additional screening criteria recommended was to include proximity of nearby or adjacent federal lands (BLM) for potential to increase developable lands.

6.2.1 Solar-CSP Screening Criteria Development

From previous federal land renewable resource assessments, the NREL team met with CSP industry technology representatives to review the current list of high-potential site screening criteria. The following were identified as the most important screening criteria (in order of importance).

Central Generation Technology Criteria

1. Solar resource is >= 5 kWh/m^2/day of direct normal, and ideally greater than 6.5 kWh/m^2/day.
2. Slope of land area at the site must be less than 3%, and ideally less than 1%.
3. Transmission access is within 25 miles (69-765 kV), and transmission capacity is available.
4. Site must have access to roads or rail within 25 miles.
5. Development does not occur on the disposal cell.

Distributed Generation Technology Criteria

1. Solar resource is 5 kWh/m^2/day of direct normal.
2. Slope of land area at the site must be less than 10%.
3. Site must have access to roads.
4. Development does not occur on the disposal cell.

The following items were also identified by the meeting participants. But they were not identified as the most important screening criteria.

Central Generation Technology Criteria

- The site must have a low average wind speed (average wind speed < 10 miles/hour).
- Water resources must be available.
- The site should be within 25 miles of a main natural gas pipeline for some configurations.
- All vegetation at the site must be removed.
- Federal, state, and local policies are supportive.
- The site must allow structures 15 feet - 50 feet high. Some technologies could require structures hundreds of feet high.
- Livestock protection is possible.
- Light reflection at sites near major roads could be an issue for some technologies.
- A population center should be within 100 miles.

Distributed Generation Criteria

- The site is within 100 miles of a population center.
- Transmission access, water availability, and minimum parcel size are not an issue.

6.2.2 Solar–PV Screening Criteria Development

From previous federal land renewable resource assessments, the NREL team met with PV industry technology representatives to review the current list of high-potential site screening criteria. The following were identified as the most important screening criteria (in order of importance).

Large-Scale Technologies

1. Solar resource availability is known, and favorable to large-scale PV.
2. Full cost of competing power (production, transmission and distribution [T&D], environmental costs, etc.) is known and favorable to PV.
3. Transmission line is accessible, plus available capacity.
4. Electric power regulatory regime (want retail access) is favorable to PV.
5. Federal, state, and local policies are supportive.
6. Development does not occur on the disposal cell.

Small-Scale Technologies

1. Full cost of competing power (production, T&D, environmental costs, etc.) is known and favorable to PV.
2. Current fuel use at the site (especially unpowered and diesel-powered sites) is known and favors PV.
3. Water access is available (important for water-pumping applications).
4. Grazing sites are good small-scale applications.
5. Existing and planned recreation areas are good for remote applications.
6. Development does not occur on the disposal cell.

The following items were also identified by the meeting participants, but they were not identified as the most important screening criteria.

Less Important Screening Criteria

- Cost of environmental impacts of existing infrastructure is favorable to PV.
- Cost of maintaining existing energy infrastructure is favorable.
- High or unique environmental standards exist in the region.
- Cost of a site-specific environmental assessment is favorable.
- Security must be considered.
- Road access is needed for construction equipment.
- Extending transmission is needed in some cases for large-scale PV systems.
- Projected growth in the region is known, if supplying additional energy.
- Local utilities and peak unit power production costs should be considered.

6.2.3 Wind Screening Criteria Development

From previous federal land renewable resource assessments, the NREL team met with wind industry technology representatives to review the current list of high-potential site screening criteria.

The Most Important Screening Criteria (in order of importance)

1. Wind resource is wind power Class 4 and above for short term, Class 3 and above for long term.
2. Federal, state, and local policies support wind energy.
3. Transmission access is within 25 miles (69-345 kV) and transmission capacity is available.
4. Site must be compatible with wind energy development; scenic areas, view-sheds, and non-development regions must be eliminated.
5. Development does not occur on the disposal cell.

The following items were also identified by the meeting participants, but were not identified as the most important screening criteria.

Less Important Screening Criteria

- Ease of permitting and siting should be considered.
- Regional market conditions are important (electricity rates, load growth, reserve margins, etc.).
- Site is five miles from the nearest population center.
- Elevation of 3,000 ft - 4,500 ft is optimal (generally, the site must be below 7,000 ft).
- Slope of land area is a 14% grade (maximum) or less.
- Minimum parcel size is 20 MW per section (1 square mile) on rolling terrain.
- Large contiguous parcels are best; 10 square miles is optimal and at least 1 square mile is necessary.

6.3 TASK 3—Process Data Identifying DOE LM Sites with Potential for Renewable Energy Development

This task ultimately focused on processing GIS data to identify potential areas for renewable energy development. A GIS system is a computer-based system used to manipulate, manage, and analyze multidisciplinary geographic and related attribute data. All the information in a GIS is linked to a spatial reference system used to store and access the data. GIS data layers can be recombined, manipulated, and analyzed with other layers of information to identify relationships between features, within a common layer or across layers.

This analysis was conducted using regional scale resource data, and the results are suitable for use as a first-pass evaluation. On-site measurement and analysis are recommended before the development of any facilities, but this analysis should be useful in refining the prospecting process of site identification.

Initial meetings held to discuss technology screening criteria relied on previous assessments performed for the BLM, USDA Forest Service, DOE Wind Program, and DOE Solar Program. A later meeting held with LM Site Operations staff further clarified these criteria and identified several categories of GIS data to be used in the screening process. Unfortunately, the GIS data needed to implement several of the screening criteria were not available or could not be fully implemented in the limited amount of time available for this analysis. In particular, one constraint was mentioned in each technology meeting: transmission line congestion and availability. Detailed data are available for some areas, but not usually in a spatially referenced format. Several other data sets were not available at the regional scale with the level of informational detail that participants wanted, but they were deemed adequate given the regional nature of the analysis.

The roads data set used in the analysis depicts only major paved roads, although all groups agreed that an upgradeable dirt road would be acceptable. Generally, it was

agreed that all LM sites have acceptable road access. The transmission line data set covers the contiguous United States and is generally complete down to 69 kV. The screening criteria applied to each technology are described below in order of importance.

6.3.1 CSP

Screening Criteria

1. Direct solar resource is 6.5 kWh/m^2/day or greater.
2. Terrain slope is ≤ 1%.
3. Site is within 25 miles of transmission lines at 115 kV - 765 kV.
4. Site is within 25 miles of a major road or railroad.
5. Land use is compatible with legacy management of disposal cell.

6.3.2 PV

Screening Criteria

1. Direct solar resource is 5 kWh/m^2/day or greater.
2. Site is within 25 miles of transmission lines at 115 kV - 345 kV.
3. Land use is compatible with legacy management of disposal cell.

6.3.4 Wind

Screening Criteria

1. Wind resource is Wind Power Class 3 or greater.
2. Site is within 25 miles of transmission lines at 69 kV - 345 kV.
3. Site is within 25 miles of a major road or railroad.
4. Land use is compatible with legacy management of disposal cell.

6.4 Summary of DOE LM site renewable energy GIS screening

Each screening criterion was developed into a separate data layer indicating whether the criterion was met. The layers were combined into a final data set that included only lands that met all the criteria for each technology. Tables of individual sites, ranked in order or resource potential, are in Appendix C. Maps of LM sites based on initial GIS screening for CSP and Wind are at end of Appendix C.

7.0 Analysis of CSP and Wind Sample Top Pick Sites

7.1 CSP Estimation for Two Legacy Management Sites

The estimate of the power production range for a particular parcel of land involves several steps. First, the amount of developable solar land in square kilometers is calculated. Developable solar land is defined as land with sufficient solar resource potential (ideally at annual direct normal solar radiation least 6 kWh/m2/day) that has not been excluded due to environmental or land-use considerations. The next step is to convert the solar land area into the potential installed capacity of solar energy. NREL uses the conversion factor of 1 MW of installed capacity per five acres of developable land. The final step is to estimate a capacity factor for the solar plants that would be established on the land parcels. The capacity factor increases with increasing solar resource and is related to the percentage of energy a solar generating plant produces compared to its installed capacity. A solar plant without thermal-energy storage or natural gas fired steam generator to compensate for cloudy conditions, is limited to an annual capacity factor of 20% to 30%. For example, a 100 MW solar generating station with a capacity factor of 30% would produce on average at a rate of 30 MW of electricity for the entire year.

Bluewater and Ambrosia Lake

- For the Bluewater and Amborsia Lake parcels, the solar resource does not vary significantly across the parcels, the estimated range of capacity factors is between 25% and 30%, without thermal energy storage or natural gas hybridization.
- The maximum developable land area at Bluewater is 3.04 Km2 or about 2630 acres. Using 5 acres /MWe, the resulting maximum installed capacity is about 150 MW.
- The maximum developable land at Ambrosia Lake is 0.26 Km2 or about 64 acres. Using 5 acres /MWe, the resulting maximum installed capacity is about 13 MW.
- Applying the capacity factor ranges of 25% - 30%, based on direct normal solar resource: range of 6.8 - 6.9 kWh/m2/day.
- Bluewater maximum installed MWe is from 39 MW (~3290001.MWh/year) to 45 MW (~395,000 MWh/year).
- Ambrosia Lake maximum installed MWe is from 3.2 MW (28000 MWh/year) to 3.8 MW (34000 MWh/year)

During June 18, 2007 meeting in Golden, CO, CSP industry response to the two potential CSP sites presented indicated some interest in Bluewater site due to large developable land supporting a 100+MW CSP plant. The Ambrosia site was considered too small to attract CSP industry development interest.

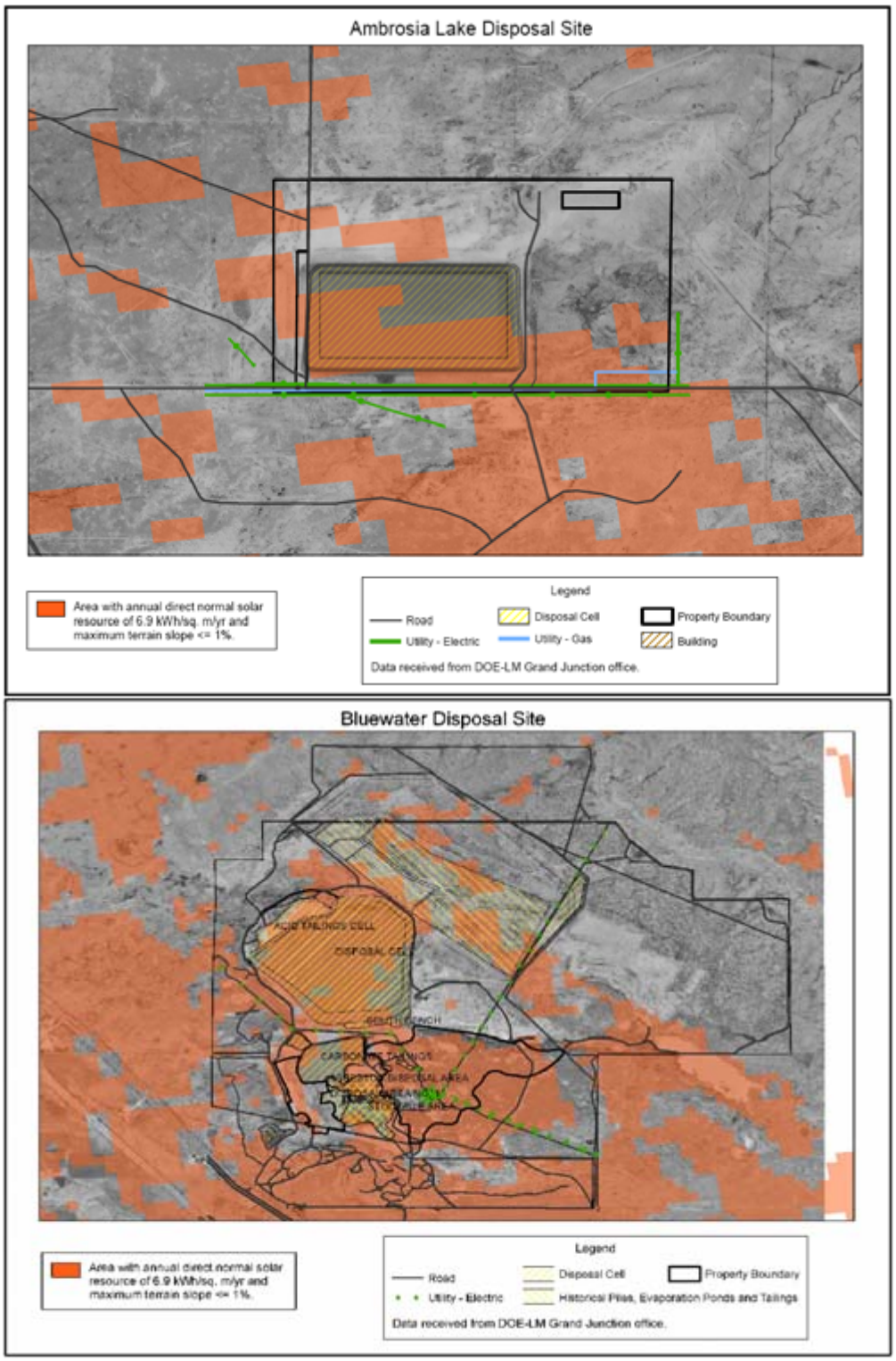


Figure 7.1.1. Sample CSP Sites: Ambrosia lake Disposal Site and Bluewater Disposal Site.

7.2 Wind Power Estimation for Two Legacy Management Sites

The estimate of a power production range for a particular parcel of land involves several steps. First, the amount of developable windy land in square kilometers is calculated. Developable windy land is defined as land with sufficient wind resource potential (as determined by average wind speed or wind power class) that has not been excluded due to environmental or land-use considerations. NREL defines non-excluded land having wind resource of power class 4 or greater as windy land. The next step is to convert the windy land area into the potential installed capacity of wind energy. NREL uses the conversion factor of 5 MW of installed capacity per square kilometer of developable windy land. The final step is to estimate a capacity factor for the wind farms that would be established on the land parcels. The capacity factor increases with increasing wind resource and is related to the percentage of energy a wind farm produces compared to its installed capacity. For example, a 100 MW wind farm with a capacity factor of 35% would produce on average at a rate of 35 MW of electricity for the entire year. A range of power production can be estimated by varying the assumptions used to calculate the windy land area and the capacity factor.

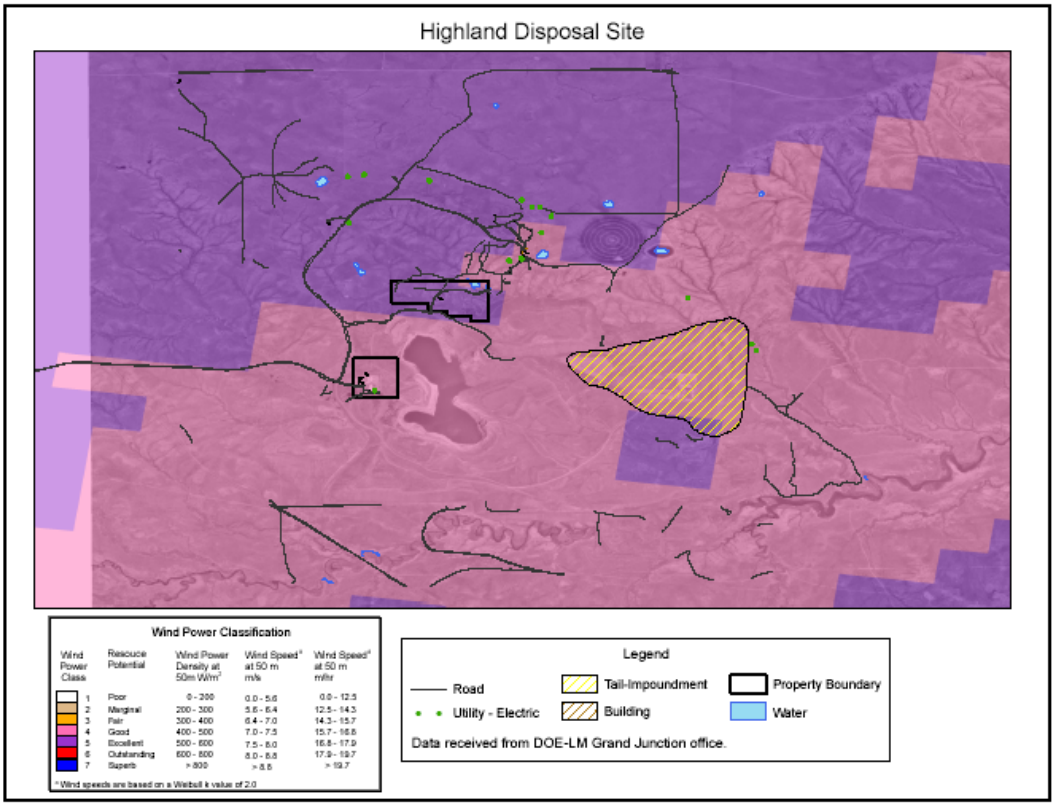
Highland and Bear Creek

- The Highland parcel has 6.5 sq. km of windy land—a potential installed capacity of 32.5 MW. The distribution of the wind resource on the parcel would support capacity factors between 35% and 38%. The range of annual power production for Highland is between 11.4 MW and 12.4 MW.
- The Bear Creek parcel has 3.2 sq. km of windy land and a potential installed capacity of 16 MW. The capacity factor on the Bear Creek parcel is estimated to be between 38% and 41%. The range of annual power production for Bear Creek is between 6.1 MW and 6.6 MW.

Table 7.2.1. LM Wind Power and Energy Estimates DOE

	Installation capacity	Estimated capacity factor	Estimated annual energy
	[MW]	[%]	[MWh/yr]
Highland parcel	32.5	35% - 38%	99.6 - 108.2
Bear Creek parcel	16	38% - 41%	53.3 - 57.5

During the June 18, 2007 meeting in Golden, CO, wind industry response to presentation of the two top pick wind sites, was a low level of interest to pursue wind farm development in western states, due to the small developable land area. A suggestion was to consider if there were adjacent federal lands, such as BLM public lands, to expand developable land area to increase industry interest.



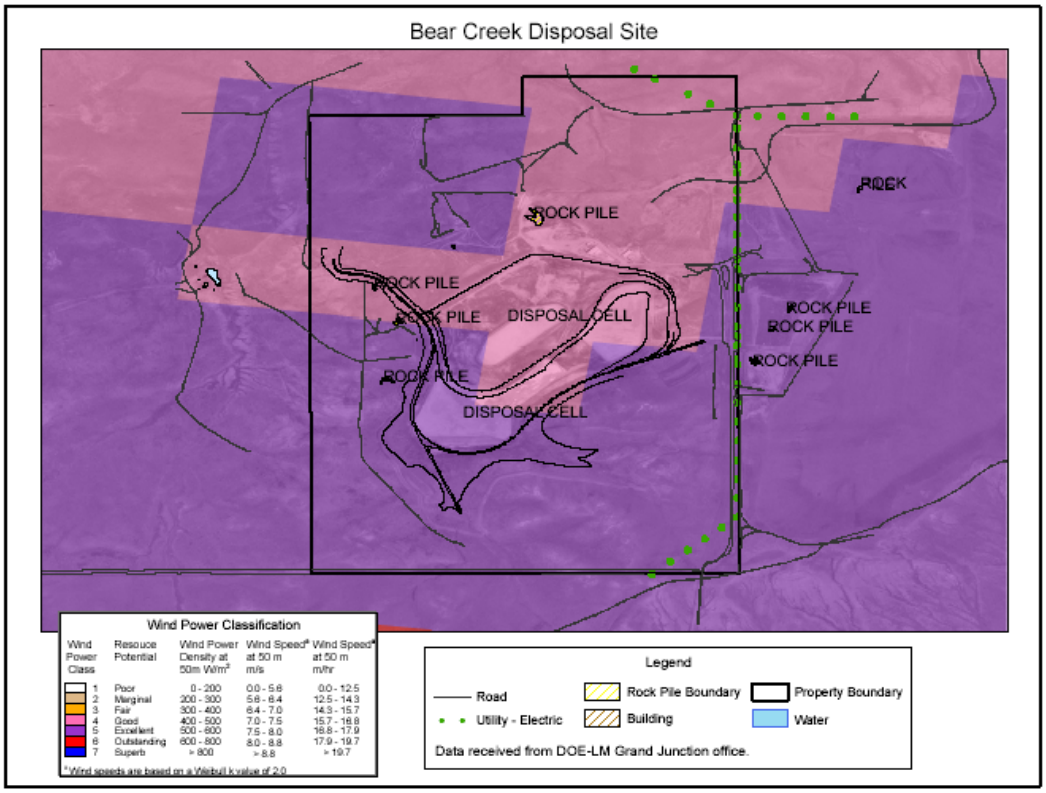


Figure 7.2.1. Maps for Highlands and Bear Creek parcels.

8.0 Example of Potential to Utilize Renewable Energy for Site Operations

A study was conducted by NREL's Andy Walker and S.M. Stoller Corporation's Carl Jacobsen, Site Project Manager of the Tuba City, AZ Disposal Site, to examine the potential use of distributed renewable energy for reducing energy use and costs of water distillation site operations. Proposed site operation renewable energy applications for the Tuba City site, included concentrating solar thermal hot water and PV. For the evaluation of solar energy alternatives at the site, NREL:

- Provided solar resource data and analysis for estimating annual hot water and electrical production
- Reviewed a technical savings estimate by Carl Jacobsen
- Provided sample procurement specifications
- Reviewed revised specifications
- Provided strategies to capture state financial and federal tax incentives through private financing of proposed renewable energy systems
- Provided a list of providers certified by the Arizona Solar Energy Industries Association.

A study found that the solar thermal hot water project is cost effective with a 5.6 year payback at a cost of $162,342 with state financial incentives available. The PV system cost savings had a >26 year payback, including all possible incentives at a cost of $749,554. The site project manager now has results to consider acquiring funds to install a 3700 square foot solar thermal system. Details of this study are provided in Appendix F.

9.0 DOE Legacy Management Compliance Issues

9.1 NEPA Compliance

DOE LM sites are federal lands. In accordance with the National Environmental Policy Act of 1969 (42 USC 4321), development on federal lands will require assessment of environmental impacts, specifically focused on addressing any "adverse impacts on the environment."

For CSP, PV, and wind power generation facilities, it is anticipated that the developer will be required to develop an EIS for review by DOE, due the ground disturbance during construction of utility scale power generation facilities. DOE will be responsible for processing the accepted EIS through DOE's Office of NEPA Policy and Compliance to issue a Record of Decision, approving project development.

In some cases, DOE LM may have recently conducted an EIS for the site. Based on the scope of the EIS, it may be feasible to amend the EIS or if consistent with the EIS, prepare an EA, which when approved by the DOE Office of NEPA Policy and Compliance, a FONSI will be published in newspapers in proximity to the LM site, for

public notification. Upon issuance of a FONSI and no public protest within 30 days, the developer would be authorized to proceed with project development.

9.2 Health and Safety Requirements

For CSP, PV, or wind project development on DOE LM sites, the project developer (principal party with the DOE land lease or license for land reuse) will be responsible for: establishing written safety and health policy and goals, providing mechanisms to involve its workers and those of subcontractors in the safety and health program, establishing procedures for workers and those of its subcontractors to report hazards and stop work, and to use qualified safety and health professionals. Workers must comply with the safety and health requirements of the DOE rule established at 42 CFR 851. The project developer will: be provided access to safety and health information, observe the monitoring of hazardous chemicals, and receive results of monitoring and inspections.

9.3 Site Institutional Controls

Renewable power plant development at DOE LM sites—as a land reuse opportunity—is to be compatible with Institutional Controls at the site,which vary based on regulations and requirement of regulatory bodies such as Nuclear Regulatory Commission, EPA's CERCLA program, and others. Potential developers would be advised of applicable institutional controls in place if a LM site is recommended for renewable power reuse.

10.0 Solar and Wind Meeting to Assess Industry Development Interest

This renewable energy assessment of DOE LM has identified several land parcels that indicate economic and technical feasibility using GIS screening techniques. The next key step was to gauge with solar and wind industry representatives the interest level in pursuing power generation project development on DOE LM lands; so the emphasis shifted from broad GIS screening to economic and technical issues focused at the DOE LM site level.

Economically, the market for renewable energy power production and distributed generation has experienced substantial growth in federal and state incentives. Federal tax incentives to the private sector (developer and its investors), include wind production and solar investment tax credits. Many states include tax credits and/or financial incentives for investing in renewable energy technologies. These incentives have significantly improved the economic viability of renewable projects for developer and energy consumers. Appendix D provides a summary of the state policies encouraging renewable energy development and financial incentives.

Technically, there are some development risks and compliance processes that are unique to renewable development on DOE LM lands such as statutory, regulatory, policy, and land lease processes. The June 18, 2007 meeting in Golden CO was intended to assemble DOE LM, NREL, other interested federal agencies and industry stakeholders to exchange

viewpoints and issues and establish the level of industry interest in renewable project development. The meeting agenda and meeting notes are provided in Appendix E.

The industry view of solar and wind power development on LM sites reflected major concerns about the limited developable acreage available for CSP and Wind power development.

10.1 CSP Industry

- Interest is focused on 100 MW or larger plants requiring land parcels of 500 acres or preferably more developable land.
- Recommended prequalifying sites through installation of weather monitoring stations with radiometer to confirm solar resource.
- Availability of water for wet cooled CSP power plants is an important requirement, although dry cooled systems can be built with lower efficiency and resultant higher cost per kWh.

10.2 Wind Industry

- The western states need larger parcels for consideration as focus is on large wind farms (100 MW) requiring >2000 acres.
- Consider DOE sites bordered by BLM public lands to expand the available developable land.
- Consider smaller wind farm projects in the eastern states where financial incentives, such as high value RECs improve wind development economic feasibility.

Common across the renewable industry participants is the high level of concerns about the environmental compliance requirements for federal land development.

10.3 DOE LM

Key to DOE LM's mission is:

- The protection of human health and environment
- Stewardship through LTSM of closed sites transferred to DOE
- Management of land and assets with emphasis on protective reuse or real estate disposition.

LM supports beneficial reuse of sites which may include the use of renewables and have supported agriculture, recreation, and reindustrialization. LM can't sell land, but it can lease to commercial organizations. Many sites would require Nuclear Regulatory Commission (NRC) leasing permits for surface development. DOE LM will investigate the ability to implement land lease for terms of 30 years, which is not the current practice. NEPA compliance is a requirement. There may be options for EAs to meet these requirements. An option for wind EA is to tier off BLM Wind PEIS if adopted by DOE.

10.4 BLM

BLM provided some valuable insight on the progress of addressing issues they faced and the policies and processes they have developed to streamline wind development on public lands. A key process has been implementation of periodic cost recovery from developers, to support BLM resources to process ROW applications, execute NEPA documents, coordination with regulatory organizations, and monitor project development. BLM was interested in partnering with LM to expand suitable land for wind farm development.

10.5 Open Discussion Points

- DOE/BLM indemnification for safety/liability issues
- DOE responsible for hazards on the site (e.g. would know the location of plumes and migration direction)
- Recommend that industry, not DOE LM, prospect potential sites (no resources for site resource monitoring).

10.6 Wrap-up/Actions

10.6.1 NREL

- Add Proximity to BLM other Federal lands in LM site screening (Tables in Appendix C)
- Address RPS and availability of RECs as revenue source (in Appendix D)

10.6.2 DOE LM

- Investigate potential to issue lease for 30-year term
- Consider partnering with BLM for western lands wind development

11.0 Recommendations

- Share results with DOE LM Office of Site Operation and Land Reuse team personnel for considering renewable development as a land reuse option. Appendix C results provide,in descending order renewable resource potential of LM sites.
- Consider discussions with BLM for expanding developable lands for wind farms in western states.
- Consider sites in eastern U.S. for small wind projects in states with RPS and REC trading to improve project economic feasibility.
- If opportunities for renewable development land reuse arise, seek support from DOE Office of Energy Efficiency and Renewable Energy and NREL for technology expertise and project development facilitation.

Appendices

Appendix A: Renewable Resource and DOE LM Site GIS Maps

Appendix B: Detailed Description and Data Sets for GIS Screening

Appendix C: Analysis Results – Prioritized list of DOE LM Sites for Solar and Wind

Table C1. DOE LM Sites High- and Medium-Potential Concentrating Solar Power Sites

Table C2. DOE LM High- to Medium-Potential Photovoltaic Sites

Table C3. DOE LM Sites with High- and Medium-Potential Wind Class

Figure C1. Map of Initial GIS Screening Results for CSP

Figure C2. Map of Initial GIS Screening Results for Wind

Appendix D. Federal and State Policies and Financial Incentives for Renewable Energy

Appendix E. Wind and Solar Power Development on DOE Legacy Management Lands Meeting – June 18, 2007 (Attendees, Agenda, Meeting Notes with Presentations)

Appendix F. Solar Thermal and Photovoltaic (PV) Applications for Site Operations at Tuba City, Arizona

Appendix G. References

Appendix H. DOE and NREL Contacts

Appendix I. Acronyms and Definitions

Appendix A: Renewable Resource and DOE LM Site GIS Maps

Map of DOE Legacy Management Sites (provided by LM)

Legacy Management Future Sites Through FY 2015

Appendix B: Detailed Description and Data Sets for GIS Screening

Solar

This report utilizes a national solar resource assessment for the United States at a resolution of approximately 10 km by 10 km. The CSP analysis utilizes direct normal data, which represent concentrating systems that track the sun throughout the day, such as trough collectors or dishes. The PV analysis used data representing a 1-axis tracking flat plate collector with tilt equal to the latitude of the location, oriented in a north-south direction.

This dataset was developed by the State University of New York's GOES satellite solar model. This data provides monthly average and annual average daily total solar resource averaged over surface cells of approximately 10 km by 10 km in size. The solar resource value is represented as $kWh/m^2/day$, representing an average over eight years (1998-2005). This model uses hourly satellite observed visible irradiance, atmospheric water vapor and trace gases, and the amount of aerosols in the atmosphere to calculate the monthly average daily total of the normal or beam insolation falling on a tracking concentrator pointed directly at the sun. Existing ground-measurement stations are used to validate the data where possible. The modeled values are accurate to approximately 12% of a true measured value within the grid cell as a result of the uncertainties associated with meteorological input to the model.

Because of terrain effects and other microclimate influences, local cloud cover can vary significantly even within a single grid cell. Furthermore, the uncertainty of the modeled estimates increases with distance from reliable measurement sources and with the complexity of the terrain. Concentrating solar collectors are much more sensitive to solar resource characteristics than flat-plate collectors, so these sources of uncertainty are more important to concentrator applications.

Wind

Wind resource data from many different sources was used in this analysis. Updated resource assessments of Alaska (part of the state), Arizona, California, Colorado, Connecticut, Delaware, Hawaii, Idaho, Illinois, Indiana, Maine, Maryland, Massachusetts, Michigan, Missouri, Montana, Ohio, Nebraska, Nevada, New Hampshire, New Jersey, New Mexico, North Carolina, North Dakota, Oregon, Pennsylvania, Rhode Island, South Dakota, Utah, Vermont, Virginia, Washington, West Virginia, and Wyoming were complete at the time the analysis was performed. These assessments have a surface resolution that varies from 1 km by 1 km to 200 m by 200 m. Additional states assessments are underway by NREL, and several additional areas may be complete by the time this report is published. Most of the updated assessments were produced using the Mesomap system and historical weather data in a collaborative effort between NREL and AWS TrueWind Solutions and were validated with available surface data by NREL and wind-energy meteorological consultants. The Illinois, North Dakota, and South Dakota wind-resource assessments were produced and validated solely by NREL.

The assessment accuracy for both types of updated wind resource data is generally within 20% for wind power density for 80% of the areas. A significant difference between these two types of data is that the AWS assessments account for the effects of surface roughness, whereas the NREL assessments do not. In areas of high surface roughness (i.e., forest), the wind resource may be 1-2 power classes lower than shown. For more information, see http://www.eere.energy.gov/windandhydro/windpoweringamerica/wind_maps.asp.

For the remaining states, data from the *Wind Energy Resource Atlas of the United States* was used. This atlas was produced in 1987 by staff at the Pacific Northwest National Laboratory. The resolution of the gridded contiguous United States wind resource data is 1/4 degree of latitude by 1/3 degree of longitude, roughly 25 km by 25 km. Each grid cell was assigned a wind-power class, which applies only to sites within the grid cell that are well exposed to the wind. Depending on the terrain type within the grid cell, the portion of the grid cell that is exposed could vary from as little as 5% (ridge crests) to 95% (flat plains). The values were assigned by integrating several subjective factors: quantitative wind data; qualitative indicators of wind speed or power; the characteristics of exposed sites in various terrains; and familiarity with the meteorology, climatology, and topography of the region. As a result, the degree of certainty with which the wind power class can be specified depended on the abundance and quality of wind data, the complexity of the terrain, and the geographical variability of the resource. For more information, see http://rredc.nrel.gov/wind/pubs/atlas.

Reference

Elliott, D. L., Holladay, C. G., Barchet, W. R., Foote, H.P., and Sandusky, W.F. 1987. *Wind Energy Resource Atlas of the United States.* Golden, CO: Solar Energy Research Institute.

Other Datasets

Roads: The roads data used represent major roads in the United States, such as interstates, U.S. and state highways, and other major thoroughfares. The data were produced by Geographic Data Technology (2006) and are distributed by Environmental Systems Research Institute, Inc.

Populated Place Areas: United States populated place areas are represented in this data set, as identified by the U.S. Census Bureau. Population statistics are based on the 1990 Census. The data are distributed by Environmental Systems Research Institute, Inc.

Topography: 90 m by 90 m digital elevation model (DEM) data from the U.S. Geological Survey National Elevation Dataset were used to calculate percent slope.

Transmission Lines: The transmission line data used are licensed by NREL from POWERmap, ©2007 Platts, a Division of the McGraw-Hill Companies. The data are generally complete down to 69 kilovolts (kV) and contain lower voltage lines in selected areas. The transmission line locations have been verified in many areas using aerial photography.

Appendix C: Analysis Results – Prioritized List of DOE LM Sites for Solar and Wind

Table C1. DOE LM Sites High- and Medium-Potential Concentrating Solar Power Sites

Table C2. DOE LM High- to Medium-Potential Photovoltaic Sites

Table C3. DOE LM Sites with High- and Medium-Potential Wind Class

Figure C1. Initial GIS Screening of Concentrating Solar Power Potential at DOE LM Sites

Figure C2. Initial GIS Screening of Concentrating Solar Power Potential at DOE LM Sites

Table C1. DOE LM Sites High- and Medium-Potential Concentrating Solar Power Sites

Solar resource information for 105 sites. Site locations provided by DOE Office of Legacy Management on 10/9/2006, sorted by potential CSP resource level.

Site ID	Name	Longitude	Latitude	Placement	Solar-CSP (Annual kWh/m2/day)	Acreage	Distance to Closest Transmission (Miles)	Closest Transmission Line Voltage (kV)	Within 5 miles of Tribal Lands	Within 5 miles of BLM lands	Within 5 miles of USFS land	Within 2 miles of Tribal Lands	Within 2 miles of BLM lands	Within 2 miles of USFS land
134	Monument Valley, AZ, Processing Site	-109.866515	36.931242	Actual location, center of site	7.448	Unknown	5.2	230	Yes			Yes		
106	Central Nevada Test Area, NV, Site	-116.181771	38.173350	Estimated location, based on the very general location shown in the NDAA book	7.191	1560.00	38.0	120						
121	**L-Bar, NM, Disposal Site**	-107.334722	35.187651	Actual location, center of disposal cell	7.035	738.29	4.1	115	Yes					
85	Rio Blanco, CO, Site	-108.367501	39.792404	Project 7 data	6.841	Unknown	15.6	138		Yes			Yes	
20	Salt Lake City, UT, Disposal Site	-113.111437	40.690666	Actual location, site marker on top of disposal cell	6.677	228.40	48.8	138		Yes			Yes	
21	Salt Lake City 11e(2), UT, Disposal Site	-113.118687	40.684563	Actual location, center of site	6.677	228.40	48.5	138		Yes			Yes	
70	Slick Rock, CO, Disposal Site	-108.864253	38.054538	Actual location, site marker # 2	6.609	112.96	10.0	115		Yes			Yes	
88	Slick Rock East, CO, Processing Site	-108.894528	38.043158	Actual location, center of site	6.609	112.96	10.4	115		Yes			Yes	
89	Slick Rock West, CO, Processing Site	-108.909424	38.045816	Actual location, center of site	6.609	112.96	11.1	115		Yes			Yes	
114	**Bluewater, NM, Disposal Site**	-107.947483	35.270623	Actual location, center of disposal cell	6.608	3304.65	0.0	115	Yes	Yes	Yes		Yes	
117	Grants, NM, Disposal Site	-107.863454	35.244028	Estimated location based on NDAA book and http://www.pixxures.ca/canada/index.html	6.608	0.85	1.8	115		Yes	Yes			
112	**Ambrosia Lake, NM, Disposal Site**	-107.799285	35.408798	Actual location, site marker on top of cell	6.602	314.97	0.5	230	Yes	Yes	Yes	Yes	Yes	
15	Mexican Hat, UT, Disposal Site	-109.874549	37.133607	Actual location, site marker #2	6.542	119.00	16.4	230	Yes	Yes		Yes	Yes	
82	Naturita, CO, Disposal Site	-108.754430	38.360283	Actual location, site marker #2	6.531	167.65	15.8	115		Yes			Yes	
135	Tuba City, AZ, Disposal Site	-111.134793	36.145483	Actual location, center of disposal cell	6.511	145.00	16.2	500	Yes			Yes		
17	Shootaring, UT, Disposal Site	-110.690360	37.712543	Estimated location based on information received from Steve Haymes (DOE lands for renewable energy). This location disagrees with the NDAA book but is closer to the town of Ticaboo.	6.439	Unknown	65.7	230		Yes			Yes	
115	Gas Buggy, NM, Site	-107.210230	36.678031	Project 7 data	6.439	Unknown	24.6	345	Yes	Yes	Yes	Yes		Yes
16	**Monticello, UT, Disposal and Processing Sites**	-109.325213	37.851103	Actual location, site marker on top of disposal cell	6.425	995.15	0.8	345		Yes	Yes			
119	Ambrosia Lake West, NM, Disposal Site	-107.829434	35.394755	Estimated location based on NDAA book	6.425	314.97	0.4	115	Yes	Yes	Yes	Yes	Yes	
13	White Mesa, UT, Disposal Site	-109.511362	37.523455	Actual location, center of site (Moab EIS: O:\GIS\DATA2\Moab\moa\EISBase_Meter\PROPERTYBOUNDARY_V01 .shp)	6.355		11.0	345	Yes	Yes			Yes	
69	Durango, CO, Disposal Site	-107.903876	37.248481	Actual location, site marker #2	6.341	199.20	0.2	115	Yes	Yes				
73	Durango, CO, Processing Site	-107.884723	37.265620	Actual location, center of site	6.341	199.20	0.3	115	Yes	Yes	Yes		Yes	
122	Church Rock, NM, Disposal Site	-108.504634	35.645226	Estimated location based on NDAA book	6.327	Unknown	2.0	115	Yes	Yes		Yes	Yes	
18	Lisbon Valley, UT, Disposal Site	-109.278997	38.266144	Actual location, based on information received from Steve Haymes (DOE lands for renewable energy) and http://www.pixxures.ca/canada/index.html	6.292	Unknown	0.9	138		Yes	Yes		Yes	
80	Maybell, CO, Disposal Site	-107.992870	40.543859	Actual location, site marker #2	6.269	250.36	3.9	138		Yes			Yes	
90	Maybell West, CO, Disposal Site	-108.015615	40.544556	Estimated location based on ULM staff visits to the area	6.269	250.36	3.8	138		Yes			Yes	
72	Canon City, CO, Site	-105.228496	38.394973	Estimated location based on http://emaps.dphe.state.co.us/hmsitemap/npl/lincolnpark.htm	6.203	Unknown	1.3	115		Yes	Yes		Yes	Yes
71	Grand Junction, CO, Disposal Site	-108.338213	38.902364	Actual location, center of disposal cell	6.099	564.35	0.6	345		Yes			Yes	
75	Grand Junction, CO, Processing Site	-108.549250	39.055441	Actual location, center of site	6.099	564.35	0.4	230		Yes			Yes	
76	Grand Junction, CO, Site	-108.573355	39.043371	Actual location, center of site	6.099	564.35	1.5	230		Yes			Yes	
143	Crescent Junction, UT, Site	-108.240312	38.964307	Actual location, west end of site	6.099	Unknown	5.8	115		Yes	Yes		Yes	Yes
77	Gunnison, CO, Disposal Site	-106.846387	38.510140	Actual location, site marker on top of disposal cell	6.038	176.24	2.0	230		Yes			Yes	
78	Gunnison, CO, Processing Site	-106.942532	38.528258	Actual location, center of site	6.038	176.24	1.5	115		Yes			Yes	
107	Shoal, NV, Site	-118.387466	39.201384	Project 7 data	6.019	Unknown	2.7	230		Yes			Yes	
87	Rulison, CO, Site	-107.950010	39.406040	Project 7 data	6.014	Unknown	3.2	345		Yes	Yes		Yes	Yes
120	Shiprock, NM, Disposal Site	-108.684297	36.770014	Actual location, site marker on top of cell	5.998	105.00	4.5	230	Yes			Yes		
14	Green River, UT, Disposal Site	-110.136749	38.978164	Actual location, site marker on top of disposal cell	5.971	26.27	0.1	345		Yes			Yes	
116	Gnome, NM, Site	-103.869695	32.263092	Project 7 data	5.948	Unknown	1.4	69		Yes			Yes	
91	Uravan, CO, Disposal Site	-108.741669	38.366815	Estimated location based on ULM personel information	5.943	Unknown	15.5	115		Yes			Yes	
74	Rifle, CO, Disposal Site	-107.801258	39.614434	Actual location, site marker on top of disposal cell	5.909	Unknown	0.1	345		Yes			Yes	
83	Rifle New, CO, Processing Site	-107.814042	39.524991	Actual location, center of site	5.909	957.08	1.8	230		Yes			Yes	
84	Rifle Old, CO, Processing Site	-107.771654	39.529479	Actual location, center of site	5.812	957.08	1.3	230		Yes			Yes	
79	Durita, CO, Disposal Site	-108.616242	38.197065	http://www.pixxures.ca/canada/index.html	5.810	Unknown	5.8	115		Yes			Yes	
81	Naturita, CO, Processing Site	-108.611094	38.239805	Actual location, center of site	5.810	167.65	5.6	115		Yes			Yes	
7	Edgemont, SD, Disposal Site	-103.794231	43.273539	Actual location, center of disposal cell	5.803	360.00	1.2	69			Yes			Yes
12	Moab, UT, Site	-109.594880	38.601090	Actual location, center of site	5.754	2731.92	0.5	138						
144	Moab, UT, Site Vicinity Properties	-109.594880	38.601090	Actual location, center of site	5.754	2731.92	0.5	138						
39	Laboratory for Energy Related Health Research, CA, Site	-121.755111	38.519166	Estimated location based on The 1996 Baseline Environmental Management Report	5.686	Unknown	4.0	115						

27	Sweetwater, WY, Disposal Site	-107.898265	42.054577	Estimated location based on information received from Steve Haymes (DOE lands for renewable energy) and http://www.pixxures.ca/canada/index.html	5.612	Unknown	12.0	230		Yes			Yes	
31	Riverton, WY, Processing Site	-108.410329	42.997679	Actual location, center of site	5.545	Unknown	0.2	230	Yes			Yes		
19	Salt Lake City, UT, Processing Site	-111.911462	40.702191	Actual location, center of site	5.520	228.40	2.7	138						
86	Rocky Flats, CO, Site	-105.209222	39.889868	Actual location, east side of Building 123	5.420	6301.44	0.6	115						
35	Split Rock, WY, Disposal Site	-107.798611	42.504768	Estimated location based on NDAA book and http://www.pixxures.ca/canada/index.html	5.402	Unknown	1.1	230		Yes				
94	Lowman, ID, Disposal Site	-115.606689	44.084790	Actual location, site marker on top of cell	5.383	18.08	39.5	230			Yes			Yes
28	Gas Hills North, WY, Disposal Site	-107.614165	42.818193	Estimated location based on NDAA book and http://www.pixxures.ca/canada/index.html	5.348	~1920	8.0	69		Yes			Yes	
33	Gas Hills East, WY, Disposal Site	-107.493303	42.834911	Estimated location based on information received from Steve Haymes (DOE lands for renewable energy) and http://www.pixxures.ca/canada/index.html	5.348	~1100	7.7	69		Yes			Yes	
25	Gas Hills West, WY, Disposal Site	-107.637650	42.800260	Estimated location based on information received from Steve Haymes (DOE lands for renewable energy) and http://www.pixxures.ca/canada/index.html	5.348	Unknown	8.4	69		Yes			Yes	
3	Lakeview, OR, Processing Site	-120.363670	42.210080	Actual location, center of site	5.301	55.00	0.5	115			Yes			Yes
29	Shirley Basin North, WY, Disposal Site	-106.174319	42.363845	http://www.pixxures.ca/canada/index.html	5.244	1526.92	0.7	69		Yes			Yes	
30	Shirley Basin South, WY, Disposal Site	-106.196273	42.335323	Actual location, center of the disposal cell	5.244	1526.92	0.3	115		Yes			Yes	
32	Spook, WY, Disposal Site	-105.622524	43.238852	Actual location, center of disposal cell	5.182	22.41	7.5	230		Yes	Yes		Yes	Yes
34	Bear Creek, WY, Disposal Site	-105.630659	43.269611	Actual location, center of site	5.182	Unknown	9.2	230		Yes	Yes			Yes
26	Highland, WY, Disposal Site	-105.503960	43.071020	Estimated location based on NDAA book and http://www.pixxures.ca/canada/index.html	5.182	~400	4.1	230		Yes			Yes	
4	Lakeview, OR, Disposal Site	-120.433462	42.285784	Actual location, site marker #2	5.126	55.00	4.0	69			Yes			Yes
10	Ray Point, TX, Disposal Site	-98.126071	28.562482	Estimated location based on NDAA book	4.895	Unknown	5.9	138						
140	Sequoyah Fuels, OK, Disposal Site	-95.082400	35.501798	Estimated location based on information contained in the following document. (http://www.nrc.gov/reading-rm/doc-collections/news/2003/03-022iv.pdf)	4.836	Unknown	1.8	138						
142	Hanford Reach, WA, Site	-119.516874	46.730052	Includes Wahluke Slope and Arid Lands Ecology Reserve at the Hanford Site(NDAA pg. 17, first paragraph in the Hanford Site section)	4.799	Unknown	2.6	500		Yes				
93	Pinellas County, FL, Site	-82.749012	27.874948	Actual location, center of site	4.696	4.29	1.9	115						
105	Hallam, NE, Decommissioned Reactor	-96.784697	40.558519	Actual location, center of site	4.588	Unknown	0.0	115						
11	Falls City, TX, Disposal Site	-98.132276	28.905375	Actual location, boundary monument on top of disposal cell	4.526	744.15	1.1	138						
8	Panna Maria, TX, Disposal Site	-97.944297	28.962956	Location coordinates based upon General Location Map from WESTEC dated Sept. 1997	4.526	Unknown	0.9	138						
9	Conquista, TX, Disposal Site	-98.096919	28.902142	Estimated location, based on information contained within the Falls City data that shows the location of the Conquista disposal cell. Also verified the location by viewing imagery at the VALTUS Imagery Services web site.	4.526	Unknown	1.2	138						
23	Sherwood, WA, Disposal Site	-118.106188	47.876183	Actual location, center of disposal cell	4.525	382.38	9.7	115	Yes			Yes		
104	Weldon Spring, MO, Site	-90.728274	38.698168	Actual location, site marker on top of disposal cell	4.415	266.90	4.6	161						
22	Ford, WA, Disposal Site	-117.824932	47.906669	Estimated location near Ford, WA.	4.259	Unknown	0.2	115	Yes			Yes		
99	Salmon, MS, Site	-89.574517	31.138625	Actual location, center of site	4.249	Unknown	1.6	230						
100	Latty Avenue, MO, Site	-90.347047	38.768758	Estimated location based on http://www.atsdr.cdc.gov/HAC/PHA/sla/sla_p4.html and http://www.mvs.usace.army.mil/engr/fusrap/HISS.htm	4.027	Unknown	1.4	138						
101	St. Louis Airport, MO, Site	-90.357429	38.759161	Estimated http://www.mvs.usace.army.mil/engr/fusrap/home2.htm(north of the Lambert-St. Louis International Airport and is bounded by the Norfolk and Western Railroad and Banshee Road on the south, Coldwater Creek on the west, and McDonnell	4.027	Unknown	1.9	138						
102	St. Louis Airport Vicinity Properties, MO, Site	-90.364742	38.765778	Estimated location based on http://www.mvs.usace.army.mil/engr/fusrap/home2.htm	4.027	Unknown	2.3	138						
103	St. Louis Downtown, MO, Site	-90.194087	38.660805	Estimated location based on http://www.nukeworker.com/nuke_facilities/North_America/usa/DOE_Facilities/FUSRAP/FUSRAP_Site_Specific_Information.htm(North Broadway and Destrehan)	4.027	Unknown	0.6	138						
130	Fernald, OH, Site	-84.692082	39.296415	Project 7 data	3.905	1138.22	0.4	138						
108	E.I. Du Pont, NJ, Site	-75.492297	39.686341	Estimated location based on NDAA book and http://www.nukeworker.com/nuke_facilities/North_America/usa/DOE_Facilities/FUSRAP/FUSRAP_Site_Specific_Information.htm	3.903	Unknown	0.6	230						
97	W.R. Grace Co., MD, Site	-76.567466	39.212997	Estimated location based on http://www.nukeworker.com/nuke_facilities/North_America/usa/DOE_Facilities/FUSRAP/FUSRAP_Site_Specific_Information.htm(5500 Chemical Rd., Baltimore, Md)	3.832	Unknown	1.8	115						

111	Wayne, NJ, Site	-74.270936	40.969628	Estimated location based on NDAA book and http://www.nukeworker.com/nuke_facilities/North_America/usa/DOE_Facilities/FUSRAP/FUSRAP_Site_Specific_Information.htm(868 Black Oak Ridge Road)	3.694	6.50	2.8	230						
67	Chariot, AK, Site	-165.767382	68.079582	Estimated location based on http://arcticcircle.uconn.edu/VirtualClassroom/Chariot/candegraft.html	3.683	Unknown	No Data	No Data						
96	Site A / Plot M, IL, Decommissioned Reactor	-87.910908	41.705321	Actual location, point between Site A and Plot M sites	3.569	Unknown	2.1	345						
126	Colonie Site, NY	-73.801826	42.691198	Estimated location based on NDAA book and http://www.nukeworker.com/nuke_facilities/North_America/usa/DOE_Facilities/FUSRAP/FUSRAP_Site_Specific_Information.htm(1130 Central Avenue)	3.503	11.20	0.6	115						
123	Ashland Oil 1, NY, Site	-78.920011	42.991815	Estimated location based on NDAA book and http://www.factsofwny.com/sitemap.htm	3.484	Unknown	0.0	230						
124	Ashland Oil 2, NY, Site	-78.916985	42.997011	Estimated location based on NDAA book and http://www.factsofwny.com/sitemap.htm	3.484	Unknown	0.0	230						
129	Seaway Industrial Park, NY, Site	-78.918667	42.994257	Estimated location based on NDAA book and http://www.factsofwny.com/sitemap.htm	3.484	Unknown	0.0	230						
98	Shpack Landfill, MA, Site	-71.234169	41.943430	Estimated location based on http://web.em.doe.gov/bemr96/shlf.html(northwest by Peckham Road; on the north by Union Road on the south and west by the Attleboro Landfill, operated by Attleboro Landfill, Inc)	3.315	Unknown	0.0	345						
131	Luckey, OH, Site	-83.481862	41.452944	Estimated location based on http://www.nukeworker.com/nuke_facilities/North_America/usa/DOE_Facilities/FUSRAP/FUSRAP_Site_Specific_Information.htm(Luckey, Ohio)	3.298	Unknown	1.4	345						
146	Harshaw Chemical Company, OH, Site	-81.686429	41.447345	Estimated location based on http://offo2.epa.state.oh.us/DOE/FUSRAP/Harshaw_Chemical.htm(1000 Harvard Ave. Cleveland OH)	3.276	Unknown	0.1	138						
132	Mound, OH, Site	-84.286025	39.627799	Estimated location based on NDAA book	3.276	305.34	0.6	138						
6	Canonsburg, PA, Disposal Site	-80.199721	40.256152	Actual location, center of disposal cell	3.262	34.30	1.6	138						
41	Ashtabula, OH, Site	-80.775889	41.890601	Project 7 data	3.250	Unknown	0.4	345						
5	Burrell, PA, Disposal Site	-79.242531	40.433059	Actual location, center of disposal cell	3.242	72.83	0.5	115						
2	Piqua, OH, Decommissioned Reactor	-84.234620	40.131900		3.219	0.46	2.4	138						
92	Combustion Engineering, CT, Site	-72.673400	41.892280	Estimated location based on http://web.em.doe.gov/bemr96/coen.html(located on Prospect Hill Road in a mixed industrial and residential area of Windsor, Connecticut. Interstate 91 adjoins the site on the east)	3.188	Unknown	3.0	115						
51	Niagara Falls Storage Site Vicinity Properties, NY	-78.991017	43.221023	Estimated location based on NDAA book and http://www.factsofwny.org/ltmk65.pdf	3.145	191.00	0.0	115	Yes					
128	Niagara Falls Storage Site, NY	-78.991017	43.221023	Estimated location based on NDAA book and http://www.factsofwny.org/ltmk65.pdf	3.145	191.00	0.0	115	Yes					
24	Parkersburg, WV, Disposal Site	-81.685817	39.250115	Actual location, center of disposal cell	3.109	15.50	0.2	138						
127	Linde Air Products Division, NY, Site	-78.891405	42.974669	Estimated location based on NDAA book and http://www.factsofwny.com/sitemap.htm	3.083	Unknown	0.1	115						
133	Amchitka, AK, Site	-178.877400	51.567100	Estimated location of the airport at Amchitka (http://www.wapf.com/world/t.amchitka.html)	1.986	Unknown	No Data	No Data						
145	BONUS, PR, Decommissioned Reactor	-67.268557	18.364744	Actual location, BONUS Reactor	N/A	Unknown	No Data	No Data						

Table C2. DOE LM High- to Medium-Potential Photovoltaic Sites

Solar resource information for 105 sites. Site locations provided by DOE Office of Legacy Management on 10/9/2006, sorted by potential PV resource level.

Site ID	Name	Longitude	Latitude	Placement	Solar-PV (Annual kWh/m2/day)	Acreage	Distance to Closest Transmission (Miles)	Closest Transmission Line Voltage (kV)	Within 5 miles of Tribal Lands	Within 5 miles of BLM lands	Within 5 miles of USFS land	Within 2 miles of Tribal Lands	Within 2 miles of BLM lands	Within 2 miles of USFS land
134	Monument Valley, AZ, Processing Site	-109.866515	36.931242	Actual location, center of site	6.334	Unknown	5.2	230	Yes			Yes		
106	Central Nevada Test Area, NV, Site	-116.181771	38.173350	Estimated location, based on the very general location shown in the NDAA book	6.171	1560.00	38.0	120						
121	**L-Bar, NM, Disposal Site**	-107.334722	35.187651	Actual location, center of disposal cell	6.162	738.29	4.1	115	Yes					
85	Rio Blanco, CO, Site	-108.367501	39.792404	Project 7 data	6.037	Unknown	15.6	138		Yes			Yes	
15	Mexican Hat, UT, Disposal Site	-109.874549	37.133607	Actual location, site marker #2	6.005	119.00	16.4	230	Yes	Yes		Yes	Yes	
70	Slick Rock, CO, Disposal Site	-108.864253	38.054538	Actual location, site marker # 2	5.990	112.96	10.0	115		Yes			Yes	
88	Slick Rock East, CO, Processing Site	-108.894528	38.043158	Actual location, center of site	5.990	112.96	10.4	115		Yes			Yes	
89	Slick Rock West, CO, Processing Site	-108.909424	38.045816	Actual location, center of site	5.990	112.96	11.1	115		Yes			Yes	
114	**Bluewater, NM, Disposal Site**	-107.947483	35.270623	Actual location, center of disposal cell	5.981	3304.65	0.0	115	Yes	Yes	Yes		Yes	
117	Grants, NM, Disposal Site	-107.863454	35.244028	Estimated location based on NDAA book and http://www.pixxures.ca/canada/index.html	5.981	0.85	1.8	115		Yes	Yes			
112	**Ambrosia Lake, NM, Disposal Site**	-107.799285	35.408798	Actual location, site marker on top of cell	5.975	314.97	0.5	230	Yes	Yes	Yes	Yes	Yes	
82	Naturita, CO, Disposal Site	-108.754430	38.360283	Actual location, site marker #2	5.971	167.65	15.8	115		Yes			Yes	
135	Tuba City, AZ, Disposal Site	-111.134793	36.145483	Actual location, center of disposal cell	5.955	145.00	16.2	500	Yes			Yes		
17	Shootaring, UT, Disposal Site	-110.690360	37.712543	Estimated location based on information received from Steve Haymes (DOE lands for renewable energy). This location disagrees with the NDAA book but is closer to the town of Ticaboo.	5.953	Unknown	65.7	230		Yes			Yes	
20	Salt Lake City, UT, Disposal Site	-113.111437	40.690666	Actual location, site marker on top of disposal cell	5.921	228.40	48.8	138		Yes			Yes	
21	Salt Lake City 11e(2), UT, Disposal Site	-113.118687	40.684563	Actual location, center of site	5.921	228.40	48.5	138		Yes			Yes	
16	**Monticello, UT, Disposal and Processing Sites**	-109.325213	37.851103	Actual location, site marker on top of disposal cell	5.899	995.15	0.8	345		Yes	Yes			
13	White Mesa, UT, Disposal Site	-109.511362	37.523455	Actual location, center of site (Moab EIS: O:\GIS\DATA2\Moab\moa\EISBase_Meter\PROPERTYBOUNDARY_V01 .shp)	5.890	Unknown	11.0	345	Yes	Yes			Yes	
116	Gnome, NM, Site	-103.869695	32.263092	Project 7 data	5.890	Unknown	1.4	69		Yes			Yes	
119	Ambrosia Lake West, NM, Disposal Site	-107.829434	35.394755	Estimated location based on NDAA book	5.882	314.97	0.4	115	Yes	Yes	Yes	Yes	Yes	
115	Gas Buggy, NM, Site	-107.210230	36.678031	Project 7 data	5.873	Unknown	24.6	345	Yes	Yes	Yes	Yes		Yes
69	Durango, CO, Disposal Site	-107.903876	37.248481	Actual location, site marker #2	5.834	199.20	0.2	115	Yes	Yes				
73	Durango, CO, Processing Site	-107.884723	37.265620	Actual location, center of site	5.834	199.20	0.3	115	Yes	Yes	Yes		Yes	
18	Lisbon Valley, UT, Disposal Site	-109.278997	38.266144	Actual location, based on information received from Steve Haymes (DOE lands for renewable energy) and http://www.pixxures.ca/canada/index.html	5.833	Unknown	0.9	138		Yes	Yes		Yes	
122	Church Rock, NM, Disposal Site	-108.504634	35.645226	Estimated location based on NDAA book	5.828	Unknown	2.0	115	Yes	Yes		Yes	Yes	
72	Canon City, CO, Site	-105.228496	38.394973	Estimated location based on http://emaps.dphe.state.co.us/hmsitemap/npl/lincolnpark.htm	5.823	Unknown	1.3	115		Yes	Yes		Yes	Yes
71	Grand Junction, CO, Disposal Site	-108.338213	38.902364	Actual location, center of disposal cell	5.717	564.35	0.6	345		Yes			Yes	
75	Grand Junction, CO, Processing Site	-108.549250	39.055441	Actual location, center of site	5.717	564.35	0.4	230		Yes			Yes	
76	Grand Junction, CO, Site	-108.573355	39.043371	Actual location, center of site	5.717	564.35	1.5	230		Yes			Yes	
143	Crescent Junction, UT, Site	-108.240312	38.964307	Actual location, west end of site	5.717	Unknown	5.8	115		Yes	Yes		Yes	Yes
120	Shiprock, NM, Disposal Site	-108.684297	36.770014	Actual location, site marker on top of cell	5.703	105.00	4.5	230	Yes			Yes		
14	Green River, UT, Disposal Site	-110.136749	38.978164	Actual location, site marker on top of disposal cell	5.699	26.27	0.1	345		Yes			Yes	
80	Maybell, CO, Disposal Site	-107.992870	40.543859	Actual location, site marker #2	5.696	250.36	3.9	138		Yes			Yes	
90	Maybell West, CO, Disposal Site	-108.015615	40.544556	Estimated location based on ULM staff visits to the area	5.696	250.36	3.8	138		Yes			Yes	
107	Shoal, NV, Site	-118.387466	39.201384	Project 7 data	5.674	Unknown	2.7	230		Yes			Yes	
87	Rulison, CO, Site	-107.950010	39.406040	Project 7 data	5.670	Unknown	3.2	345		Yes	Yes		Yes	Yes
77	Gunnison, CO, Disposal Site	-106.846387	38.510140	Actual location, site marker on top of disposal cell	5.649	176.24	2.0	230		Yes			Yes	
78	Gunnison, CO, Processing Site	-106.942532	38.528258	Actual location, center of site	5.649	176.24	1.5	115		Yes			Yes	
74	Rifle, CO, Disposal Site	-107.801258	39.614434	Actual location, site marker on top of disposal cell	5.610	Unknown	0.1	345		Yes			Yes	
83	Rifle New, CO, Processing Site	-107.814042	39.524991	Actual location, center of site	5.610	957.08	1.8	230		Yes			Yes	
12	Moab, UT, Site	-109.594880	38.601090	Actual location, center of site	5.606	2731.92	0.5	138						
144	Moab, UT, Site Vicinity Properties	-109.594880	38.601090	Actual location, center of site	5.606	2731.92	0.5	138						
91	Uravan, CO, Disposal Site	-108.741669	38.366815	Estimated location based on ULM personel information	5.605	Unknown	15.5	115		Yes			Yes	
7	Edgemont, SD, Disposal Site	-103.794231	43.273539	Actual location, center of disposal cell	5.573	360.00	1.2	69			Yes			Yes
79	Durita, CO, Disposal Site	-108.616242	38.197065	http://www.pixxures.ca/canada/index.html	5.562	Unknown	5.8	115		Yes			Yes	
81	Naturita, CO, Processing Site	-108.611094	38.239805	Actual location, center of site	5.562	167.65	5.6	115		Yes			Yes	
84	Rifle Old, CO, Processing Site	-107.771654	39.529479	Actual location, center of site	5.555	957.08	1.3	230		Yes			Yes	
31	Riverton, WY, Processing Site	-108.410329	42.997679	Actual location, center of site	5.507	Unknown	0.2	230	Yes			Yes		
39	Laboratory for Energy Related Health Research, CA, Site	-121.755111	38.519166	Estimated location based on The 1996 Baseline Environmental Management Report	5.504	Unknown	4.0	115						
27	Sweetwater, WY, Disposal Site	-107.898265	42.054577	Estimated location based on information received from Steve Haymes (DOE lands for renewable energy) and http://www.pixxures.ca/canada/index.html	5.488	Unknown	12.0	230		Yes			Yes	
10	Ray Point, TX, Disposal Site	-98.126071	28.562482	Estimated location based on NDAA book	5.483	Unknown	5.9	138						

86	Rocky Flats, CO, Site	-105.209222	39.889868	Actual location, east side of Building 123	5.483	6301.44	0.6	115					
35	Split Rock, WY, Disposal Site	-107.798611	42.504768	Estimated location based on NDAA book and http://www.pixxures.ca/canada/index.html	5.442	Unknown	1.1	230	Yes				
28	Gas Hills North, WY, Disposal Site	-107.614165	42.818193	Estimated location based on NDAA book and http://www.pixxures.ca/canada/index.html	5.403	~1920	8.0	69	Yes		Yes		
33	Gas Hills East, WY, Disposal Site	-107.493303	42.834911	Estimated location based on information received from Steve Haymes (DOE lands for renewable energy) and http://www.pixxures.ca/canada/index.html	5.403	~1100	7.7	69	Yes		Yes		
25	Gas Hills West, WY, Disposal Site	-107.637650	42.800260	Estimated location based on information received from Steve Haymes (DOE lands for renewable energy) and http://www.pixxures.ca/canada/index.html	5.403	Unknown	8.4	69	Yes		Yes		
19	Salt Lake City, UT, Processing Site	-111.911462	40.702191	Actual location, center of site	5.335	228.40	2.7	138					
29	Shirley Basin North, WY, Disposal Site	-106.174319	42.363845	http://www.pixxures.ca/canada/index.html	5.316	1526.92	0.7	69	Yes		Yes		
30	Shirley Basin South, WY, Disposal Site	-106.196273	42.335323	Actual location, center of the disposal cell	5.316	1526.92	0.3	115	Yes		Yes		
32	Spook, WY, Disposal Site	-105.622524	43.238852	Actual location, center of disposal cell	5.285	22.41	7.5	230	Yes	Yes	Yes	Yes	
34	Bear Creek, WY, Disposal Site	-105.630659	43.269611	Actual location, center of site	5.285	Unknown	9.2	230	Yes	Yes		Yes	
26	Highland, WY, Disposal Site	-105.503960	43.071020	Estimated location based on NDAA book and http://www.pixxures.ca/canada/index.html	5.285	~400	4.1	230	Yes		Yes		
140	Sequoyah Fuels, OK, Disposal Site	-95.082400	35.501798	Estimated location based on information contained in the following document. (http://www.nrc.gov/reading-rm/doc-collections/news/2003/03-022iv.pdf)	5.283	Unknown	1.8	138					
11	Falls City, TX, Disposal Site	-98.132276	28.905375	Actual location, boundary monument on top of disposal cell	5.242	744.15	1.1	138					
8	Panna Maria, TX, Disposal Site	-97.944297	28.962956	Location coordinates based upon General Location Map from WESTEC dated Sept. 1997	5.242	Unknown	0.9	138					
9	Conquista, TX, Disposal Site	-98.096919	28.902142	Estimated location, based on information contained within the Falls City data that shows the location of the Conquista disposal cell. Also verified the location by viewing imagery at the VALTUS Imagery Services web site.	5.242	Unknown	1.2	138					
94	Lowman, ID, Disposal Site	-115.606689	44.084790	Actual location, site marker on top of cell	5.239	18.08	39.5	230		Yes		Yes	
3	Lakeview, OR, Processing Site	-120.363670	42.210080	Actual location, center of site	5.211	55.00	0.5	115		Yes		Yes	
93	Pinellas County, FL, Site	-82.749012	27.874948	Actual location, center of site	5.206	4.29	1.9	115					
4	Lakeview, OR, Disposal Site	-120.433462	42.285784	Actual location, site marker #2	5.115	55.00	4.0	69		Yes		Yes	
99	Salmon, MS, Site	-89.574517	31.138625	Actual location, center of site	5.110	Unknown	1.6	230					
105	Hallam, NE, Decommissioned Reactor	-96.784697	40.558519	Actual location, center of site	5.102	0.00	0.0	115					
104	Weldon Spring, MO, Site	-90.728274	38.698168	Actual location, site marker on top of disposal cell	5.043	266.90	4.6	161					
142	Hanford Reach, WA, Site	-119.516874	46.730052	Includes Wahluke Slope and Arid Lands Ecology Reserve at the Hanford Site(NDAA pg. 17, first paragraph in the Hanford Site section)	4.867	Unknown	2.6	500	Yes				
100	Latty Avenue, MO, Site	-90.347047	38.768758	Estimated location based on http://www.atsdr.cdc.gov/HAC/PHA/sla/sla_p4.html and http://www.mvs.usace.army.mil/engr/fusrap/HISS.htm	4.831	Unknown	1.4	138					
101	St. Louis Airport, MO, Site	-90.357429	38.759161	Estimated http://www.mvs.usace.army.mil/engr/fusrap/home2.htm(north of the Lambert-St. Louis International Airport and is bounded by the Norfolk and Western Railroad and Banshee Road on the south, Coldwater Creek on the west, and McDonnell	4.831	Unknown	1.9	138					
102	St. Louis Airport Vicinity Properties, MO, Site	-90.364742	38.765778	Estimated location based on http://www.mvs.usace.army.mil/engr/fusrap/home2.htm	4.831	Unknown	2.3	138					
103	St. Louis Downtown, MO, Site	-90.194087	38.660805	Estimated location based on http://www.nukeworker.com/nuke_facilities/North_America/usa/DOE_Facilities/FUSRAP/FUSRAP_Site_Specific_Information.htm(North Broadway and Destrehan)	4.831	Unknown	0.6	138					
23	Sherwood, WA, Disposal Site	-118.106188	47.876183	Actual location, center of disposal cell	4.748	382.38	9.7	115	Yes			Yes	
108	E.I. Du Pont, NJ, Site	-75.492297	39.686341	Estimated location based on NDAA book and http://www.nukeworker.com/nuke_facilities/North_America/usa/DOE_Facilities/FUSRAP/FUSRAP_Site_Specific_Information.htm	4.745	Unknown	0.6	230					
130	Fernald, OH, Site	-84.692082	39.296415	Project 7 data	4.714	1138.22	0.4	138					
111	Wayne, NJ, Site	-74.270936	40.969628	Estimated location based on NDAA book and http://www.nukeworker.com/nuke_facilities/North_America/usa/DOE_Facilities/FUSRAP/FUSRAP_Site_Specific_Information.htm(868 Black Oak Ridge Road)	4.633	6.50	2.8	230					
22	Ford, WA, Disposal Site	-117.824932	47.906669	Estimated location near Ford, WA.	4.606	Unknown	0.2	115	Yes			Yes	
97	W.R. Grace Co., MD, Site	-76.567466	39.212997	Estimated location based on http://www.nukeworker.com/nuke_facilities/North_America/usa/DOE_Facilities/FUSRAP/FUSRAP_Site_Specific_Information.htm(5500 Chemical Rd., Baltimore, Md)	4.535	Unknown	1.8	115					
96	Site A / Plot M, IL, Decommissioned Reactor	-87.910908	41.705321	Actual location, point between Site A and Plot M sites	4.512	Unknown	2.1	345					

126	Colonie Site, NY	-73.801826	42.691198	Estimated location based on NDAA book and http://www.nukeworker.com/nuke_facilities/North_America/usa/DOE_Facilities/FUSRAP/FUSRAP_Site_Specific_Information.htm(1130 Central Avenue)	4.368		11.20	0.6	115	
132	Mound, OH, Site	-84.286025	39.627799	Estimated location based on NDAA book	4.358		305.34	0.6	138	
123	Ashland Oil 1, NY, Site	-78.920011	42.991815	Estimated location based on NDAA book and http://www.factsofwny.com/sitemap.htm	4.349		Unknown	0.0	230	
124	Ashland Oil 2, NY, Site	-78.916985	42.997011	Estimated location based on NDAA book and http://www.factsofwny.com/sitemap.htm	4.349		Unknown	0.0	230	
129	Seaway Industrial Park, NY, Site	-78.918667	42.994257	Estimated location based on NDAA book and http://www.factsofwny.com/sitemap.htm	4.349		Unknown	0.0	230	
131	Luckey, OH, Site	-83.481862	41.452944	Estimated location based on http://www.nukeworker.com/nuke_facilities/North_America/usa/DOE_Facilities/FUSRAP/FUSRAP_Site_Specific_Information.htm(Luckey, Ohio)	4.342		Unknown	1.4	345	
6	Canonsburg, PA, Disposal Site	-80.199721	40.256152	Actual location, center of disposal cell	4.332		34.30	1.6	138	
98	Shpack Landfill, MA, Site	-71.234169	41.943430	Estimated location based on http://web.em.doe.gov/bemr96/shlf.html(northwest by Peckham Road; on the north by Union Road on the south and west by the Attleboro Landfill, operated by Attleboro Landfill, Inc)	4.328		Unknown	0.0	345	
2	Piqua, OH, Decommissioned Reactor	-84.234620	40.131900		4.315		0.46	2.4	138	
5	Burrell, PA, Disposal Site	-79.242531	40.433059	Actual location, center of disposal cell	4.312		72.83	0.5	115	
146	Harshaw Chemical Company, OH, Site	-81.686429	41.447345	Estimated location based on http://offo2.epa.state.oh.us/DOE/FUSRAP/Harshaw_Chemical.htm(1000 Harvard Ave. Cleveland OH)	4.311		Unknown	0.1	138	
24	Parkersburg, WV, Disposal Site	-81.685817	39.250115	Actual location, center of disposal cell	4.277		15.50	0.2	138	
41	Ashtabula, OH, Site	-80.775889	41.890601	Project 7 data	4.268		Unknown	0.4	345	
92	Combustion Engineering, CT, Site	-72.673400	41.892280	Estimated location based on http://web.em.doe.gov/bemr96/coen.html(located on Prospect Hill Road in a mixed industrial and residential area of Windsor, Connecticut. Interstate 91 adjoins the site on the east)	4.250		Unknown	3.0	115	
127	Linde Air Products Division, NY, Site	-78.891405	42.974669	Estimated location based on NDAA book and http://www.factsofwny.com/sitemap.htm	4.088		Unknown	0.1	115	
51	Niagara Falls Storage Site Vicinity Properties, NY	-78.991017	43.221023	Estimated location based on NDAA book and http://www.factsofwny.org/ltmk65.pdf	3.928		191.00	0.0	115	Yes
128	Niagara Falls Storage Site, NY	-78.991017	43.221023	Estimated location based on NDAA book and http://www.factsofwny.org/ltmk65.pdf	3.928		191.00	0.0	115	Yes
67	Chariot, AK, Site	-165.767382	68.079582	Estimated location based on http://arcticcircle.uconn.edu/VirtualClassroom/Chariot/candegraft.html	3.315		Unknown	No Data	No Data	
133	Amchitka, AK, Site	-178.877400	51.567100	Estimated location of the airport at Amchitka (http://www.wapf.com/world/t.amchitka.html)	3.097		Unknown	No Data	No Data	
145	BONUS, PR, Decommissioned Reactor	-67.268557	18.364744	Actual location, BONUS Reactor		N/A	Unknown	No Data	No Data	

Table C3. DOE LM Sites with High and Medium Potential Wind Class

Wind resource information for 105 sites. Site locations provided by DOE Office of Legacy Management on 10/9/2006, sorted by wind resource at the coordinate.

Wind resource can change quickly based on terrain and wind climate. If an acreage value was available, the resource in a surrounding circular area equivalent to the acreage was extracted in addition to calculating the distance to specific wind resource levels.

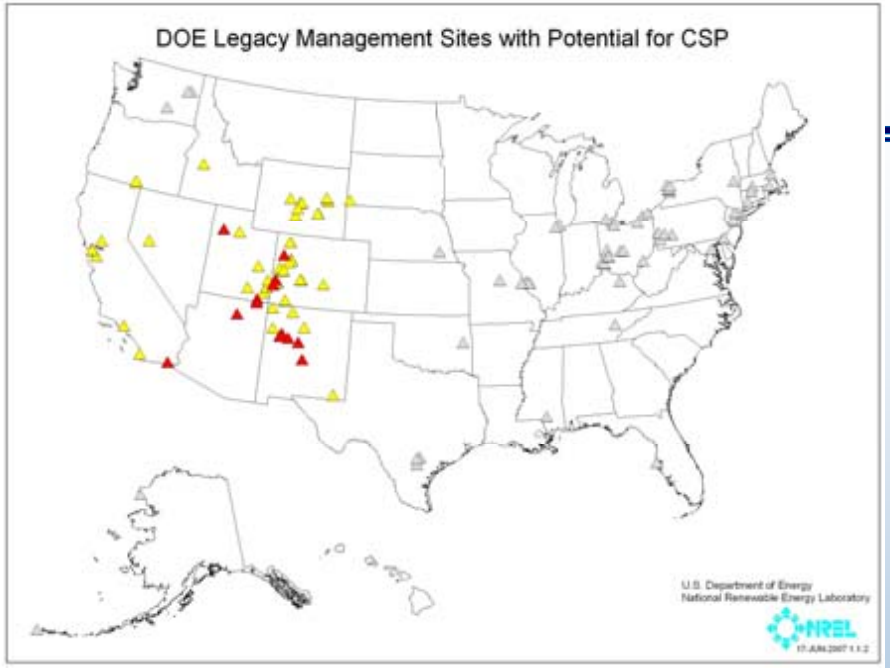
Site ID	Name	Longitude	Latitude	Placement	Wind (Annual Wind Power Class at 50 m)	Acreage	Radius km	Highest Wind Class in the radius	Distance to Closest Wind >= Class 3 (Miles)	Distance to Closest Wind >= Class 4 (Miles)	Distance to Closest Wind >= Class 5 (Miles)	Distance to Closest Wind >= Class 6 (Miles)	Distance to Closest Transmission (Miles)	Closest Transmission Line Voltage (kV)	Within 5 miles of Tribal Lands	Within 5 miles of BLM lands	Within 5 miles of USFS land	Within 2 miles of Tribal Lands	Within 2 miles of BLM lands	Within 2 miles of USFS land
133	Amchitka, AK, Site	-178.877400	51.567100	Estimated location of the airport at Amchitka (http://www.wapf.com/world/t.amchitka.html)	7	Unknown			0.0	0.0	0.0	0.0	No Data	No Data						
67	Chariot, AK, Site	-165.767382	68.079582	Estimated location based on http://arcticcircle.uconn.edu/VirtualClassroom/Chariot/candegraft.html	7	Unknown			0.0	0.0	0.0	0.0	No Data	No Data						
35	Split Rock, WY, Disposal Site	-107.798611	42.504768	Estimated location based on NDAA book and http://www.pixxures.ca/canada/index.html	5	Unknown			0.0	0.0	0.0	1.0	1.1	230		Yes				
32	Spook, WY, Disposal Site	-105.622524	43.238852	Actual location, center of disposal cell	5	22.41	0.17	5	0.0	0.0	0.0	1.2	7.5	230		Yes	Yes		Yes	Yes
34	Bear Creek, WY, Disposal Site	-105.630659	43.269611	Actual location, center of site	4	Unknown			0.0	0.0	0.1	1.0	9.2	230		Yes	Yes			Yes
33	**Gas Hills East, WY, Disposal Site**	-107.493303	42.834911	Estimated location based on information received from Steve Haymes (DOE lands for renewable energy) and http://www.pixxures.ca/canada/index.html	4	~1920			0.0	0.0	1.1	2.2	7.7	69		Yes			Yes	
28	**Gas Hills North, WY, Disposal Site**	-107.614165	42.818193	Estimated location based on NDAA book and http://www.pixxures.ca/canada/index.html	4	~1100			0.0	0.0	1.3	4.7	8.0	69		Yes			Yes	
26	**Highland, WY, Disposal Site**	-105.503960	43.071020	Estimated location based on NDAA book and http://www.pixxures.ca/canada/index.html	4	~400			0.0	0.0	0.5	6.5	4.1	230		Yes			Yes	
123	Ashland Oil 1, NY, Site	-78.920011	42.991815	Estimated location based on NDAA book and http://www.factsofwny.com/sitemap.htm	3	Unknown			2.8	4.0	93.9	168.6	0.0	230						
124	Ashland Oil 2, NY, Site	-78.916985	42.997011	Estimated location based on NDAA book and http://www.factsofwny.com/sitemap.htm	3	Unknown			3.2	4.2	94.0	168.9	0.0	230						
7	**Edgemont, SD, Disposal Site**	-103.794231	43.273539	Actual location, center of disposal cell	3	360.00	0.68	4	0.0	0.8	5.6	20.9	1.2	69			Yes			Yes
25	Gas Hills West, WY, Disposal Site	-107.637650	42.800260	Estimated location based on information received from Steve Haymes (DOE lands for renewable energy) and http://www.pixxures.ca/canada/index.html	3	Unknown			0.0	0.1	3.0	4.3	8.4	69		Yes			Yes	
105	Hallam, NE, Decommissioned Reactor	-96.784697	40.558519	Actual location, center of site	3	Unknown	0.00	3	0.0	1.5	35.4	60.7	0.0	115						
127	Linde Air Products Division, NY, Site	-78.891405	42.974669	Estimated location based on NDAA book and http://www.factsofwny.com/sitemap.htm	3	Unknown			3.4	5.5	92.1	167.2	0.1	115						
129	Seaway Industrial Park, NY, Site	-78.918667	42.994257	Estimated location based on NDAA book and http://www.factsofwny.com/sitemap.htm	3	Unknown			3.1	4.0	94.1	168.8	0.0	230						
29	Shirley Basin North, WY, Disposal Site	-106.174319	42.363845	http://www.pixxures.ca/canada/index.html	3	1526.92	1.40	3	0.0	1.4	4.5	11.1	0.7	69		Yes			Yes	
30	Shirley Basin South, WY, Disposal Site	-106.196273	42.335323	Actual location, center of the disposal cell	3	1526.92	1.40	3	0.0	0.9	6.2	9.9	0.3	115		Yes			Yes	
96	Site A / Plot M, IL, Decommissioned Reactor	-87.910908	41.705321	Actual location, point between Site A and Plot M sites	3	Unknown			0.1	33.9	113.3	177.2	2.1	345						
27	Sweetwater, WY, Disposal Site	-107.898265	42.054577	Estimated location based on information received from Steve Haymes (DOE lands for renewable energy) and http://www.pixxures.ca/canada/index.html	3	Unknown			0.0	5.4	13.9	15.9	12.0	230		Yes			Yes	
41	Ashtabula, OH, Site	-80.775889	41.890601	Project 7 data	2	Unknown			0.7	1.8	141.7	155.3	0.4	345						
9	Conquista, TX, Disposal Site	-98.096919	28.902142	Estimated location, based on information contained within the Falls City data that shows the location of the Conquista disposal cell. Also verified the location by viewing imagery at the VALTUS Imagery Services web site.	2	Unknown			52.0	201.8	228.2	254.4	1.2	138						
11	Falls City, TX, Disposal Site	-98.132276	28.905375	Actual location, boundary monument on top of disposal cell	2	744.15	0.98	1	53.3	200.2	227.1	252.4	1.1	138						
116	Gnome, NM, Site	-103.869695	32.263092	Project 7 data	2	Unknown			0.4	27.7	30.9	34.7	1.4	69		Yes			Yes	
3	Lakeview, OR, Processing Site	-120.363670	42.210080	Actual location, center of site	2	55.00	0.27	2	1.4	1.4	1.6	5.3	0.5	115			Yes			Yes
100	Latty Avenue, MO, Site	-90.347047	38.768758	Estimated location based on http://www.atsdr.cdc.gov/HAC/PHA/sla/sla_p4.html and http://www.mvs.usace.army.mil/engr/fusrap/HISS.htm	2	Unknown			4.6	62.0	236.6	305.9	1.4	138						
121	L-Bar, NM, Disposal Site	-107.334722	35.187651	Actual location, center of disposal cell	2	738.29	0.98	2	0.9	1.3	1.8	2.9	4.1	115	Yes					
131	Luckey, OH, Site	-83.481862	41.452944	Estimated location based on http://www.nukeworker.com/nuke_facilities/North_America/usa/DOE_Facilities/FUSRAP/FUSRAP_Site_Specific_Information.htm(Luckey, Ohio)	2	Unknown			13.9	20.3	165.9	236.5	1.4	345						
51	Niagara Falls Storage Site Vicinity Properties, NY	-78.991017	43.221023	Estimated location based on NDAA book and http://www.factsofwny.org/ltmk65.pdf	2	191.00	0.50	2	2.3	15.4	108.3	184.9	0.0	115	Yes					
128	Niagara Falls Storage Site, NY	-78.991017	43.221023	Estimated location based on NDAA book and http://www.factsofwny.org/ltmk65.pdf	2	191.00	0.50	2	2.3	15.4	108.3	184.9	0.0	115	Yes					
8	Panna Maria, TX, Disposal Site	-97.944297	28.962956	Location coordinates based upon General Location Map from WESTEC dated Sept. 1997	2	Unknown			48.9	204.5	228.4	258.2	0.9	138						
10	Ray Point, TX, Disposal Site	-98.126071	28.562482	Estimated location based on NDAA book	2	Unknown			35.5	219.4	245.5	265.8	5.9	138						
86	Rocky Flats, CO, Site	-105.209222	39.889868	Actual location, east side of Building 123	2	6301.44	2.85	2	1.0	2.6	3.6	3.7	0.6	115						
140	Sequoyah Fuels, OK, Disposal Site	-95.082400	35.501798	Estimated location based on information contained in the following document. (http://www.nrc.gov/reading-rm/doc-collections/news/2003/03-022iv.pdf)	2	Unknown			4.9	4.9	4.9	317.0	1.8	138						
101	St. Louis Airport, MO, Site	-90.357429	38.759161	Estimated http://www.mvs.usace.army.mil/engr/fusrap/home2.htm(north of the Lambert-St. Louis International Airport and is bounded by the Norfolk and Western Railroad and Banshee Road on the south, Coldwater Creek on the west, and McDonnell	2	Unknown			5.4	62.4	235.8	305.6	1.9	138						

97	W.R. Grace Co., MD, Site	-76.567466	39.212997	Estimated location based on http://www.nukeworker.com/nuke_facilities/North_America/usa/DOE_Facilities/FUSRAP/FUSRAP_Site_Specific_Information.htm(5500 Chemical Rd., Baltimore, Md)	2	Unknown			12.7	26.0	58.8	60.4	1.8	115						
119	Ambrosia Lake West, NM, Disposal Site	-107.829434	35.394755	Estimated location based on NDAA book	1	314.97	0.64	1	5.5	7.0	15.7	15.9	0.4	115	Yes	Yes	Yes	Yes	Yes	
112	Ambrosia Lake, NM, Disposal Site	-107.799285	35.408798	Actual location, site marker on top of cell	1	314.97	0.64	1	3.9	8.9	15.2	15.4	0.5	230	Yes	Yes	Yes	Yes	Yes	
114	Bluewater, NM, Disposal Site	-107.947483	35.270623	Actual location, center of disposal cell	1	3304.65	2.06	2	5.2	6.1	10.6	16.4	0.0	115	Yes	Yes	Yes		Yes	
5	Burrell, PA, Disposal Site	-79.242531	40.433059	Actual location, center of disposal cell	1	72.83	0.31	1	3.5	3.9	33.0	33.2	0.5	115						
72	Canon City, CO, Site	-105.228496	38.394973	Estimated location based on http://emaps.dphe.state.co.us/hmsitemap/npl/lincolnpark.htm	1	Unknown			0.6	2.8	4.1	4.2	1.3	115		Yes	Yes		Yes	Yes
6	Canonsburg, PA, Disposal Site	-80.199721	40.256152	Actual location, center of disposal cell	1	34.30	0.21	1	38.0	38.7	41.6	70.7	1.6	138						
106	Central Nevada Test Area, NV, Site	-116.181771	38.173350	Estimated location, based on the very general location shown in the NDAA book	1	1560.00	1.42	2	2.5	4.0	12.5	15.2	38.0	120						
122	Church Rock, NM, Disposal Site	-108.504634	35.645226	Estimated location based on NDAA book	1	Unknown			5.2	20.1	21.4	23.7	2.0	115	Yes	Yes		Yes	Yes	
126	Colonie Site, NY	-73.801826	42.691198	Estimated location based on NDAA book and http://www.nukeworker.com/nuke_facilities/North_America/usa/DOE_Facilities/FUSRAP/FUSRAP_Site_Specific_Information.htm(1130 Central Avenue)	1	11.20	0.12	1	10.0	10.0	15.1	25.4	0.6	115						
92	Combustion Engineering, CT, Site	-72.673400	41.892280	Estimated location based on http://web.em.doe.gov/bemr96/coen.html(located on Prospect Hill Road in a mixed industrial and residential area of Windsor, Connecticut. Interstate 91 adjoins the site on the east)	1	Unknown			7.6	24.2	24.3	33.8	3.0	115						
143	Crescent Junction, UT, Site	-108.240312	38.964307	Actual location, west end of site	1	Unknown			6.8	12.5	32.2	32.2	5.8	115		Yes	Yes		Yes	Yes
69	Durango, CO, Disposal Site	-107.903876	37.248481	Actual location, site marker #2	1	199.20	0.51	1	5.4	10.1	10.1	11.5	0.2	115	Yes	Yes				
73	Durango, CO, Processing Site	-107.884723	37.265620	Actual location, center of site	1	199.20	0.51	2	3.9	10.0	10.2	11.1	0.3	115	Yes	Yes	Yes		Yes	
79	Durita, CO, Disposal Site	-108.616242	38.197065	http://www.pixxures.ca/canada/index.html	1	Unknown			16.4	17.5	28.9	28.9	5.8	115		Yes			Yes	
108	E.I. Du Pont, NJ, Site	-75.492297	39.686341	Estimated location based on NDAA book and http://www.nukeworker.com/nuke_facilities/North_America/usa/DOE_Facilities/FUSRAP/FUSRAP_Site_Specific_Information.htm	1	Unknown			7.8	39.8	106.6	106.9	0.6	230						
130	Fernald, OH, Site	-84.692082	39.296415	Project 7 data	1	1138.22	1.21	1	49.3	168.0	185.0	189.8	0.4	138						
22	Ford, WA, Disposal Site	-117.824932	47.906669	Estimated location near Ford, WA.	1	Unknown			4.4	15.8	20.2	20.4	0.2	115	Yes			Yes		
115	Gas Buggy, NM, Site	-107.210230	36.678031	Project 7 data	1	Unknown			18.8	35.9	36.1	40.6	24.6	345	Yes	Yes	Yes	Yes		Yes
71	Grand Junction, CO, Disposal Site	-108.338213	38.902364	Actual location, center of disposal cell	1	564.35	0.85	1	5.6	6.8	36.0	36.0	0.6	345		Yes			Yes	
75	Grand Junction, CO, Processing Site	-108.549250	39.055441	Actual location, center of site	1	564.35	0.85	1	9.0	20.0	26.8	27.4	0.4	230		Yes			Yes	
76	Grand Junction, CO, Site	-108.573355	39.043371	Actual location, center of site	1	564.35	0.85	1	9.2	19.7	28.1	28.7	1.5	230		Yes			Yes	
117	Grants, NM, Disposal Site	-107.863454	35.244028	Estimated location based on NDAA book and http://www.pixxures.ca/canada/index.html	1	0.85	0.03	1	3.8	5.9	9.1	14.0	1.8	115		Yes	Yes			
14	Green River, UT, Disposal Site	-110.136749	38.978164	Actual location, site marker on top of disposal cell	1	26.27	0.18	1	7.0	7.0	7.0	7.3	0.1	345		Yes			Yes	
77	Gunnison, CO, Disposal Site	-106.846387	38.510140	Actual location, site marker on top of disposal cell	1	176.24	0.48	1	5.7	12.1	12.5	15.5	2.0	230		Yes			Yes	
78	Gunnison, CO, Processing Site	-106.942532	38.528258	Actual location, center of site	1	176.24	0.48	1	8.7	13.2	13.3	16.1	1.5	115		Yes			Yes	
142	Hanford Reach, WA, Site	-119.516874	46.730052	Includes Wahluke Slope and Arid Lands Ecology Reserve at the Hanford Site(NDAA pg. 17, first paragraph in the Hanford Site section)	1	Unknown			4.4	4.8	9.5	21.7	2.6	500		Yes				
146	Harshaw Chemical Company, OH, Site	-81.686429	41.447345	Estimated location based on http://offo2.epa.state.oh.us/DOE/FUSRAP/Harshaw_Chemical.htm(1000 Harvard Ave. Cleveland OH)	1	Unknown			4.4	18.9	154.8	178.4	0.1	138						
39	Laboratory for Energy Related Health Research, CA, Site	-121.755111	38.519166	Estimated location based on The 1996 Baseline Environmental Management Report	1	Unknown			9.5	16.8	17.1	33.5	4.0	115						
4	Lakeview, OR, Disposal Site	-120.433462	42.285784	Actual location, site marker #2	1	55.00	0.27	2	3.4	5.0	5.0	5.3	4.0	69			Yes			Yes
18	Lisbon Valley, UT, Disposal Site	-109.278997	38.266144	Actual location, based on information received from Steve Haymes (DOE lands for renewable energy) and http://www.pixxures.ca/canada/index.html	1	Unknown			8.5	8.7	8.7	8.9	0.9	138		Yes	Yes		Yes	
94	Lowman, ID, Disposal Site	-115.606689	44.084790	Actual location, site marker on top of cell	1	18.08	0.15	1	6.5	22.5	23.2	23.9	39.5	230			Yes			Yes
90	Maybell West, CO, Disposal Site	-108.015615	40.544556	Estimated location based on ULM staff visits to the area	1	250.36	0.57	1	5.7	6.1	18.6	18.8	3.8	138		Yes			Yes	
80	Maybell, CO, Disposal Site	-107.992870	40.543859	Actual location, site marker #2	1	250.36	0.57	1	6.0	6.4	19.8	19.9	3.9	138		Yes			Yes	
15	Mexican Hat, UT, Disposal Site	-109.874549	37.133607	Actual location, site marker #2	1	119.00	0.39	1	7.7	7.8	7.8	29.2	16.4	230	Yes	Yes		Yes	Yes	
12	Moab, UT, Site	-109.594880	38.601090	Actual location, center of site	1	2731.92	1.88	5	0.8	0.8	1.0	1.7	0.5	138						
144	Moab, UT, Site Vicinity Properties	-109.594880	38.601090	Actual location, center of site	1	2731.92	1.88	5	0.8	0.8	1.0	1.7	0.5	138						
16	Monticello, UT, Disposal and Processing Sites	-109.325213	37.851103	Actual location, site marker on top of disposal cell	1	995.15	1.13	2	5.9	6.4	6.4	6.9	0.8	345		Yes	Yes			
134	Monument Valley, AZ, Processing Site	-109.866515	36.931242	Actual location, center of site	1	Unknown	0.00	1	7.1	8.7	13.8	24.6	5.2	230	Yes			Yes		
132	Mound, OH, Site	-84.286025	39.627799	Estimated location based on NDAA book	1	305.34	0.63	1	39.4	147.7	193.0	194.4	0.6	138						
82	Naturita, CO, Disposal Site	-108.754430	38.360283	Actual location, site marker #2	1	167.65	0.46	1	12.1	13.4	24.5	24.7	15.8	115		Yes			Yes	
81	Naturita, CO, Processing Site	-108.611094	38.239805	Actual location, center of site	1	167.65	0.46	1	13.6	14.7	30.9	30.9	5.6	115		Yes			Yes	
24	Parkersburg, WV, Disposal Site	-81.685817	39.250115	Actual location, center of disposal cell	1	15.50	0.14	1	72.3	76.4	87.0	92.1	0.2	138						
93	Pinellas County, FL, Site	-82.749012	27.874948	Actual location, center of site	1	4.29	0.07	1	459.1	459.1	461.0	492.7	1.9	115						
2	Piqua, OH, Decommissioned Reactor	-84.234620	40.131900		1	0.46	0.02	1	28.5	116.5	208.8	215.5	2.4	138						
83	Rifle New, CO, Processing Site	-107.814042	39.524991	Actual location, center of site	1	957.08	1.11	1	5.8	10.2	10.3	28.4	1.8	230		Yes			Yes	
84	Rifle Old, CO, Processing Site	-107.771654	39.529479	Actual location, center of site	1	957.08	1.11	1	7.5	10.9	10.9	26.6	1.3	230		Yes			Yes	
74	Rifle, CO, Disposal Site	-107.801258	39.614434	Actual location, site marker on top of disposal cell	1	Unknown			5.0	16.5	16.6	24.0	0.1	345		Yes			Yes	
85	Rio Blanco, CO, Site	-108.367501	39.792404	Project 7 data	1	Unknown			3.6	8.7	9.1	17.0	15.6	138		Yes			Yes	
31	Riverton, WY, Processing Site	-108.410329	42.997679	Actual location, center of site	1	Unknown	0.00	1	12.8	16.4	20.5	21.1	0.2	230	Yes			Yes		
87	Rulison, CO, Site	-107.950010	39.406040	Project 7 data	1	Unknown			0.8	6.9	7.1	21.4	3.2	345		Yes	Yes		Yes	Yes
99	Salmon, MS, Site	-89.574517	31.138625	Actual location, center of site	1	Unknown			293.1	293.1	319.1	417.1	1.6	230						
21	Salt Lake City 11e(2), UT, Disposal Site	-113.118687	40.684563	Actual location, center of site	1	228.40	0.54	1	4.0	8.3	20.4	25.3	48.5	138		Yes			Yes	
20	Salt Lake City, UT, Disposal Site	-113.111437	40.690666	Actual location, site marker on top of disposal cell	1	228.40	0.54	1	4.1	8.8	19.8	24.8	48.8	138		Yes			Yes	
19	Salt Lake City, UT, Processing Site	-111.911462	40.702191	Actual location, center of site	1	228.40	0.54	1	4.9	7.0	8.2	10.4	2.7	138						
23	Sherwood, WA, Disposal Site	-118.106188	47.876183	Actual location, center of disposal cell	1	382.38	0.70	1	6.0	12.8	19.1	19.2	9.7	115	Yes			Yes		
120	Shiprock, NM, Disposal Site	-108.684297	36.770014	Actual location, site marker on top of cell	1	105.00	0.37	1	7.8	11.1	11.8	22.7	4.5	230	Yes			Yes		

107	Shoal, NV, Site	-118.387466	39.201384	Project 7 data	1	Unknown			1.9	5.0	6.8	12.1	2.7	230		Yes			Yes	
17	Shootaring, UT, Disposal Site	-110.690360	37.712543	Estimated location based on information received from Steve Haymes (DOE lands for renewable energy). This location disagrees with the NDAA book but is closer to the town of Ticaboo.	1	Unknown			3.3	3.5	3.9	3.9	65.7	230		Yes			Yes	
98	Shpack Landfill, MA, Site	-71.234169	41.943430	Estimated location based on http://web.em.doe.gov/bemr96/shlf.html(northwest by Peckham Road; on the north by Union Road on the south and west by the Attleboro Landfill, operated by Attleboro Landfill, Inc)	1	Unknown			19.7	29.9	39.5	50.2	0.0	345						
88	Slick Rock East, CO, Processing Site	-108.894528	38.043158	Actual location, center of site	1	112.96	0.38	1	3.2	9.5	29.9	30.2	10.4	115		Yes			Yes	
89	Slick Rock West, CO, Processing Site	-108.909424	38.045816	Actual location, center of site	1	112.96	0.38	1	2.4	10.2	29.2	29.5	11.1	115		Yes			Yes	
70	Slick Rock, CO, Disposal Site	-108.864253	38.054538	Actual location, site marker # 2	1	112.96	0.38	1	4.6	9.8	30.2	30.5	10.0	115		Yes			Yes	
102	St. Louis Airport Vicinity Properties, MO, Site	-90.364742	38.765778	Estimated location based on http://www.mvs.usace.army.mil/engr/fusrap/home2.htm	1	Unknown			4.9	61.8	236.0	305.0	2.3	138						
103	St. Louis Downtown, MO, Site	-90.194087	38.660805	Estimated location based on http://www.nukeworker.com/nuke_facilities/North_America/usa/DOE_Facilities/FUSRAP/FUSRAP_Site_Specific_Information.htm(North Broadway and Destrehan)	1	Unknown			8.5	72.3	234.0	316.0	0.6	138						
135	Tuba City, AZ, Disposal Site	-111.134793	36.145483	Actual location, center of disposal cell	1	145.00	0.43	1	8.4	15.5	22.2	29.8	16.2	500	Yes			Yes		
91	Uravan, CO, Disposal Site	-108.741669	38.366815	Estimated location based on ULM personel information	1	Unknown			11.3	12.5	25.0	25.2	15.5	115		Yes			Yes	
111	Wayne, NJ, Site	-74.270936	40.969628	Estimated location based on NDAA book and http://www.nukeworker.com/nuke_facilities/North_America/usa/DOE_Facilities/FUSRAP/FUSRAP_Site_Specific_Information.htm(868 Black Oak Ridge Road)	1	6.50	0.09	1	16.0	25.3	25.3	37.0	2.8	230						
104	Weldon Spring, MO, Site	-90.728274	38.698168	Actual location, site marker on top of disposal cell	1	266.90	0.59	1	14.6	61.6	223.3	288.2	4.6	161						
13	White Mesa, UT, Disposal Site	-109.511362	37.523455	Actual location, center of site (Moab EIS: O:\GIS\DATA2\Moab\moa\EISBase_Meter\PROPERTYBOUNDARY_V01.shp)	1	Unknown			12.3	19.3	20.1	20.1	11.0	345	Yes	Yes			Yes	
145	BONUS, PR, Decommissioned Reactor	-67.268557	18.364744	Actual location, BONUS Reactor	N/A	Unknown			N/A	N/A	N/A	N/A	No Data	No Data						

Initial GIS Screening CSP

Red: >= 6.5
Yellow: 5.0 – 6.5
Gray: <5.0



- Criteria for identifying areas with CSP development potential:
  - Resource >= 5.0 kWh/m^2/day, ideally >= 6.5 kWh/m^2/day
  - Slope < 3%, ideally <1%
  - Within 25 miles of transmission between 69 and 765 kV
  - Within 25 miles of a major road or rail
  - No development on the disposal cell

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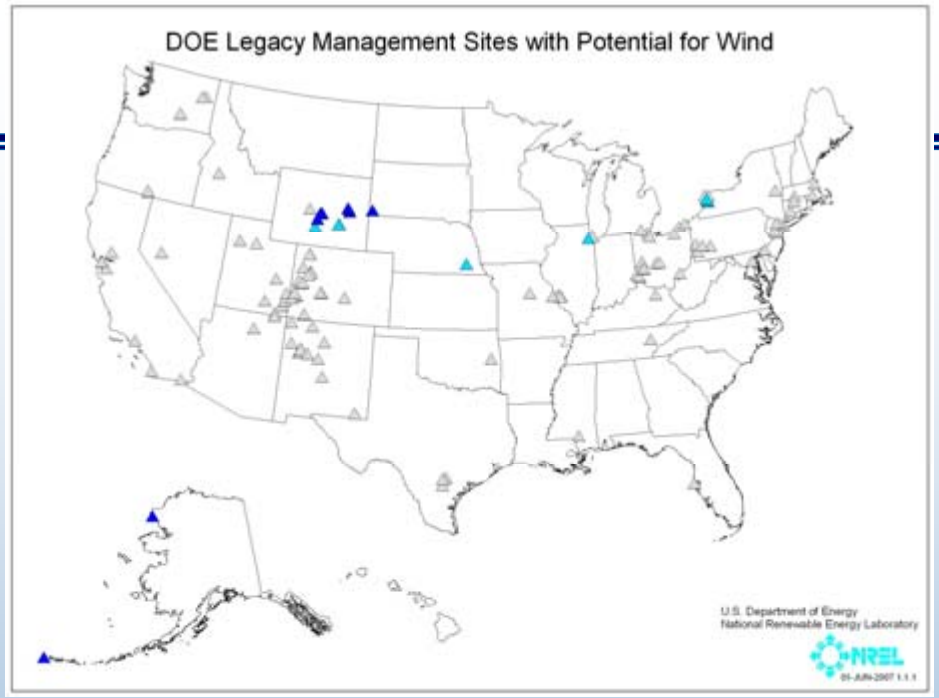
Figure C-1. Map of Initial GIS Screening Results for CSP.

Initial GIS Screening Wind

Dk Blue: Class 4-7
Lt Blue: Class 3
Gray: Class 1-2



- Criteria for identifying areas with wind development potential:
  - At least class 3 resource, ideally class 4 or higher
  - Within 25 miles of transmission between 69 and 345 kV
  - Within 25 miles of a major road
  - No development on the disposal cell

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Figure C2. Map of Initial GIS Screening Results for Wind.

Appendix D: Federal and State Policies and Financial Incentives for Renewable Energy

Federal Policies

Modified Accelerated Cost Recovery System (MACRS) with 50% Bonus Depreciation

Under the Modified Accelerated Cost-Recovery System (MACRS), businesses can recover investments in certain property through depreciation deductions. The MACRS establishes a set of class lives for various types of property, ranging from three to 50 years, over which the property may be depreciated. For solar, wind and geothermal property placed in service after 1986, the current MACRS property class is five years. With the passage of the the Energy Policy Act of 2005, fuel cells, microturbines, and solar hybrid lighting technologies are now classified as 5-year property as well. 26 USC § 168 references 26 USC § 48(a)(3)(A) with respect to classifying property as "5-year property" and EPAct 2005 added these technologies definition of energy property in § 48 as part of the business energy tax credit expansion.

For more information, see *IRS Publication 946, IRS Form 4562: Depreciation and Amortization*, and *Instructions for Form 4562*. The IRS web site (http://www.irs.gov/) provides a search mechanism for forms and publications. Enter the relevant form, publication name or number, and click "GO" to receive the requested form or publication.

Renewable Electricity Production Tax Credit

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Geothermal Electric, Municipal Solid Waste, Cogeneration, Refined Coal, Anaerobic Digestion, Small Hydroelectric

Amount: 1.8 cents/kWh for wind, solar, geothermal, closed-loop biomass; 0.9 cents/kWh for others

Terms: First ten years of operation for wind, closed-loop biomass; first five years for other technologies

Website: http://www.irs.gov/pub/irs-pdf/f8835.pdf
Note, however, that owners of solar and geothermal projects who claim the 10% federal business energy tax credit may NOT also claim this production tax credit. (http://www.dsireusa.org/library/includes/incentive2.cfm?Incentive_Code=US02F&State=Federal&currentpageid=1)

Solar and Geothermal Business Energy Tax Credit

Eligible Technologies: Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Geothermal Electric

Amount: 30%

Terms: Credit may be carried back to the three preceding years and then carried forward15 years

State Policies

(Ref: Database of State Incentives for Renewables and Efficiency – DSIRE at http://www.dsireusa.org/)

Alaska

Power Project Loan Fund

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind

Amount: Varies

Terms: Interest rate tied to municipal bonds

Website: http://akenergyauthority.org/programsloan.html

Program focuses on small-scale power production facilities produced by independent power producers. Includes loans for energy production, transmission and distribution.

Arizona

Renewables Portfolio Standard

Eligible Technologies: Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Geothermal Heat Pumps, CHP/Cogeneration, Solar Pool Heating (commercial only), Daylighting (non-residential only), Solar Space Cooling, Solar HVAC, Additional technologies upon approval, Anaerobic Digestion, Fuel Cells using Renewable Fuels.

Applicable Sectors: Utility

Standard: 15% by 2015

Technology Minimum: By 2012, at least 30% of the standard must be derived from distributed renewable energy (4.5% of total electricity sales by regulated utilities).

Credit Trading: Yes

Website: http://www.cc.state.az.us/utility/electric/environmental.htm

In November 2006, the Arizona Corporation Commission (ACC) adopted final rules to expand the state's Renewable Energy Standard (RES) to 15% by 2025, with 30% of the renewable energy to be derived from distributed energy technologies (~2,000 MW). On June 15, 2007 the Attorney General certified the rule as constitutional, allowing the new rules to go forward. Investor-owned utilities serving retail customers in Arizona, with the exception of distribution companies with more than half of their customers outside Arizona, are subject to the standard.

Utilities subject to the RES must obtain renewable energy credits (RECs) (equal to 1 kWh) from eligible renewable resources to meet 15% of their retail electric load by 2025

and thereafter. Of this percentage, 30% (i.e. 4.5% of total retail sales) must come from distributed renewable (DR) resources by 2012 and thereafter. One-half of the distributed renewable energy requirement must come from residential applications and the remaining one-half from nonresidential, non-utility applications.

Production Incentive – Green Tag Purchase Program

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind, Biomass, Geothermal Electric, Small Hydroelectric, Renewable Fuels.

Amount: $1 to $100 per MWh total production; varies by technology and contract length.

Terms: Any size system, grid tied, new renewable (January 1, 1999, or later).

Website: http://www.mainstayenergy.com/

Mainstay Energy is a private company offering customers who install, or have installed, renewable energy systems the opportunity to sell the green-tag RECs associated with the energy generated by these systems. These green tags will be brought to market as Green-e* (http://www.green-e.org/) certified products. Through the Mainstay Energy Rewards Program, participating customers receive regular, recurring payments.

The amount of the payments depends on the type of renewable energy technology, the production of electricity by that system, and the length of the contract period. Mainstay offers three-, five-, and ten-year purchase contracts. The longer the contract period, the greater the incentive payment on a $/kWh basis. Payments are made quarterly.

Generation Disclosure

The Arizona Corporation Commission adopted disclosure provisions as part of its 1996 Retail Electric Competition Rules. Under the disclosure provisions, all retail suppliers of electricity must disclose composition, fuel mix, and emissions characteristics upon request.

Green Power Purchasing

Scottsdale – local government buildings using photovoltaics, Salt River Project
Tucson Electric Power Company.

Tax Incentive: Non-Residential Solar & Wind Tax Credit (Corporate)

Eligible Technologies: Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Wind, Solar Cooling, Solar Pool Heating, Daylighting.

Amount: 10% of installed cost.

Maximum Incentive: $25,000 for any one building in the same year and $50,000 in total credits in any year.

Carryover Provisions: Unused credit may be carried forward for not more than five consecutive taxable years.

Eligible System Size: No system size restrictions specified.

Project Review/Certification: Businesses/Non-residential entities must apply to the Arizona Department of Commerce and receive certification to be eligible for the credit.

Website:
http://www.azcommerce.com/BusAsst/Incentives/Solar+Energy+Tax+Incentives+Program.htm

Arizona's tax credit for solar and wind installations in commercial and industrial applications was established in June 2006 (HB 2429). In May 2007, the credit was revised by House Bill 2491 to extend the credit to all non-residential entities, including those that are tax-exempt. Third parties who install or manufacture the system are now eligible as well—not only those that finance a system as allowed in the original legislation. These provisions are retroactive to January 1, 2006.

The tax credit, which may be applied against corporate or personal taxes, is equal to 10% of the installed cost of qualified "solar energy devices" and applies to taxable years beginning January 1, 2006 and extending through December 31, 2012.

California

Renewables Portfolio Standard

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Geothermal Electric, Municipal Solid Waste, Anaerobic Digestion, Small Hydroelectric, Tidal Energy, Wave Energy, Ocean Thermal, Biodiesel, Fuel Cells using Renewable Fuels.

Applicable Sectors: Investor-Owned Utility, Electric Service Providers, Small and Multi-Jurisdictional Utilities and Community Choice Aggregators

Standard: Legislative mandate to increase the percentage of renewable retail sales by at least 1% per year to reach at least 20% by end of 2010; goal of 33% by end of 2020

Technology Minimum: No

Credit Trading: Tradable RECs may be allowed after the CPUC and Energy Commission conclude that the Western Renewable Energy Generation Information System (WREGIS) is operational and when other criteria are met.

Website: http://www.energy.ca.gov/portfolio/index.html

California's Renewables Portfolio Standard (RPS) program requires retail sellers of electricity to increase their sales of eligible renewable-energy resources by at least 1 percent of retail sales per year, so that 20% of their retail sales are served with eligible renewable energy resources by 2010. Governor Schwarzenegger has set a longer-term state goal of 33% by 2020, and currently the California Public Utilities Commission (CPUC) and the California Energy Commission (Energy Commission) are considering ways to achieve that goal.

The CPUC has developed RPS compliance rules for investor owned utilities (IOUs), electric service providers, small and multi-jurisdictional utilities and community choice aggregators. Publicly-owned utilities are responsible for implementing and enforcing an

RPS that recognizes the intent of the Legislature to encourage renewable resources, while taking into consideration the effect of the standard on rates, reliability, and financial resources and the goal of environmental improvement.

The law assigned specific roles to the CPUC and the Energy Commission and directed the agencies to work in collaboration to implement the RPS program.

Corporate production Incentive – Supplemental Energy Payments

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Fuel Cells, Municipal Solid Waste, Anaerobic Digestion, Tidal Energy, Wave Energy, Ocean Thermal

Amount: For above-market costs as compared to a market-price referent (subject to determination by the Energy Commission)

Terms: Three- to ten-year contracts

Website: http://www.energy.ca.gov/portfolio/

Tax Incentive - Solar Property Tax Exemption

Eligible Technologies: Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Solar Mechanical Energy.

Amount: 100% of system value

Maximum Limit: None

Terms: 75% exemption for dual-use equipment.

Section 73 of the California Revenue and Taxation Code allows a property tax exemption for certain types of solar energy systems installed on or before December 31, 2009. (The original expiration year of 2005 was extended by AB 1099 [2005]) (http://www.leginfo.ca.gov/cgi-bin/postquery?bill_number=ab_1099&sess=PREV&house=B&author=leno). Qualifying active solar energy systems are defined as those that "are thermally isolated from living space or any other area where the energy is used, to provide for the collection, storage, or distribution of solar energy." These include solar space conditioning systems, solar water heating systems, active solar energy systems, solar process heating systems, PV systems, and solar thermal electric systems, and solar mechanical energy. Solar pool heating systems and solar hot-tub-heating systems are not eligible.

Components included under the exemption include storage devices, power conditioning equipment, transfer equipment, and parts. Pipes and ducts that are used to carry both solar energy and energy derived from other sources qualify for the exemption only to the extent of 75% of their full cash value. Likewise, dual-use equipment for solar-electric systems qualifies for the exemption only to the extent of 75% of its value.

Generation Disclosure

California's energy suppliers must disclose to all customers the energy resource mix used in generation. Providers must use a standard label created by the California Energy Commission (CEC), and this information must be provided to end-use customers at least four times per year.

Green Power Purchasing

- Davis – local government buildings using photovoltaics
- Los Angeles – local government buildings
- San Diego – local government buildings using solar water heat, solar thermal electric, photovoltaics, landfill gas, wind, biomass, geothermal electric, fuel cells, municipal solid waste, digester gas, small hydroelectric, tidal energy, wave energy, and ocean thermal
- Santa Monica – local government buildings using geothermal electric.

Net Metering

California's net-metering law, which took effect in 1996, requires all utilities to allow net metering to all customers for solar and wind-energy systems up to 1 MW. Investor owned-utilities are required to offer net metering for biogas-electric systems and fuel cells.

The original law applied to wind-energy systems, solar-electric systems and hybrid (wind/solar) systems. In September 2002, legislation (AB 2228) allowed biogas-electric facilities up to 1 MW to net meter until December 31, 2005, under a pilot program. This pilot program was extended until December 31, 2009, upon the enactment of AB 728 in September 2005. A customer-generator may continue to net meter an eligible biogas digester for the life of the facility, provided the digester meets California's best available control technology (BACT) requirements upon installation. Furthermore, AB 728 (2005) authorizes up to three large biogas digesters—systems with a capacity greater than 1 MW but no more than 10 MW—to net meter. There is a 50-MW statewide limit on net-metered biogas digesters. California law provides for retail cost recovery of revenue loss from net-metered biogas digesters.

Public Benefits Fund

California's 1996 electric industry restructuring legislation (AB 1890) (http://www.leginfo.ca.gov/pub/95-96/bill/asm/ab_1851-1900/ab_1890_bill_960924_chaptered.html) directed the state's three major investor-owned utilities (Southern California Edison, Pacific Gas and Electric Company, and San Diego Gas & Electric) to collect a "public goods surcharge" on ratepayer electricity use from 1998 through 2001 to create public benefits funds for renewable energy ($540 million), energy efficiency ($872 million), and research, development & demonstration (RD&D) ($62.5 million).
Subsequent legislation in 2000 (AB 995 and SB 1194) (http://www.energy.ca.gov/renewables/documents/ab995_bill_20000930_chap.html) (http://www.energy.ca.gov/renewables/documents/sb1194_bill_20000930_chap.html) extended the programs for 10 years beginning in 2002, with annual funding of ~$135

million for renewable energy programs (projected to be ~$150 million annually for 2007-2011), $228 million for energy efficiency programs, and $62.5 million for RD&D. In September 2005, the California Public Utilities Commission (CPUC) boosted energy efficiency funding to $2 billion for 2006 – 2008.

With the passage of California's Renewables Portfolio Standard legislation (SB 1078) in 2002, RPS goals inform the policies of the elements in the Renewable Energy Program.

Renewable Energy Programs

The California Energy Commission manages the renewables funds through four programs:

- Existing Renewable Facilities Program - 10% ($15 million/year)
- New Renewables Facilities Program - 51.5% ($77.2 million/year)
- Emerging Renewables Program - 37.5% ($56.2 million/year)
- Consumer Education Program - 1% ($1.6 million/year)

The Existing Renewable Facilities Program provides production incentives, based on kilowatt-hours generated, to support existing renewable energy facilities. The program is divided into two tiers: (1) biomass and solar-thermal projects and (2) wind projects. Although existing wind facilities are technically eligible for funding, they currently do not require assistance. Therefore, all Existing Renewable Facilities Program funds are available for eligible existing solid-fuel biomass facilities and solar thermal electric facilities.

The New Renewable Facilities Program supports prospective new renewable energy projects that generate electricity and consists of two parts. Under the first, incentives are paid to new facilities for a maximum of five years once they are online, and like the Existing Program, incentives are awarded based on the number of kilowatt-hours generated. Secondly, under California's RPS, the New Renewable Facilities Program will provide supplemental energy payments for the above-market costs of renewable energy.

The Emerging Renewables Program is administered through a rebate program. Through 2006, photovoltaics, solar thermal electric, fuel cells that use renewable fuels, and wind turbines were eligible under this program. However, effective January 1, 2007, only small wind and fuel cells using renewable fuels are eligible, with the program's solar component replaced by the New Solar Homes Partnership program. As part of the $3.35 billion California Solar Initiative, the $400 million New Solar Homes Partnership is focused on encouraging solar installations in the residential new construction market. Its goal is to install 400 MW and 50% of new homes with solar by the end of 2016.

The Consumer Education Program provides funds to promote renewable energy and help build the market for emerging renewable technologies.

Colorado

Production Incentive – Green Tag Purchase Program

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind, Biomass, Geothermal Electric, Small Hydroelectric, Renewable Fuels

Amount: $1 to $100 per MWh total production; varies by technology and contract length

Terms: Any size system, grid tied, new renewable (January 1, 1999 or later)

Website: http://www.mainstayenergy.com/

Mainstay Energy is a private company offering customers who install, or have installed, renewable energy systems the opportunity to sell the green tags RECs associated with the energy generated by these systems. These green tags will be brought to market as Green-e* (http://www.green-e.org/) certified products. Through the Mainstay Energy Rewards Program, participating customers receive regular, recurring payments.

The amount of the payments depends on the type of renewable energy technology, the production of electricity by that system, and the length of the contract period. Mainstay offers three-, five-, and ten-year purchase contracts. The longer the contract period, the greater the incentive payment on a $/kWh basis. Payments are made quarterly.

Generation Disclosure

Colorado is one of several states to require disclosure without having restructured its electricity market. In January 1999, the Colorado Public Utility Commission (PUC) adopted regulations requiring the state's investor-owned utilities (IOUs) to disclose information regarding their fuel mix to retail customers. Utilities with a total system load of more than 100 MW are required to provide this information as a bill insert or as a separate mailing twice annually, beginning October 1999.
The PUC provided a suggested format for the disclosure. Fuel mix percentages are to be based on the power supply mix for the previous calendar year. Supporting documentation concerning

Green Power Purchasing

- Aspen – local government buildings using wind
- Boulder – local government buildings using wind.

Net Metering

Aspen Electric/Holy Cross Electric Fort Collins Utilities Gunnison County Electric Xcel Energy.

Renewables Portfolio Standard

State

The initiative requires Colorado utilities with 40,000 or more customers to generate or purchase a percentage of their electricity from renewable sources according to the following schedule:

- 3% from 2007 through 2010

- 6% from 2011 through 2014
- 10% by 2015 and thereafter.

Of the electricity generated each year from renewable sources, at least 4% must come from solar technologies. At least one-half of this percentage must come from solar systems located on-site at customers' facilities. Other eligible technologies include wind, geothermal heat, biomass facilities that burn nontoxic plants, landfill gas, animal waste, small hydroelectric, and hydrogen fuel cells. Energy generated in Colorado is favored: each kWh of renewable electricity generated in-state will be counted as 1.25 kWh for the purposes of meeting this standard.

Fort Collins

Electric Energy Supply Policy - Standard: Additional 2% by 2004; 15% by 2017.

Georgia

Production Incentive - Green Tag Purchase Program

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind, Biomass, Geothermal Electric, Small Hydroelectric, Renewable Fuels

Terms: Any size system, grid tied, new renewable (January 1, 1999, or later)

Website: http://www.mainstayenergy.com/

Mainstay Energy is a private company offering customers who install, or have installed, renewable energy systems the opportunity to sell the green tag RECs associated with the energy generated by these systems. These green tags will be brought to market as Green-e* (http://www.green-e.org/) certified products. Through the Mainstay Energy Rewards Program, participating customers receive regular, recurring payments.

The amount of the payments depends on the type of renewable energy technology, the production of electricity by that system, and the length of the contract period. Mainstay offers three-, five-, and ten-year purchase contracts. The longer the contract period, the greater the incentive payment on a $/kWh basis. Payments are made quarterly.

TVA – Green Power Switch Generation Partners Program

Eligible Technologies: Photovoltaics, Wind

Amount: $500 (residential only) plus $0.15 per kWh for 10 years (residential and commercial)

Terms: $500 payment available until the program capacity reaches 150 kW

Website: http://www.gpsgenpartners.com

TVA and participating power distributors currently offer a dual-metering option to residential and small-commercial consumers (non-demand-metered) through the Green Power Switch Generation Partners program. The output (green power) generated from this program will be counted as a TVA Green Power Switch resource.

Through this program, TVA will purchase the entire output of a qualifying system at $0.15 per kWh through a participating power distributor, and the consumer will receive a credit for the power generated. Participation in this program is entirely up to the discretion of the power distributor. As of June 2004, about a dozen distributors have signed up for the program. Thus far, the program includes several residential solar participants and one 20-kW wind project.

Net Metering

While resembling a standard net metering law on the surface, Georgia's legislation helps pave the way for a new relationship between utility and customer-generator by combining net metering with green pricing. Utilities will purchase energy until renewable capacity reaches 0.2% of the utility's system peak. Eligible technologies include PV, fuel cells, and wind systems up to 10 kW for residential applications and 100 kW for commercial applications. The key to the law is a provision that power flows to and from the home are separately measured with the intent that customers will see added value because utilities can package the excess kilowatt-hours for other Green Power Marketing programs

Idaho

Production Incentive – Green Tag Purchase Program

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind, Biomass, Geothermal Electric, Small Hydroelectric, Renewable Fuels

Amount: $1 to $100 per MWh total production; varies by technology and contract length

Terms: Any size system, grid tied, new renewable (January 1, 1999, or later)

Website: http://www.mainstayenergy.com/

Mainstay Energy is a private company offering customers who install, or have installed, renewable energy systems the opportunity to sell the green tag RECs associated with the energy generated by these systems. These green tags will be brought to market as Green-e* (http://www.green-e.org/) certified products. Through the Mainstay Energy Rewards Program, participating customers receive regular, recurring payments.

The amount of the payments depends on the type of renewable energy technology, the production of electricity by that system, and the length of the contract period. Mainstay offers three-, five-, and ten-year purchase contracts. The longer the contract period, the greater the incentive payment on a $/kWh basis. Payments are made quarterly.

Net Metering

Idaho does not have a state-wide net-metering rule. However, all three investor-owned utilities—Avista Utilities, Idaho Power Company, and Utah Power & Light Company (owned by PacifiCorp)—have net-metering tariffs on file with the Idaho Public Utilities Commission.

Avista, which serves the northern part of Idaho, allows net metering to all customers generating up to 25 kW of electricity using solar, wind, biomass, hydropower, or fuel cells. Enrollment is limited to 0.1% of 1996 peak demand (1.52 MW). Excess

generation is credited to the customer's monthly bill and used to reduce the bill for the following period. At the end of the year, any remaining credits are granted to Avista.

Idaho Power made net metering available only to residential and small commercial customers generating up to 25 kW of wind, solar, biomass, hydro, or power from fuel cells. In August 2002, the PUC issued Order No. 29094 amending Idaho Power's Schedule 84 to include other schedules, such as large commercial and irrigation. This allows net-metered projects up to 100 kW for schedules other than residential and small commercial. Excess kWh generation per month is paid at 85% of the Mid-Columbia market price for non-firm energy. Total enrollment cannot exceed 2.9 MW (0.1%) of Idaho Power's peak demand in 2000.

Utah Power & Light Company allows net metering to residential and small-commercial customers generating up to 25 kW of electricity using solar, wind, biomass or hydropower, and to irrigation and large commercial customers generating up to 100 kW. Enrollment is limited to 0.1% of the company's Idaho retail peak demand in 2002.

Illinois

Renewable Portfolio Standard

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind

Applicable Sectors: Utility

Standard: 25% by 2025

Technology Minimum: 75% Wind

Credit Trading: Yes

Public Law pdf: http://www.ilga.gov/legislation/publicacts/95/PDF/095-0481.pdf

In August, 2007, Illinois passed Public Act 095-0481, which created the Illinois Power Agency. The purpose of the agency is to develop electricity procurement plans for state utilities supplying over 100,000 Illinois customers to ensure "adequate, reliable, affordable, efficient, and environmentally sustainable electric service at the lowest total cost." The Agency is charged with competitively procuring energy supply according to the plans (as appropriate), and with meeting a renewable portfolio standard of 25% by 2025.

Tax Incentive – Commercial Wind Energy Property Valuation – *Property Tax Assessment*

Eligible Technologies: Wind

Terms:
Valuation: $360,000/MW (annually adjusted for inflation) for commercial wind devices greater than 500kW.

Depreciation: Up to 70% of the trended real property cost basis

Expiration Date: 2011 Assessment Year

Prior to 2007, wind energy devices generating electricity for commercial sale were assessed differently depending on where they were located. Some counties valued the entire turbine structure (tower plus generation equipment) as "real property", subject to taxation, while others deemed only the tower portion as taxable property. This difference in valuation procedure meant that the taxable value of identical wind turbines could vary by as much as 75% from county to county, creating dramatically different tax loads and complicating projects that cross county lines.

Tax Incentive – Special Assessment for Solar Energy Systems – *Property Tax Exemption*

Eligible Technologies: Photovoltaics

Maximum Limit: None

Illinois offers a special assessment of solar energy systems for property-tax purposes. For property owners who register with a chief county assessment officer, solar energy equipment is valued at no more than a conventional energy system. Eligible equipment includes both active and passive solar-energy systems.

State Grant Program - Solar Thermal Grant Program

Eligible Technologies: Solar Thermal Electric

Amount: Up to 30% of project cost

Maximum Amount: $400,000 (this limitation may be waived for specific projects)

Project Review/Certification: Incentive agreements may require performance monitoring for a period of 12 months or longer

Funding Source: Illinois Renewable Energy Resources Trust Fund

Website:
http://www.illinoisbiz.biz/dceo/Bureaus/Energy_Recycling/Energy/Clean+Energy/03-Thermal_incentive.htm

The Illinois Solar Thermal Grant Program provides funding for the purchase and installation of solar-energy systems that collect and transfer heat for space, water heating, and/or electric generation, and that minimum cost of $50,000. This program does not provide funding for photovoltaic (PV) systems, nor will it provide funding for the installation of renewable energy equipment at single-family residences. Grants are available to residents, businesses, state and local government entities, schools, and nonprofit organizations. An applicant must be a customer within the service area of a utility that imposes the Renewable Energy Resources and Coal Technology Development Assistance Charge as defined in 20 ILCS 687/6-5. Participating utilities are listed on the application available at the program website.

State Grant Program - Wind Energy Production Development Program

Eligible Technologies: Wind

Amount: Varies

Maximum Amount: $25,000 (limit may be waived under special circumstances)

Equipment Requirements: Minimum 0.5 MW capacity

Funding Source: Illinois Renewable Energy Resources Trust Fund (Public Benefits Fund)

Website:
http://www.illinoisbiz.biz/dceo/Bureaus/Energy_Recycling/Energy/Clean+Energy/04-wind_energy.htm

Kansas

Production Incentive – Green Tag Purchase Program

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind

Amount: $1 to $100 per MWh total production; varies by technology and contract length

Terms: Any size system, grid tied, new renewable (January 1, 1999, or later)

Website: http://www.mainstayenergy.com/

Mainstay Energy is a private company offering customers who install, or have installed, renewable energy systems the opportunity to sell the green tag RECs associated with the energy generated by these systems. These green tags will be brought to market as Green-e* (http://www.green-e.org/) certified products. Through the Mainstay Energy Rewards Program, participating customers receive regular, recurring payments.

The amount of the payments depends on the type of renewable energy technology, the production of electricity by that system, and the length of the contract period. Mainstay offers three-, five-, and ten-year purchase contracts. The longer the contract period, the greater the incentive payment on a $/kWh basis. Payments are made quarterly.

Renewable Energy Property Tax Exemption

This statute exempts renewable energy equipment from property taxes. Renewable energy includes wind, solar thermal electric, photovoltaic, biomass, hydropower, geothermal, and landfill gas resources or technologies that are actually and regularly used predominantly to produce and generate electricity.

Kentucky

Tax Incentive: *Tax Credit for Renewable Energy Facilities*

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric

Amount: 100% State Income Tax, 4% wage assessment

Maximum Incentive: 50% of capital investment; negotiated incentive package may not exceed 25 years

Eligible System Size: >50 kW for solar power, >1 MW for wind power, biomass, landfill gas, hydropower or similar resource

In August 2007 Kentucky established the *Incentives for Energy Independence Act* to promote the development of renewable energy and alternative fuel* facilities, energy efficient buildings, alternative fuel vehicles, research & development activities and other energy initiatives. For renewable energy facilities, the bill provides incentives to companies that build or renovate facilities that utilize renewable energy, which may include:

- Up to 100% of the Kentucky income tax or the limited liability entity tax
- Sales and use tax incentives of up to 100%;
- A wage assessment of up to 4% for associated employees.

A renewable energy facility is defined as one that generates at least 50 kW of electricity from solar power or at least 1 MW from wind power, biomass resources, landfill gas, hydropower or similar renewable resources. The electricity must be sold to an unrelated party. The minimum investment in any renewable energy facility must be $1 million in capital expenditure which is defined to include various non-capital costs such as labor.

Productions Incentive TVA - Green Power Switch Generation Partners Program

TVA and participating power distributors currently offer a dual-metering option to residential/small-commercial and commercial consumers through the Green Power Switch Generation Partners program. The output (green power) generated from this program will be counted as a TVA Green Power Switch resource.

Consumers participate as either residential/small-commercial or commercial customers. Under the residential/small-commercial contract, TVA will purchase the entire output of a qualifying system at $0.15 per kWh through a participating power distributor, and the consumer will receive a credit for the power generated. In September 2004, larger commercial customers were included in the program. Under the larger commercial contract, TVA will purchase the output at $0.20 per kWh. Participation in this program is entirely up to the discretion of the power distributor. As of August 2006, 30 distributors have signed up for the program. Thus far, the program includes several residential solar participants, a 20-kW wind project, a 50-kW commercial solar system, and a 10-kW commercial solar system.

Qualifying sources for residential/small-commercial projects include photovoltaic and wind turbine systems with a minimum output of 500 watts AC and a maximum of 50 kW. For commercial consumers, qualifying sources are restricted to PV only. Although the maximum output for commercial generation systems remains at 50 kW, the power distributor may elect to permit larger systems with mutual agreement of TVA on a case-by-case basis. Qualifying systems must be used primarily to provide all or part of the energy needs at a particular site and must not have previously generated into the grid. Installations must also comply with local codes and adhere to specific interface guidelines established by the program.

Until a total capacity of 150 kW has been reached, the owner of a qualifying residential system will receive a $500 payment when the site is connected to the grid. The goal for the entire program is 5 MW. The credit of $0.15/kWh is available for a minimum of ten years from the signing of the contract, regardless of the amount produced. Payment is made in the form of a credit issued by the local power distributor on the monthly power bill for the home or business where the generation system is located. TVA retains sole rights to any renewable energy credits.

Customers of TVA distribution utilities in Kentucky who are interested in this program should contact their utility customer services representative.

For more information, please see the program website at www.gpsgenpartners.com.

Tax Incentive: *Sales Tax Exemption for Large-Scale Renewable Energy Projects*

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, similar renewable resources

Amount: 100% of sales and use tax

Maximum Incentive: 50% of capital investment

Eligible System Size: >50 kW for solar power, >1 MW for wind power, biomass, landfill gas, hydropower or similar resource

In August 2007 Kentucky established the Independence Energy to promote the development of renewable energy and alternative fuel facilities, energy efficient buildings, alternative fuel vehicles, research & development activities and other energy initiatives. For renewable energy facilities, the bill provides incentives to companies that build or renovate facilities that utilize renewable energy, which may include:

- Up to 100% of the Kentucky income tax or the limited liability entity tax;
- A wage assessment of up to 4% for associated employees.

A renewable energy facility is defined as one that generates at least 50 kW of electricity from solar power or at least 1 MW from wind power, biomass resources, landfill gas, hydropower or similar renewable resources. The electricity must be sold to an unrelated party. The minimum investment in any renewable energy facility must be $1 million in capital expenditure which is defined to include various non-capital costs such as labor.

Companies may receive a sales tax incentive of up to 100% of the Kentucky sales and use tax paid (on or after the activation date) on materials, machinery and equipment used to construct, retrofit or upgrade an eligible project.

In addition the tax credit for renewable energy facilities allows approved facilities to receive a credit up to 100% of Kentucky income tax and the limited liability tax for projects that construct, retrofit, or upgrade facilities that generate power from renewable resources.

Approved companies may also require that employees whose jobs were created as a result of the associated project, as a condition of employment, agree to pay a wage assessment of up to 4% of their gross wages. Employees will be allowed a Kentucky income tax credit equal to the assessment withheld from their wages.

The maximum recovery for a single project from all incentives, including the income and liability entity tax credit, sales tax refund, and the wage assessment may not exceed 50% of the capital investment.

Prior to making any capital investments in a project, each eligible company must submit an application for incentives to the Kentucky Economic Development Finance Authority. Each incentive contract is negotiated on a case-by-case basis to determine the conditions and termination date of the project, not to exceed 25 years from the project's activation date.

Maryland

Tax Incentive – Corporate Tax Credit

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind

Amount: $0.0085/kWh

Maximum Incentive: $2.5 million (total credit during five-year period)

Website: http://www.energy.state.md.us/financial/renewable/cep_taxcredit.htm

To qualify, a facility that "primarily uses" eligible resources to generate electricity must be placed in service on or after January 1, 2006, but before January 1, 2011.

Massachusetts

Renewable Portfolio Standard

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind

Applicable Sectors: Utility

Standard: 1% new renewables in 2003, increasing to 4% in 2009 (plus 1% each year after 2009)

Credit Trading: Yes

Website: http://www.state.ma.us/doer/rps/index.htm

Financial Incentive: Renewable Energy Trust Fund (Public Benefits Fund)

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind

Total Fund: $25 million each year

Charge: $0.0005 per kilowatt-hour (0.5 mill/kWh) in 2003 and each following year

Website: http://www.mtpc.org/RenewableEnergy/index.htm

Tax Incentive – Excise Tax Deduction for Solar or Wind-Powered Systems

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind

Amount: 100%

Maximum Incentive: None Specified

Website: http://www.state.ma.us/doer/programs/renew/renew.htm#taxcred

Businesses may deduct from net income, for state excise tax purposes, costs incurred from the installation of any "solar or wind powered climatic control unit and any solar or wind powered water heating unit or any other type unit or system powered thereby." The installation must be located in Massachusetts and used exclusively in the trade or business of the corporation. A system or unit that qualifies for this deduction will not be taxed under the tangible property measure of the state's corporate excise tax. The exemption is in effect for the length of the equipment's depreciation period.

Tax Incentive – Excise Tax Exemption for Solar or Wind-Powered Systems

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind

Amount: 100% of the tangible property portion of the excise tax (0.26% of the taxable value of the system)

Maximum Incentive: None

Terms: Length of depreciation

Website: http://www.state.ma.us/doer/programs/renew/renew.htm#taxcred

This statute exempts solar and wind energy systems that qualify for the Excise Tax Deduction for Solar or Wind Powered Systems from the tangible property measure of the state's corporate excise tax. The exemption is in effect for the length of the system's depreciation period.

Tax Incentive – Excise Tax Exemption for Solar or Wind-Powered Systems

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind

Amount: 100% of the tangible property portion of the excise tax (0.26% of the taxable value of the system)

Maximum Incentive: None

Terms: Length of depreciation

Website: http://www.state.ma.us/doer/programs/renew/renew.htm#taxcred

This statute exempts solar and wind energy systems that qualify for the Excise Tax Deduction for Solar or Wind Powered Systems from the tangible property measure of the state's corporate excise tax. The exemption is in effect for the length of the system's depreciation period.

State Grant Program – MTC Large Onsite Renewables Initiative (LORI) Grants

Eligible Technologies: Solar Thermal Electric and Wind

Amount: Varies by solicitation

Maximum Amount: Feasibility Grants are capped at $40,000 with an applicant cost share of 15%. Design grants are capped at the lesser of $125,000 or 75% of actual costs. Construction grants are capped at the lesser of $275,000 or 75% of actual costs.

Website: http://www.masstech.org/renewableenergy/large_renewables.htm

The Massachusetts Technology Collaborative's (MTC) Large Onsite Renewables Initiative (LORI) provides two types of grants – Feasibility Study Grants and Design & Construction Grants – on a competitive basis to expand the production and use of distributed renewable-energy technologies in the state. MTC is the administrator of the Renewable Energy Trust Fund, the state's public benefits fund for renewable energy.

Michigan

Production Incentive – Green Tag Purchase Program

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind

Amount: $1 to $100 per MWh total production; varies by technology and contract length

Terms: Any size system, grid tied, new renewable (January 1, 1999, or later)

Website: http://www.mainstayenergy.com/

Mainstay Energy is a private company offering customers who install, or have installed, renewable energy systems the opportunity to sell the green tag RECs associated with the energy generated by these systems. These green tags will be brought to market as Green-e* (http://www.green-e.org/) certified products. Through the Mainstay Energy Rewards Program, participating customers receive regular, recurring payments.

The amount of the payments depends on the type of renewable energy technology, the production of electricity by that system, and the length of the contract period. Mainstay offers three-, five-, and ten-year purchase contracts. The longer the contract period, the greater the incentive payment on a $/kWh basis. Payments are made quarterly.

State Grant Program

Eligible Technologies: Wind, Fuel Cells, Solar, Energy Efficiency

Applicable Sectors: Commercial, Nonprofit, Schools, Local Government, State Government

Amount: Varies

Max. Limit: $6 million

Website: http://www.michigan.gov/mpsc/0,1607,7-159--102226--,00.html

The Michigan Public Service Commission (PSC) will award $6 million in funding—in the form of one or more grants—to support energy-efficiency projects, including renewable-energy technologies such as wind, solar, and fuel cells. It is anticipated that the grant(s) will be awarded in winter 2005 to businesses, non-profit organizations, government agencies, and/or schools. The award(s) will be funded by the state's Low-Income and Energy Efficiency Fund (http://www.michigan.gov/mpsc/0,1607,7-159-16370_27289-79463--,00.html)

Generation Disclosure

Michigan's Customer Choice and Electric Reliability Act of 2000 requires electricity suppliers to disclose customer information related to the suppliers' fuel mix and emissions and requires that electric suppliers use a regional average fuel mix and emissions data when the fuel mix cannot otherwise be determined, along with the regional electric generation fuel mix, emissions and nuclear waste characteristics. All electric suppliers must disclose to customers information pertaining to the environmental characteristics of electricity production. This information must be provided twice annually and based on a rolling average.

Mississippi

No financial or tax incentives for Solar Thermal Electric, Photovoltaics or Wind electrical generation systems.

Missouri

Columbia - Renewables Portfolio Standard

Eligible Technologies: Solar Thermal Electric and Photovoltaics

Applicable Sectors: Utility

Standard: 2% by 12/31/07; 15% by 12/31/22

Website:
http://www.gocolumbiamo.com/WaterandLight/Electric/ElectricSupplyInformation.php

New Jersey

Renewables Portfolio Standard

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind

Applicable Sectors: Utility

Standard: 22.5% by 2021 (2.12% from solar; 17.88% from other Class I renewables; 2.5% from Class II or additional Class I renewables)

Technology Minimum: 2.12% of retail electricity supply must be generated using solar by 2021 (approximately 1,500 MW solar)

Credit Trading: Yes

Website: http://njcleanenergy.com/renewable-energy/program-updates/solar-transition/solar-transition

New Jersey's RPS—one of the most aggressive in the United States—requires each supplier/provider serving retail customers in the state to include in the electricity it sells 22.5% qualifying renewables by 2021. The New Jersey Board of Public Utilities (BPU) made extensive revisions to the RPS in April 2006, significantly increasing the required percentages of "Class I" and "Class II" renewable energy, as well as the required separate percentage of solar electricity. By reporting year 2021, 2.12% solar electricity is required.

Production Incentive - NJ Board of Public Utilities - Solar Renewable Energy Certificates (SRECs)

Eligible Technologies: Photovoltaics

Amount: Approximately $200 per MWh ($0.20 per kWh)

Maximum Incentive: Approximately $300 per MWh ($0.30 per kWh)

Terms: Systems must be registered with NJBPU

Website: http://www.njcep.com/srec

NOTE: NJBPU has proposed plans to restructure its solar programs in September 2007. The reader is recommended to review the DSIRE website for future NJBPU SRECs availability.

Tax Incentive – Solar and Wind Energy Systems Exemption (Sales Tax Exemption)

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind

Amount : All

Maximum Incentive: None

New Jersey offers a full exemption from the state's 7% sales tax for all solar and wind energy equipment. This exemption is available to all taxpayers. All major types of solar energy equipment, including equipment for passive solar design, is considered eligible for the exemption. The statute directed the New Jersey Division of Energy Planning and Conservation in the to DOE to establish technical standards for qualifying solar energy systems.

New Hampshire

Production Incentive – Green Tag Purchase Program

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind

Amount: 1.7 cents to 6.4 cents/kWh; varies based on technology, payment plan, and contract length

Terms: Any size system, grid tied, new renewable (January 1, 1998, or later)

Website: http://www.mainstayenergy.com/

Mainstay Energy is a private company offering customers who install, or have installed, renewable energy systems the opportunity to sell the green tag RECs associated with the energy generated by these systems. These green tags will be brought to market as Green-e (http://www.green-e.org/) certified products. Eligible technologies include PV, wind, biomass, geothermal electric, and hydroelectric.

Through the Mainstay Energy Rewards Program, participating customers in New England receive either quarterly production-based payments, or an up-front payment. The amount of the incentive is based on the type of renewable energy technology, the production of electricity by that system (or size, in the case of the up-front payment), and the length of the contract period. Mainstay offers three-, five-, and ten-year purchase contracts. The longer the contract period, the greater the incentive payment.

Net Metering

On June 25, 1998, Governor Shaheen signed into law a net-metering bill that directs all utilities selling power in New Hampshire to credit homeowners and small businesses that generate a portion of their own electricity through wind turbines, PV electric systems, or hydro power.

On January 12, 2001, the New Hampshire Public Utilities Commission approved net metering and interconnection rules for homeowners and small businesses with grid-tied renewable energy systems under 25 kW. The statewide limit on capacity enrolled in net metering is 0.05% of the annual peak demand of each utility. Customers generating more electricity than they use in a given billing period receive credit for excess kWh generated.

New Mexico

Renewables Portfolio Standard

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind

Applicable Sectors: Investor-Owned Utility, Rural Electric Cooperative

Standard: Investor-Owned Utilities: 20% by 2020; Rural Electric Cooperatives: 10% by 2020

Technology Maximum: For IOUs only by 2020:

- 20% of RPS from solar (4% of total sales)
- 20% of RPS from wind (i.e. 4% of total sales
- 10% of RPS from geothermal and biomass (2% of total sales)
- 3% of RPS from distributed renewables (0.6% of total sales)

Credit Trading: Yes

Website: http://www.nmprc.state.nm.us/renewable.htm

In March 2007, New Mexico passed SB 418, which directs investor-owned utilities to generate 20% of total retail sales to New Mexico customers from renewable energy resources by 2020, with interim standards of 10% by 2011 and 15% by 2015. The bill also establishes a standard for rural electric cooperatives of 10% by 2020 (see below).

Furthermore, utilities are to set a goal of at least 5% reduction in total retail sales to New Mexico customers, adjusted for load growth, by January 1, 2020.

Tax Incentive - Renewable Energy Production Tax Credit

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind

Amount:

- $0.01/kWh for Wind
- $0.27/kWh (average) for Solar

Maximum Incentive:
Wind and biomass: First 400,000 MWh annually for 10 years (i.e. $4,000,000/year)
Solar electric: First 200,000 MWh annually for 10 years (annual amount varies)
Statewide cap: 2,000,000 MWh plus an additional 500,000 MWh for solar electric

Carryover Provisions:
Prior to 10/1/2007: Excess credit may be carried forward five years
After 10/1/2007: Excess credit is refunded to the taxpayer

Eligible System Size: Minimum of 1 MW capacity per facility

Equipment Installation Requirements: System must be new and in compliance with all applicable performance and safety standards; generators must be certified by the New Mexico Energy, Minerals, and Natural Resources Department (EMNRD).

Website: http://www.cleanenergynm.org

Tax Incentive - Solar Thermal Electric Tax Credit

Eligible Technologies: Solar Thermal Electric

Amount: 6% credit against gross receipts, compensating, or withholding taxes

Maximum Incentive: $60 million

Carryover Provisions: Five years

Project Review/Certification: Projects must obtain a certificate of eligibility from the Environment Department

As of July 2007, the development and construction costs of solar thermal electric plants and associated energy storage devices are eligible for a 6% tax credit. The credit may be claimed against New Mexico gross receipts, compensating, or withholding taxes and can be carried forward for up to five years. The tax credit amount is capped at $60 million.

Production Incentive – Green Tag Purchase Program

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind, Biomass, Geothermal Electric, Small Hydroelectric, Renewable Fuels

Amount: $1 to $100 per MWh total production; varies by technology and contract length

Terms: Any size system, grid tied, new renewable (January 1, 1999, or later)

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Mandatory Utility Green Power Option

On December 17, 2002, the NMPRC unanimously approved an expansive new renewable energy rule. The rule requires investor-owned utilities and electric cooperatives to offer a voluntary renewable energy tariff (green-pricing program) for those customers who want the option to purchase additional renewable energy. The exception is for cooperatives — they need offer this option only to the extent that their suppliers, under their all-requirements contracts, make such renewable resources available. These utilities must also develop an educational program to communicate the benefits and availability of its voluntary renewable energy program. The rule also requires public utility companies to produce 5% of all energy they generate for New Mexico customers from solar, wind, hydropower, biomass, or geothermal sources by 2006. Generation from renewables must increase by at least 1% per year until the RPS of 10% is attained in the year 2011.

Net Metering

On September 30, 1999, the NMPRC issued a rule requiring all utilities regulated by the PRC (investor-owned and cooperatives) to offer net metering for cogeneration facilities and small power producers with systems of 10 kW or less. Municipal utilities are exempt because they are not regulated by the PRC. There is no statewide cap on the number of systems eligible for net metering.

New York

Renewables Portfolio Standard

Eligible Technologies: Photovoltaics and Wind

Applicable Sectors: Investor-owned Utility

Standard: 24% by 2013

Technology Minimum: 2% of total incremental RPS requirement is set-aside for the Customer-Sited Tier, for a total of 0.1542% of customer-sited generation

Website: http://www.dps.state.ny.us/03e0188.htm

The New York Public Service Commission (PSC) adopted a RPS in September 2004 and issued implementation rules in April 2005. New York's RPS has a target of 25% by 2013. Of this, approximately 19.3% of the target will be derived from existing (2004)

renewable energy facilities and 1% of the target is expected to be met through voluntary green power sales. The remainder will derive from new, eligible resources centrally procured by the New York State Energy Research and Development Authority (NYSERDA). NYSERDA manages an RPS fund gathered through a surcharge on each kilowatt-hour sold by the state's investor-owned utilities. The RPS surcharge is separate from and in addition to the state system benefits charge (SBC). Customers exempt from contributing to the SBC are also exempt from the RPS charge. Municipal utilities, the New York Power Authority and the Long Island Power Authority do not fall under the jurisdiction of this program, but have been encouraged by the PSC to adopt similar programs.

Tax Incentive – Solar, Wind & Biomass Energy Systems Exemption (property tax exemption)

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind

Terms: 15-year exemption

Website:
http://www.orps.state.ny.us/assessor/manuals/vol4/part1/section4.01/sec487.htm

Production Incentive – Green Tag Purchase Program

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind, Biomass, Geothermal Electric, Small Hydroelectric, Renewable Fuels

Amount: $1 to $100 per MWh total production; varies by technology and contract length

Terms: Any size system, grid tied, new renewable (January 1, 1999, or later)

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The amount of the payments depends on the type of renewable energy technology, the production of electricity by that system, and the length of the contract period. Mainstay offers three-, five-, and ten-year purchase contracts. The longer the contract period, the greater the incentive payment on a $/kWh basis. Payments are made quarterly.

Generation Disclosure

On December 15, 1998, the New York PSC issued an order requiring electric suppliers to provide information to customers regarding the environmental impacts of electricity products. The order requires suppliers to disclose fuel mix (biomass, coal, natural gas, oil, hydro, nuclear, solar, solid waste, and wind) compared to a statewide average, as well as the quantities of emissions of sulfur dioxide, nitrogen oxides, and carbon dioxide. This information must be disclosed in a standardized label twice annually. All investor-owned electric utilities and energy services companies (ESCOs) providing retail electricity, as

well as those municipal or cooperative electric utilities subject to commission jurisdiction, are required to provide the environmental disclosure label.

Green Power Purchasing

New York state buildings and vehicles (including those of quasi-independent agencies like the State University of New York and the Metropolitan Transportation Authority) using solar thermal electric, PV, landfill gas, wind, biomass, geothermal electric, fuel cells, other methane waste, and tidal energy.

Net Metering

Eligible Technologies: PV, Wind, Biomass

Limit on System Size: 10 kW (solar); 400 kW (farm-waste electric-generating equipment); 25 kW (residential wind); 125 kW (farm-based wind)

Limit on Overall Enrollment: 0.1% of 1996 demand per IOU (solar); 0.4% of demand per IOU (farm systems)

Treatment of Net Excess: Credited monthly at avoided cost, except for residential wind generation, which is credited monthly at retail rate. Accounts reconciled annually at avoided cost.

Utilities Involved: All utilities

Website: http://www.dps.state.ny.us/distgen.htm

Wind Law Expiration Date: December 31, 2008

Systems Benefits Charge

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind

Applicable Sectors: General Public/Consumer

Types: Energy efficiency, R&D (includes renewables), low-income programs

Total Fund: Eight-year budget is $210.8 million for R&D (includes renewables)

Charge: $0.6 million/kWh

Website: http://www.nyserda.org/rddopps.html

Nevada

Renewables Portfolio Standard

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind

Applicable Sectors: Investor-Owned Utility

Standard: 6% in 2005, rising to 20% by 2015

Technology Minimum: 5% of the energy portfolio must be solar

Credit Trading: Yes

Website: http://pucweb1.state.nv.us/PUCN/RenewableEnergy.aspx

Nevada enacted a renewable portfolio standard (RPS) as part of its 1997 restructuring legislation. Under the standard, the state's two investor-owned utilities—Nevada Power and Sierra Pacific Power—must use eligible renewable energy resources to supply a minimum percentage of the total electricity they sell. In 2001, the legislature revised the minimum amounts to increase by 2% every two years, culminating in a 15% requirement by 2013. In Assembly Bill (AB) 3 of the 2005 special session (http://leg.state.nv.us/22ndSpecial/bills/AB/AB3_EN.pdf), the portfolio requirement was further revised to increase by 3% every two years, to achieve 20% of retail sales by 2015. The 2005 revisions included a significant change allowing utilities to meet the standard through renewable energy generation (or credits) *and* energy savings from efficiency measures. At least 5% of the standard must be generated, acquired, or saved from solar energy systems.

Production Incentives—Green Tag Purchase Program

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind, Biomass, Geothermal Electric, Small Hydroelectric, Renewable Fuels

Amount: $1 to $100 per MWh total production; varies by technology and contract length

Terms: Any size system, grid tied, new renewable (January 1, 1999, or later)

Website: http://www.mainstayenergy.com/

Mainstay Energy is a private company offering customers who install, or have installed, renewable energy systems the opportunity to sell the green tag RECs associated with the energy generated by these systems. These green tags will be brought to market as Green-e* (http://www.green-e.org/) certified products. Through the Mainstay Energy Rewards Program), participating customers receive regular, recurring payments.

The amount of the payments depends on the type of renewable energy technology, the production of electricity by that system, and the length of the contract period. Mainstay offers three-, five-, and ten-year purchase contracts. The longer the contract period, the greater the incentive payment on a $/kWh basis. Payments are made quarterly.

Renewable Energy Credits

Nevada's Renewable Energy Portfolio Standard requires the state's two investor-owned utilities to derive a minimum percentage of the electricity they sell from renewable energy resources. Included in the standard is a REC program. The PUC is in the process of drafting the permanent regulations for RECs. Starting January 1, 2003, Nevada's renewable energy producers can earn RECs, which can then be sold to utilities that are required to meet Nevada's portfolio standard.

One REC will represent a kilowatt-hour of electricity generated from a renewable energy system, with the exception of PV, which counts as 2.4 kWh per AB 296 of 2003. The value of a REC is market-driven. RECs are issued by Nevada’s PUC and are valid for five years.

Renewable energy is defined as biomass, geothermal energy, solar energy, wind, and waterpower. Solar energy includes any displacement of fossil energy use and could include solar daylighting, solar water heating, etc. Enacted by SB 227 on June 1, 2001, this statute allows certain new or expanded businesses a 50% property tax exemption for real and personal property used to generate electricity from renewable energy. The exemption may be taken over a ten-year period by a business that uses renewable energy as its primary source of energy and that has a generating capacity of at least 10 kW. Renewable energy includes biomass, solar, and wind.

Renewable Energy Systems Exemption

This statute states that any value added by a qualified renewable energy source shall be subtracted from the assessed value of any residential, commercial, or industrial building for property tax purposes. Qualified equipment includes solar, wind, geothermal, solid waste, and hydro. This exemption applies for all years following installation.

Renewable Energy/Solar Sales Tax Exemption

The sales/use tax rate for any sales, storage, consumption, or use of products or systems designed or adapted to use renewable energy to generate electricity and all of its integral components is 2% in all counties for those purchases made from January 1, 2002, through June 30, 2005.

Renewable energy means a source of energy that occurs naturally or is regenerated naturally, including without limitation: biomass, fuel cells, geothermal energy, solar energy, waterpower, and wind. Biomass includes: agricultural crops, wastes, and residues; wood, wood wastes, and residues; animal wastes; municipal wastes; and aquatic plants. SB 489 of 2003 extended this exemption to solar water heating and solar lighting systems, as well as extending the expiration date to July 1, 2005. Systems designed or adapted to use renewable energy to generate electricity means a system of related components from which at least 75% of the electricity generated is produced from one or more sources of renewable energy and that is designed to work as an integral package such that the system is not complete without one of its related components.

Generation Disclosure

Beginning January 2002, each electric utility must disclose certain information to its customers, according to regulations established by the Nevada PUC. The disclosure must be in a standard format, provided in bill inserts twice a year, as well as on utility web sites. The disclosure must include the average mix of fuel sources used to create electricity, average emissions, customer service information, and information on low-income energy programs.

Net Metering

In 1997, Nevada enacted a law allowing investor-owned utility customers who generate up to 10 kW of solar or wind power to net meter. In 2001, AB 661 removed the limit on the amount of energy a utility can receive through net metering. In 2003, AB 429

increased the limit on system size from 10 kW to 30 kW and added waterpower (restricted to certain types) to the definition of renewable energy, which already includes biomass, geothermal energy, solar energy, and wind.

Also in 2003, per AB 296, in complying with a portfolio standard, each 1 kWh of electricity generated from PV counts as 2.4 kWh, if the electricity is generated on the premises of a retail customer who uses at least 50% of the electricity.

Customer generators are billed monthly except in situations in which the customer and the utility agree on annual billing. Net excess generation is credited to the utility and is considered renewable energy that the utility has generated to fulfill its renewable energy portfolio. Utilities are required to supply a two-way meter to measure flow in both directions, and utilities are prohibited from adding any additional charges to the bills of those customers participating in net metering. Furthermore, utilities cannot place any additional standards or requirements on customer generators beyond those requirements established by the National Electric Code (NEC), Underwriters Laboratories (UL), and the Institute of Electrical and Electronic Engineers (IEEE).

North Dakota

Production Incentive – Green Tag Purchase Program

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind, Biomass, Geothermal Electric, Small Hydroelectric, Renewable Fuels

Amount: $1 to $100 per MWh total production; varies by technology and contract length

Website: http://www.mainstayenergy.com/

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The amount of the payments depends on the type of renewable energy technology, the production of electricity by that system, and the length of the contract period. Mainstay offers three-, five-, and ten-year purchase contracts. The longer the contract period, the greater the incentive payment on a $/kWh basis. Payments are made quarterly.

Large Wind Property Tax Reduction

North Dakota modified its property tax incentives for large wind systems with its 2001 bill that reduces property taxes by 70% for wind facilities of 100 kW or larger. To be eligible, construction must begin by January 1, 2011. The state also has a sales tax exemption for these systems.

Geothermal, Solar, and Wind Property Tax Exemption

North Dakota exempts from local property taxes any solar, wind, or geothermal energy device. Qualifying systems can be stand alone or part of a conventional system, but in the case where the solar, wind, or geothermal system is part of a conventional energy system, only the renewable energy portion of the total system is eligible. This exemption is applied only during the five-year period following installation. To apply for this exemption, system owners must contact their local tax assessor or their county director of tax equalization.

Large Wind Sales Tax Exemption

North Dakota's large wind sales tax exemption applies to the owner of a wind-powered electrical generating facility that has at least one single electrical energy generation unit with a nameplate capacity of 100 kW or more. The exemption will apply to building materials, production equipment, and other tangible personal property used in the construction of the facility. The exemption applies to any sales or use tax that would be due in the construction of the facility between July 2001 and January 2011.

Net Metering

Passed in 1991 by the North Dakota PUC, this net-metering ruling applies to both renewable energy generators and cogenerators up to 100 kW in capacity. Net metering is available to all customer classes, and there is no statewide limit to the capacity signed up for net metering. When customers have excess generation in a monthly billing period, utilities must purchase net excess generation at the avoided cost.

Production Incentive – Green Tag Purchase Program

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind, Biomass, Geothermal Electric, Small Hydroelectric, Renewable Fuels

Amount: $1 to $100 per MWh total production; varies by technology and contract length

Terms: Any size system, grid tied, new renewable (January 1, 1999, or later)

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The amount of the payments depends on the type of renewable energy technology, the production of electricity by that system, and the length of the contract period. Mainstay offers three-, five-, and ten-year purchase contracts. The longer the contract period, the greater the incentive payment on a $/kWh basis. Payments are made quarterly.

Ohio

Production Incentive – ODOD – Wind Production & Manufacturing Incentive Program

Eligible Technologies - Wind

Amount: $0.01/kWh; $0.012/kWh for "Ohio-manufactured" turbines (February 2007 solicitation)

Maximum Incentive: Not specified

Website: http://www.odod.state.oh.us/cdd/oee/GrantsLoans.htm

The Ohio Wind Production & Manufacturing Incentive Program provides production-based incentives to support new Ohio wind-energy projects. The most recent solicitation, issued in February 2007, was open to utility-scale wind-energy projects (more than five megawatts) and to community wind-energy projects (500 kW to 5 MWs). The program is funded by the state's public benefits fund, the Ohio Advanced Energy Fund (also known as the Energy Loan Fund (ELF).

Tax Incentive - Energy Conversion Facilities Property Tax Exemption

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind

Amount: 100% Exemption

Maximum Incentive: None

Terms: All years upon certification

Website: http://www.odod.state.oh.us/cdd/oee/c_i_cfe.htm

Ohio exempts certain property from real and personal property taxation, the state's sales and use tax, and the state's corporate franchise tax where applicable. The exemption applies to property used in energy conversion, thermal-efficiency improvements and the conversion of solid waste to energy. Generally, “energy conversion” refers to the replacement of fossil-fuel resources with alternative fuels or technologies; “thermal efficiency improvements” refers to the recovery of waste heat or steam produced in any commercial or industrial processes; and “solid waste conversion” refers to the use of waste to produce energy and the utilization of such energy. Eligible technologies include solar-thermal systems, photovoltaic systems, wind, biomass, landfill gas, and waste-recovery systems

Tax Incentive - Energy Conversion Facilities Sales Tax Exemption

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind

Amount: 100% Exemption

Maximum Limit: None

Website: http://www.odod.state.oh.us/cdd/oee/c_i_cfe.htm

Ohio exempts certain property from real and personal property taxation, the state's sales and use tax, and the state's corporate franchise tax where applicable. The exemption applies to property used in energy conversion, thermal-efficiency improvements and the

conversion of solid waste to energy. Generally, "energy conversion" refers to the replacement of fossil-fuel resources with alternative fuels or technologies; "thermal efficiency improvements" refers to the recovery of waste heat or steam produced in any commercial or industrial processes; and "solid waste conversion" refers to the use of waste to produce energy and the utilization of such energy. Eligible technologies include solar-thermal systems, photovoltaic systems, wind, biomass, landfill, gas and waste-recovery systems.

Oklahoma

Tax Incentive - Zero-Emission Facilities Production Tax Credit

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind

Amount: $0.0025/kWh - $0.0075/kWh for 10 years; amount varies depending on when the facility is placed in operation and when electricity is generated.

Maximum Incentive: Not specified

Carryover Provisions: Excess credit may be carried forward up to ten years.

Eligible System Size: Facility must have a rated production capacity of 1 MW or greater.

Equipment Installation Requirements: Facility construction and operation must not result in the creation of pollution or emissions harmful to the environment, pursuant to determination by the DEQ.

For tax years beginning on or after January 1, 2003, a state income tax credit is available to producers of electric power using renewable energy resources from a zero-emission facility located in Oklahoma. The zero-emission facility must have a rated production capacity of one 1 MW or greater. (The initial legislation required a 50 MW minimum capacity, but a revision in 2006 (HB 1174) reduced the minimum to 1 MW.) The facility must be placed in operation after June 4, 2001, and the electricity must be sold to an unrelated party.

Facilities placed in service on or after January 1, 2007 and before January 1, 2016: For electricity generated by these zero-emission facilities, the amount of the credit is $0.0050/kWh.

Oregon

Business Energy Tax Credit

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind

Amount: 35% of project costs

Max. Limit: $10 million per project

Terms: Distributed over five years; eight-year carry forward

Website: http://www.energy.state.or.us/bus/tax/taxcdt.htm

Renewable Energy Grant

Using revenues generated from the sales of Green Tags, Bonneville Environmental Foundation (BEF), a not-for-profit organization, accepts proposals for funding for renewable energy projects located in the Pacific Northwest (Oregon, Washington, Idaho, Montana). Any private person, organization, local or tribal government located in the Pacific Northwest may participate. Projects that generate electricity are preferred. Acceptable projects include solar PV, solar thermal electric, solar hot water, wind, hydro, biomass, and animal waste-to-energy.

BEF may deliver funding through various means, including grants, loans, convertible loans, guarantees, and direct investments in renewable energy projects. BEF renewable-energy grants and investments may range from a few thousand dollars for small installations, to significant investments in central station grid-connected renewable energy projects. If a BEF grant is requested for a generating project, the BEF share will not exceed 33% of total capital costs and 0% of operating costs.

Solar Starters

BEF and the Northwest Solar Cooperative have joined together to help reduce the costs of small residential and commercial photovoltaic systems in parts of Oregon and Washington; systems up to 5 kW are approved automatically; larger sizes may be acceptable. The Northwest Solar Cooperative will sign five-year agreements with the owners of new photovoltaic systems and will pay them an annual amount equivalent to 10¢/kWh for the environmental attributes—or green tags—produced by the solar systems. System owners will be paid annually. BEF will then purchase the green tags from the Northwest Solar Cooperative and sell them to its wholesale customers and on its web site (https://www.greentagsusa.org/GreenTags/index.cfm). The first phase of the project is projected to include 30 to 50 small photovoltaic systems. There are 36 participants in the program.

Green Tag Purchase Program

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind, Biomass, Geothermal Electric, Small Hydroelectric, Renewable Fuels

Amount: $1 to $100 per MWh total production; varies by technology and contract length

Terms: Any size system, grid tied, new renewable (January 1, 1999, or later)

Website: http://www.mainstayenergy.com/

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The amount of the payments depends on the type of renewable energy technology, the production of electricity by that system, and the length of the contract period. Mainstay offers three-, five-, and ten-year purchase contracts. The longer the contract period, the greater the incentive payment on a $/kWh basis. Payments are made quarterly.

New Renewable Energy Resources Grants

This program is designed to support renewable energy projects that do not already have an established incentive program developed and launched by the Energy Trust of Oregon. They expect to reserve 10% of the Renewable Energy program budget, which is about $1 million annually, for open solicitation incentives. Projects will generally be awarded in the areas of small wind, solar PV, biomass, biogas, small hydro, and geothermal electric.

Eligible Technologies: Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Photovoltaics, Wind, Biomass, Hydroelectric, Renewable Transportation Fuels, Geothermal Electric, Municipal Solid Waste, Cogeneration, Waste Heat Recovery

Applicable Sectors: Commercial, Industrial, Residential, Nonprofit, Schools, Local Government, State Government, Tribal Government, Rural Electric Cooperative

Amount: Typically $20,000 to $20 million

Max. Limit: None

Terms: Repayment to match term of bonds

Website: http://www.energy.state.or.us/loan/selphme.htm

Generation Disclosure

Under Oregon's 1999 electric utility restructuring legislation, electricity suppliers are required to disclose their fuel mix and emissions. Beginning March 1, 2002, disclosure must be supplied using a format prescribed by the Oregon PUC. Power source and environmental impact information must be provided to all residential consumers at least quarterly.

Green Power Purchasing

Portland: municipal buildings using PV, wind, biomass, geothermal electric, and anaerobic digestion

Net Metering

Oregon's net metering law, HB 3219 of July 1999, allows net metering for customers with solar, wind, or hydropower systems up to 25 kW. All customer classes are eligible, but enrollment is limited to a total installed capacity of 0.5% of a utility's historic single-hour peak load. Above this installed capacity, net-metering eligibility can be limited by regulatory authority. Net excess generation is either purchased at avoided cost or credited to the customer's next monthly bill. At the end of an annual period, any unused credit is granted to the electric utility. This credit is then either granted to customers enrolled in the utility's low-income assistance programs, credited to the generating customer, or "dedicated to other use."

In 1996, the City of Ashland enacted a net-metering law establishing a simple grid interconnection policy. It encourages the adoption of solar energy systems by allowing net metering and committing the city to purchase, at full retail price, up to 1,000 kWhs of excess electricity per month from small wind or solar energy systems.

Eligible Technologies: Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Photovoltaics, Wind, Biomass, Hydroelectric, Geothermal Electric, Direct-Use Geothermal Energy, Fuel Cells (Renewable Fuels)

Types: Renewables, Efficiency, Low Income, Schools

Total Fund: $10 million for renewables/year

Charge: 3% paid by certain electricity users

PGE and PacifiCorp Customers

The Oregon Public Utilities Commission (PUC) adopted new rules for net metering for PGE and PacifiCorp customers in July 2007, raising the individual system limit from 25 kW to two MW for nonresidential applications. (The rules do not apply to customers of Idaho Power, which provides net metering to Oregon customers pursuant to rules adopted by the Idaho Public Utilities Commission.) The limit on individual residential systems is 25 kW. Systems that generate electricity using solar power, wind power, hydropower, fuel cells or biomass resources are eligible. Net-metered systems must be intended primarily to offset part or all of a customer's requirements for electricity. Utilities may not limit the aggregate capacity of net-metered systems.

Net excess generation (NEG) is carried over to the customer's next bill as a kilowatt-hour credit for a 12-month period. Unless a utility and a customer otherwise agree, the annual billing cycle will conclude at the end of the March billing cycle of each year. Any NEG remaining at the end of a 12-month period will be credited at the utility's avoided-cost rate to customers enrolled in Oregon's low-income assistance programs. Customers retain ownership of all ECs associated with the generation of electricity.

The aggregation of meters for net metering is permitted. There is no limit on the number of net-metering facilities per customer as long as the net-metering facilities in aggregate on a customer's contiguous property do not exceed the applicable capacity limit.

Customers of Municipal Utilities, Cooperatives and People's Utility Districts

Oregon's municipal utilities, electric cooperatives and people's utility districts must offer customers net metering pursuant to OR Revised Statutes 757.300. Systems that generate electricity using solar power, wind power, hydropower, fuel cells or biomass resources are eligible. Net-metered systems must be intended primarily to offset part or all of a customer's requirements for electricity. The aggregated capacity of all net-metered systems is limited to 0.5% of a utility's historic single-hour peak load.

NEG is either purchased at the utility's avoided-cost rate or credited to the customer's next monthly bill as a kilowatt-hour credit. At the end of an annual period, any unused NEG credit is granted to the electric utility. This credit, in turn, is then either granted to customers enrolled in the utility's low-income assistance programs, credited to the generating customer or dedicated to an "other use."

Net metering is achieved using a standard bi-directional meter. Utilities may not place any additional standards or requirements on customers beyond those requirements established by the NEC, National Electrical Safety Code (NESC), IEEE, and UL.

However, utilities may be authorized to assess a fee or charge if the utility's direct costs of interconnection and administration of net metering outweigh the distribution system, environmental and public-policy benefits of allocating costs among its customers.

Pennsylvania

Renewable Portfolio Standard (Alternative Energy Portfolio Standard)

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind

Applicable Sectors: Utility

Standard: 18% during compliance year 2020-2021 (8% Tier I and 10% Tier II)

Technology Minimum: Solar PV set-aside of 0.5% for June 1, 2020 and thereafter

Credit Trading: Yes

Website: http://www.puc.state.pa.us/electric/electric_alt_energy.aspx

Pennsylvania's Alternative Energy Portfolio Standard (AEPS) (SB 1030) (http://www2.legis.state.pa.us/WU01/LI/BI/BT/2003/0/SB1030P1973.pdf), enacted November 30, 2004, requires each electric distribution company and electric generation supplier to retail electric customers in Pennsylvania to supply 18% of its electricity using alternative-energy resources by 2020.* Pennsylvania's standard provides for a solar set-aside, mandating a certain percentage of electricity generated by PV. Pennsylvania's AEPS also includes demand-side management, waste coal, coal-mine methane and coal gasification as eligible technologies.

The law established two categories of energy sources. The standard calls for utilities to generate 8% of their electricity by using "Tier I" energy sources and 10% using "Tier II" sources by May 31, 2021. Eligible resources may originate within Pennsylvania or within the PJM regional transmission organization (RTO).

Financial Incentive – Public Benefits Fund

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind

Total Fund: Varies by fund

Charge: Varies by utility territory

Website: http://www.puc.state.pa.us/electric/electric_renew_sus_energy.aspx

* Pennsylvania's rural electric cooperatives must offer retail customers a voluntary program of energy efficiency and demand-side management programs to satisfy compliance with the AEPS.

Although Pennsylvania's December 1996 electricity restructuring law did not establish a clean-energy fund, four renewable and sustainable-energy funding programs were subsequently created through individual settlements with the state's five major distribution utilities: Metropolitan Edison Company (Met-Ed), Pennsylvania Electric Company (Penelec), PECO Energy (PECO), PP&L (PPL), and Allegheny Power/West Penn Power Company (WPP). These utilities created individual "Sustainable Energy Funds" with the goals of promoting (1) the development and use of renewable energy and

advanced clean-energy technologies, (2) energy conservation and efficiency, and (3) sustainable-energy businesses. Each utility has established an oversight board and designated a fund administrator.

The four Sustainable Energy Funds (SEF) in Pennsylvania are:

- The Metropolitan Edison Region SEF (http://www.bccf.org/pages/gr.energy.html), is administered by the Berks County Community Foundation. This is a companion fund to the Penelec Region SEF (http://www.bccf.org/pages/gr.energy.html), administered by the Community Foundation for the Alleghenies.
- The Sustainable Development Fund (http://www.trfund.com/sdf/), in Southeastern Pennsylvania PECO's service territory, is administered by The Reinvestment Fund.
- The West Penn Power SEF (http://www.wppsef.org/) is administered by The Energy Institute of Penn State University, in partnership with Energetics, Inc.
- The Sustainable Energy Fund of Central Eastern Pennsylvania (http://www.thesef.orge territory, is administered by a nonprofit organization.

Under terms of the settlements, approximately $55 million was collected through the utilities' distribution rates to promote the development of sustainable and renewable energy. The Sustainable Development Fund (in PECO's territory) received an additional $18.5 million in funding over a five-year period as a result of the PECO/Unicom merger. Likewise, the Met-Ed and Penelec funds will receive an additional $5 million ($2.5 million each) in funding due to the merger of GPU Energy and FirstEnergy. The PUC agreed to continue funding the PPL SEF though December 31, 2006. The per-kilowatt-hour surcharge included in the utility's distribution rates for 2005 and 2006 was $0.0001 and $0.00005 per kilowatt-hour, respectively.

Tax Incentive – Wind-Energy System Exemption

Eligible Technologies: Wind

Amount: 100% of system value

Maximum Incentive: None

Pennsylvania enacted legislation in November 2006 providing that wind turbines and related equipment (including towers and foundations) may not be counted by tax assessors when setting property values. However, the law states that the valuation of real property used for the purpose of wind-energy generation "shall be developed by the county assessor utilizing the income capitalization approach to value." This valuation is determined by the capitalized value of the land-lease agreements, supplemented by a sales comparison data approach as deemed necessary by county assessors. Lessees or lessors must provide relevant, nonproprietary lease and lease-income information to county assessors by September 1 of each year. Local tax information available from the Pennsylvania Department of Community and Economic Development.

Loan Programs - Pennsylvania Energy Development Authority (PEDA) – Loans and Loan Guarantees

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind

Amount: Varies

Maximum Amount: Loans: $1 million; Loan guarantees: $500,000

Website: http://www.depweb.state.pa.us/enintech/cwp/view.asp?a=1415&q=504241

The Pennsylvania Energy Development Authority (PEDA) issues funding solicitations to support advanced energy research and deployment projects, and to assist businesses interested in locating or expanding advanced energy operations in Pennsylvania. This program offers a combination of grants, loans and loan guarantees to support in-state projects, manufacturing or research involving solar energy; wind; low-impact hydropower; geothermal; biologically-derived methane gas, including landfill gas; biomass; fuel cells; coal-mine methane; waste coal; integrated gasification combined cycle, and; demand management measures, including recycled energy and energy recovery, energy efficiency and load management.

Grant/Loan Programs in Pennsylvania

There are numerous grant or loan programs for solar thermal electric, PV, and wind offered by Pennsylvania utilities or foundations. They typically vary in amounts from $25,000 (local grant programs) to $500,000 (local loan programs). Recommend reviewing DSIRE website for current grant or loan offerings.

South Dakota

Tax Incentive Renewable Energy Systems Exemption

Eligible Technologies: Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Geothermal Electric, Ethanol

Amount: 50% commercial; 100% residential

Terms: Three years

This statute exempts from local property taxes renewable energy systems on residential and commercial property. For residential systems, the exemption applies to the entire assessed value of residential systems and can be transferred when the property is sold. For commercial systems, the exemption applies to 50% of the installed cost of commercial systems, and cannot be transferred when the property is sold. The exemption may be claimed for three years after installation. After three years, the property owner can claim a portion of the exemption for three subsequent years according to the following schedule:

- Year 1: 75% of the exemption
- Year 2: 50% of the exemption
- Year 3: 25% of the exemption.

The property tax exemption is adjusted to include any federal renewable energy income tax credit which may be available at the time the owner applies for the exemption. This

exemption is not allowed for systems which produce energy for resale. For additional information or to apply for the exemption, contact the Director of Equalization for your county.

Wind Energy Property Tax Exemption

This wind energy property tax exemption bill requires that all commercial wind-power production facilities, regardless of ownership, now be assessed at the local level. Previously, some facilities were centrally assessed for tax purposes at the state level. The assessment is for the base, foundation, tower, and substations, which are considered real property. It doesn't include the generator and turbine blades, which are considered personal property.

Tennessee

Production IncentiveTVA – Green Power Switch Generation Partners Program

Eligible Technologies: Photovoltaics, Wind

Amount: $500 (residential only) plus $0.15 per kWh for ten years (residential and commercial)

Terms: $500 payment available until the program capacity reaches 150 kW

Website: http://www.gpsgenpartners.com

TVA and participating power distributors currently offer a dual-metering option to residential and small-commercial consumers (non-demand-metered) through the Green Power Switch Generation Partners program. The output (green power) generated from this program will be counted as a TVA Green Power Switch resource. Through this program, TVA will purchase the entire output of a qualifying system at $0.15 per kWh through a participating power distributor, and the consumer will receive a credit for the power generated. Participation in this program is entirely up to the discretion of the power distributor. As of June 2004, about a dozen distributors have signed up for the program. Thus far, the program includes several residential solar participants and one 20-kW wind project.

Tennessee House Bill 809, passed in June 2003, states that wind-energy systems operated by public utilities, businesses, or industrial facilities, shall not be taxed at more than one-third of their total installed cost. This law applies to the initial appraisal and subsequent appraisals of wind-energy systems.

Tax Incentive - Wind Energy Systems Exemption

Amount: 67% exemption

Maximum Limit: None

Website: http://www.state.tn.us/sos/acts/103/pub/pc0377.pdf

Tennessee House Bill 809, enacted into law in Public Chapter 377, Acts of 2003 and codifed under Title 67, Chapter 5, states that wind energy systems operated by public

utilities, businesses or industrial facilities shall not be taxed at more than one-third of their total installed cost. This law applies to the initial appraisal and subsequent appraisals of wind energy systems.

Texas

Renewables Portfolio Standard (Renewable Generation Requirement)

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind, Biomass, Geothermal Electric, Small Hydroelectric, Renewable Fuels

Applicable Sectors: Municipal Utility, Investor-Owned Utility, Rural Electric Cooperative, Retail Supplier

Standard: 2,280 MW by 1/1/2007, increasing to 5,880 MW by 1/1/2015

Technology Minimum: Target of at least 500 MW from renewables other than wind.

Credit Trading: Yes

Website: http://www.puc.state.tx.us/rules/subrules/electric/25.173/25.173ei.cfm

In 1999 the Public Utility Commission of Texas (PUCT) adopted rules for the state's Renewable Energy Mandate, establishing a RPS, a REC trading program, and renewable-energy purchase requirements for competitive retailers in Texas. The 1999 standard called for 2,000 MW of new renewables to be installed in Texas by 2009, in addition to the 880 MW of existing renewables generation at the time. In August 2005, Senate Bill 20 increased the renewable-energy mandate to 5,880 MW by 2015 (about 5% of the state's electricity demand), including a target of 500 MW of renewable-energy capacity from resources other than wind. Wind accounts for nearly all of the current renewable-energy generation in Texas. The 2005 legislation also set a target of reaching 10,000 MW in renewable energy capacity by 2025.

Austin Energy: has its own renewables portfolio standard.

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Tidal Energy, Wave Energy

Standard: 5% by 12/31/2004; 30% by 1/1/2020.

Technology Minimum: At least 100 MW from Solar by 2020

Website:
http://www.austinenergy.com/Energy%20Efficiency/Programs/Green%20Choice/index.htm

San Antonio City Public Service: has established its own Renewables Portfolio Goal

Eligible Technologies: Wind

Standard: 15% by 2020

Website: http://www.citypublicservice.com/content_listInternet.asp?cont_id=8477&elmt_id=12

Hansford County Tax Abatement

On November 12, 2002, the Hansford County, Texas Commissioners created a tax abatement agreement with Great Plains Windpower, L.L.C. The agreement authorized tax abatements (an exemption from ad valorem taxes on property) in a Reinvestment Zone located in Hansford County.

Improvements eligible for Abatement under the agreement include real property and personal property comprising the wind-energy facilities within the Reinvestment Zones, including:

- Wind-turbine generators
- Electric substations and related components
- Power collection system, electric cable, and electric power transmission lines, foundations and support structures
- Communication and other wiring and lines
- Wind measurement towers
- Roads and fences
- Spare parts and equipment
- Other physical assets and improvements.

The Abatement amount is 95% in the first through third years. In the fourth and fifth years the abatement is 90%. In the sixth and seventh years, the abatement is 70%. No abatement will be provided starting with the eighth year.

Production Incentive – Green Tag Purchase Program

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind, Biomass, Geothermal Electric, Small Hydroelectric, Renewable Fuels

Amount: $1 to $100 per MWh total production; varies by technology and contract length

Terms: Any size system, grid tied, new renewable (January 1, 1999, or later)

Website: http://www.mainstayenergy.com

Mainstay Energy is a private company offering customers who install, or have installed, renewable energy systems the opportunity to sell the green tag RECs associated with the energy generated by these systems. These green tags will be brought to market as Green-e* (http://www.green-e.org/ certified products. Through the Mainstay Energy Rewards Program, participating customers receive regular, recurring payments.

The amount of the payments depends on the type of renewable energy technology, the production of electricity by that system, and the length of the contract period.

Generation Disclosure

As part of its 1999 electric utility restructuring legislation, Texas retail electric providers (REP) are required to disclose certain information to customers on an Electricity Facts Label. Beginning July 1, 2002, REPs must provide the standardized format Electricity Facts Label to customers upon their request. The label must include electricity prices,

contract terms, sources of generation, and emissions levels. This information can help customers choose who they want to provide their electric service.

Net Metering

Texas's net-metering rule (i.e., arrangements Between Qualifying Facilities and Electric Utilities § 25.242[h][4]) was established by the Texas PUC to promote small wind power and photovoltaic generation in the state. The order requires certain utilities to offer a net-metering option to qualified facilities of 50 kW or less that use renewable resources. The rule applies to all Texas price-to-beat retail electric providers (PTB REPs), transmission and distribution utilities (TDUs), and integrated investor-owned utilities that have not unbundled in accordance with Public Utility Regulatory Act § 39.051.

This rule does not apply to municipal utilities, river authorities, or electric cooperatives. For customers of qualifying utilities, the utility must install a single meter that can read electric flow in both directions. There is no statewide limit on the number of customers or total capacity under the net metering program. Net consumption is billed at the applicable tariff and excess generation by the customers during a billing cycle is purchased by utilities at rates not to exceed the avoided cost (fuel cost only, no capacity component). San Antonio and Austin have their own net metering rules.

Utah

Production Incentive – Green Tag Purchase Program

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind, Biomass, Geothermal Electric, Small Hydroelectric, Renewable Fuels

Amount: $1 to $100 per MWh total production; varies by technology and contract length

Terms: Any size system, grid tied, new renewable (January 1, 1999, or later)

Website: http://www.mainstayenergy.com

Mainstay Energy is a private company offering customers who install, or have installed, renewable energy systems the opportunity to sell the green-tag RECs associated with the energy generated by these systems. These green tags will be brought to market as Green-e* (http://www.green-e.org) certified products. Through the Mainstay Energy Rewards Program, participating customers receive regular, recurring payments.
The amount of the payments depends on the type of renewable energy technology, the production of electricity by that system, and the length of the contract period. Mainstay offers 3-, 5-, and 10-year purchase contracts. The longer the contract period, the greater the incentive payment on a $/kWh basis. Payments are made quarterly.

Green Power Purchasing

Salt Lake City – local government buildings using wind

Net Metering

On March 15, 2002, Governor Leavitt signed into law House Bill 7, Net Metering of Electricity. This law requires all electric utilities and cooperatives in Utah (municipal

utilities are excluded) to allow customers to connect renewable energy systems to the grid for their own use and to supply excess electricity to the electric grid. Eligible renewable energy systems include fuel cells, solar, wind, or small hydropower facilities with a generating capacity of up to 25 kW. Total participation in the program is capped at 0.1% of the cumulative generating capacity of the electrical corporation's peak demand during 2001.

Utilities are required to give the customer a credit for electricity generated that exceeds the amount supplied. If net metering results in excess customer-generated electricity during the billing period, the utility must credit the customer for the excess customer-generated electricity at a value that is at least avoided cost. All credits that the customer does not use during the calendar year expire at the end of the calendar year.

Vermont

Production Incentive – Green Tag Purchase Program

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind, Biomass, Geothermal Electric, Small Hydroelectric, Renewable Fuels

Amount: 1.7 to 6.4 cents/kWh; varies based on technology, payment plan, and contract length

Terms: Any size system, grid tied, new renewable (January 1, 1998, or later)

Website: http://www.mainstayenergy.com

Mainstay Energy is a private company offering customers who install, or have installed, renewable energy systems the opportunity to sell the green-tag RECs associated with the energy generated by these systems. These green tags will be brought to market as Green-e* (http://www.green-e.org) certified products. Eligible technologies include solar PV, wind, biomass, geothermal electric and hydroelectric.

Through the Mainstay Energy Rewards Program, participating customers in New England receive either quarterly production-based payments or an up-front payment. The amount of the incentive is based on the type of renewable energy technology, the production of electricity by that system (or size, in the case of the up-front payment), and the length of the contract period. Mainstay offers 3-, 5-, and 10-year purchase contracts. The longer the contract period, the greater the incentive payment. Payments are made quarterly.

Generation Disclosure

In 2002, Vermont's Governor signed into law a bill (S.138) authorizing the Vermont Public Service Board (PSB) to prescribe standards for electricity suppliers to disclose information on fuel sources and the environmental impacts of electricity generation. This information would be provided to retail customers on an annual or less-frequent basis.

The disclosure standards may address the form of the labels and information related to retail and wholesale price, terms and conditions of service, the fraction of generation

resources in a seller's mix, the environmental effects of each energy source, and a description of other services, such as energy efficiency opportunities.

Net Metering

Vermont's net metering law caps the size of net metering generators at 15 kW AC capacity for certain renewable forms of energy generation, such as PV systems, wind turbines, and fuel cells (when fueled by renewable sources). Excess generation during a billing period will be credited to the next billing period until the end of the calendar year. At the beginning of the next calendar year, any remaining credit will be granted to the utility without compensation to the customer.

In addition, a new class of net-metering system, the farm system, was established. Farmers who generate electricity from anaerobic digestion of agricultural products, byproducts, or from PV, wind, or fuel cells, can net meter systems of up to 150 kW.

Washington

Renewable Portfolio Standard (Renewable Energy Standard)

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Anaerobic Digestion, Tidal Energy, Wave Energy, Ocean Thermal, Biodiesel

Applicable Sectors: Utility, (with >25,000 WA customers)

Standard: 15% renewables by 2020 and all cost-effective conservation

Technology Minimum: None

Credit Trading: Yes

With the passage of Initiative 937 (http://www.secstate.wa.gov/elections/initiatives/text/I937.pdf) in 2006, Washington became the second state after Colorado to pass a renewable energy standard by ballot initiative. Initiative 937 calls for electric utilities that serve more than 25,000 customers in the state of Washington to obtain 15% of their electricity from new renewable resources by 2020 *and* to undertake all cost-effective energy conservation. Of Washington's 62 utilities, 17 are considered qualifying utilities, representing about 84% of Washington's load.

Utilities subject to the standard must use eligible renewable resources or acquire equivalent renewable energy credits, or a combination of both, to meet the following annual targets:

- At least 3% percent of its load by 1/1/2012, and each year thereafter through 12/31/2015
- At least 9% of its load by 1/1/2016, and each year thereafter through 12/31/2019
- At least 15% of its load by 1/1/2020, and each year thereafter.

Investor-owned utilities subject to the standard are entitled to recover all prudently incurred costs associated with compliance.

Renewable Energy Grant

Using revenues generated from the sales of Green Tags, BEF, a not-for-profit organization, accepts proposals for funding for renewable energy projects located in the Pacific Northwest (Oregon, Washington, Idaho, Montana). Any private person, organization, local or tribal government located in the Pacific Northwest may participate. Projects that generate electricity are preferred. Acceptable projects include solar PV, solar thermal electric, solar hot water, wind, hydro, biomass, and animal waste-to-energy.

BEF may deliver funding through various means, including grants, loans, convertible loans, guarantees, and direct investments in renewable energy projects. BEF renewable energy grants and investments may range from a few thousand dollars for small installations, to significant investments in central station grid-connected renewable energy projects. If a BEF grant is requested for a generating project, the BEF share will not exceed 33% of total capital costs and 0% of operating costs.

Production Incentives

Solar Starters

The BEF and the Northwest Solar Cooperative have joined together to help reduce the costs of small residential and commercial PV systems in parts of Oregon and Washington, small systems of 5 kW are approved automatically; larger sizes may be acceptable). The Northwest Solar Cooperative will sign five-year agreements with the owners of new photovoltaic systems and will pay them an annual amount equivalent to 10¢/kWh for the environmental attributes (Green Tags) produced by the solar systems. System owners will be paid annually. BEF will then purchase the Green Tags from the Northwest Solar Cooperative and sell them to its wholesale customers and on its web site, https://www.greentagsusa.org/GreenTags/index.cfm. The first phase of the project is projected to include 30 to 50 small photovoltaic systems. There are currently 36 participants in the program.

Green Tag Purchase Program

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind, Biomass, Geothermal Electric, Small Hydroelectric, Renewable Fuels

Terms: Any size system, grid tied, new renewable (January 1, 1999, or later)

Website: http://www.mainstayenergy.com

Mainstay Energy is a private company offering customers who install, or have installed, renewable energy systems the opportunity to sell the green-tag RECs associated with the energy generated by these systems. These green tags will be brought to market as Greene* (http://www.green-e.org) participating customers receive regular, recurring payments.

The amount of the payments depends on the type of renewable energy technology, the production of electricity by that system, and the length of the contract period. Mainstay offers 3-, 5-, and 10-year purchase contracts. The longer the contract period, the greater the incentive payment on a $/kWh basis. Payments are made quarterly.

Sales and Use Tax Exemption
On May 8, 2001, the Governor of Washington signed legislation, H.B. 1859, expanding the sales and use tax exemption for solar, wind, and landfill gas electric generating facilities to include fuel cells. In addition, the exemption now applies to smaller systems, those that have a generating capacity of at least 200 W.

Generation Disclosure
Washington is one of several states that require disclosure even though its electricity market has not been restructured. Beginning in May 2001, retail electricity suppliers in Washington must provide a disclosure label in a standard format to their retail customers at least semiannually. The disclosure label must be provided to new customers at the time service is established. Existing customers should receive the disclosure label as a bill insert or mailed publication. Small utilities and mutual light and power companies must provide the disclosure label annually unless they market a "specific electric product new to that utility."

Green Power Purchasing
Clark County – local government buildings using PV and wind
Seattle – local government buildings using wind

Mandatory Utility Green Power Option
On May 8, 2001, the Governor of Washington signed EHB 2247, which requires each electric utility (this includes investor-owned utilities and consumer-owned utilities) to offer customers the option to purchase power generated from renewable sources—defined as produced by wind, solar, geothermal, landfill gas, wave or tidal action, wastewater treatment gas, some biomass and "qualified hydropower" that is fish-friendly.

Washington's net-metering law, enacted March 1998 (HB 2773), allows net metering for customers with solar, wind, and hydropower systems of 25 kW or less that are intended primarily to offset part or all of the customer's requirements for electricity. Then in 2000, EH 2334, added fuel cells as another type of eligible system. All customer classes are eligible for enrollment. Enrollment is limited to a statewide installed generating capacity of 0.1% of the utility's 1996 peak demand.

Grays Harbor PUD has established its own net-metering rules.

West Virginia

Tax Exemption for Wind Energy Generation
West Virginia passed legislation in May 2001 lowering the Business and Operation Tax (B&O) on utilities using wind-power generation. For most types of electricity-generating units, the B&O tax is 40% of the generating capacity of the unit. However, the B&O tax on a wind turbine is 5% of the generating capacity of the turbine.

Production Incentive – Green Tag Purchase Program

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind, Biomass, Geothermal Electric, Small Hydroelectric, Renewable Fuels

Amount: 1.7 to 6.4 cents/kWh; varies based on technology, payment plan, and contract length

Terms: Any size system, grid tied, new renewable (January 1, 1998, or later)

Website: http://www.mainstayenergy.com

Mainstay Energy is a private company offering customers who install, or have installed, renewable energy systems the opportunity to sell the green tag RECs associated with the energy generated by these systems. These green tags will be brought to market as Greene* (http://www.green-e.org) certified products. Eligible technologies include solar PV, wind, biomass, geothermal electric and hydroelectric.

Through the Mainstay Energy Rewards Program, participating customers in New England receive either quarterly production-based payments, or an up-front payment. The amount of the incentive is based on the type of renewable energy technology, the production of electricity by that system (or size, in the case of the up-front payment), and the length of the contract period. Mainstay offers 3-, 5-, and 10-year purchase contracts. The longer the contract period, the greater the incentive payment. Payments are made quarterly.

West Virginia enacted legislation in May 2001 lowering the property tax on utility-owned wind turbines from 100% to 5% of assessed value. This change took effect in July 2001.

Wyoming

Production Incentive – Green Tag Purchase Program

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind, Biomass, Geothermal Electric, Small Hydroelectric, Renewable Fuels

Amount: 1.7 to 6.4 cents/kWh; varies based on technology, payment plan, and contract length

Terms: Any size system, grid tied, new renewable (January 1, 1998, or later)

Website: http://www.mainstayenergy.com

Mainstay Energy is a private company offering customers who install, or have installed, renewable energy systems the opportunity to sell the green-tag RECs associated with the energy generated by these systems. These green tags will be brought to market Green* (http://www.green-e.org) certified products. Eligible technologies include solar PV, wind, biomass, geothermal electric, and hydroelectric.

Through the Mainstay Energy Rewards Program, participating customers in New England receive either quarterly production-based payments or an up-front payment. The amount of the incentive is based on the type of renewable energy technology, the

production of electricity by that system (or size, in the case of the up-front payment), and the length of the contract period. Mainstay offers 3-, 5-, and 10-year purchase contracts. The longer the contract period, the greater the incentive payment. Payments are made quarterly.

Net Metering

House Bill 195 was passed by the House and Senate of the Wyoming legislature and signed by the Governor on February 22, 2001. As a result, net metering took effect July 1, 2001. The rule applies to investor-owned utilities and rural electric cooperatives and, with the passage of Senate File 106 in 2003, to municipal utilities. Eligible technologies under the 2001 legislation include solar, wind, and hydropower systems up to 25 kW, with the addition of biomass in 2003.

Excess generation is credited to the following month. When an annual period ends, the utility purchases unused credits at avoided cost.

Appendix E: Wind and Solar Power Development on DOE Legacy Management Lands Meeting, June 18, 2007

Attendees

NREL

- Doug Dahle, Donna Heimiller, Mark Mehos, Byron Stafford, Robi Robichaud, Andy Walker, Grace Griego

DOE LM, Office of Site Operations

- Robert Baney, Ray Plieness, Tracy Plessinger, Steve Schiesswohl, and Scott Surovchak

DOE LM Contractor, SM Stoller Corp.

- Sandy Beranich, Clay Carpenter, Yvonne Deyo, Carl Jacobson, Dick Johnson, Michael Widdop

DOE Office of Energy Efficiency and Renewable Energy

- Brian Connor

Bureau of Land Management

- Walt George

Environmental Protection Agency

- Joan Fisk, Shahid Mahmud

Solar Industry

- Abengoa, Solucar Power, Inc, Hank Price; Bright Source Energy, Inc., Doug Divine; Irradiance, Inc., Edward Kern; SkyFuel, Inc., Randy Gee; Solar Millennium, LLC, Jim Augustin; United Technologies, Corp., Dale Rogers

Wind Industry

- Distributed Generation Systems, Inc., Dale Osborn; enXco Inc., Tom Weis

Agenda

Wind & Solar Power Development on DOE Managed Lands

Date: Monday June 18, 2007 1:00 pm – 5:30 pm
Location: Marriott, Denver West, Golden CO

Purpose: Stakeholder discussions among DOE, NREL, BLM, EPA and Wind and Solar Industry participants to address opportunities and barriers for private industry development of Wind and Solar Power on DOE lands. Principal objective is to identify and discuss activities and issues for gauging and attracting industry interests in power development on public lands. Topics for discussion include:

- Review of NREL analysis and assessment of wind and solar power potential on DOE lands
- Overview of DOE requirements and land reuse objectives
- DOE real estate policy/issues and related land lease actions for wind and solar power development.

1:00 – 1:15 Welcome, Meeting Objectives & Introductions (Doug Dahle)

1:15 – 1:45 Plenary Session

Review of NREL Wind and Solar Power Potential Assessment on DOE lands (Donna Heimiller)

- Discuss Screening Criteria used for High Potential Sites

1:45 – 2:45 Breakout Sessions

WIND

Present Example Candidate Wind Power Site(s) (Robi Robichaud)

- GIS Maps and Site Data Checklist Info Collected
- Range of Wind Power Production Potential
- Industry Input on RE Power Assessment Criteria & Site Data

SOLAR

Present Example Candidate Solar Power Site(s) (Mark Mehos)

- GIS Maps and Site Data Checklist Info Collected
- Range of Solar Power Production Potential
- Industry Input on RE Power Assessment Criteria & Site Data
- Brief Overview of Solar Remediation – Tuba City, AZ (Rich Bush/Andy Walker)

2:45 – 3:00 Break

3:00 – 4:00 Plenary Sessions

Overview of Legacy Management Program and Requirements (Bob Baney & Panel)

- Land Management and Administration requirements
- Land Reuse Objectives
- NEPA Compliance
  - DOE Expectations for EIS Development (adopt BLM Wind PEIS)
  - Other Environmental Issues
- Indemnification/Other Issues
- Industry Q&A

4:00 – 5:00 DOE/BLM Discussion of Real Estate Approaches & Issues (Steve Schiesswohl/Walt George)

- Replication of BLM Solar/Wind development policies as possible
- Potential Real Estate Arrangements
- Industry Q&A

5:00 – 5:30 Open Discussion (as required)/Action Items/Wrap-up (Dahle)

Meeting Notes

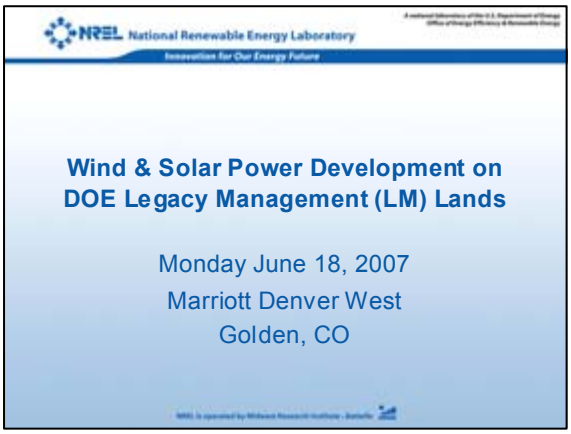
The purpose of the meeting was to hold stakeholder discussions among DOE, NREL, BLM, EPA and Wind and Solar Industry participants to address opportunities and barriers for private industry development of wind and solar power on DOE Legacy Management (LM) lands.

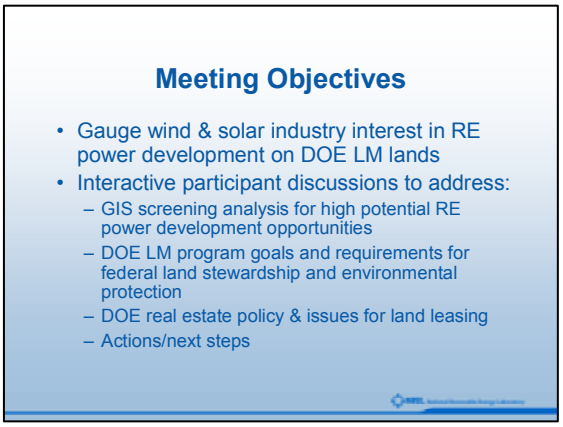
The principal objective is to identify and discuss activities and issues for gauging and attracting industry interests in power development on public lands. Topics for discussion include:

- Review of NREL analysis and assessment of wind and solar power potential on DOE lands
- Overview of DOE Legacy Management requirements and land reuse objectives
- BLM and DOE real estate policy/issues and related land lease actions for wind and solar power development.

Plenary Session—Partnerships for Renewable Power Development on Federal Lands, Doug Dahle, NREL

Presentation:





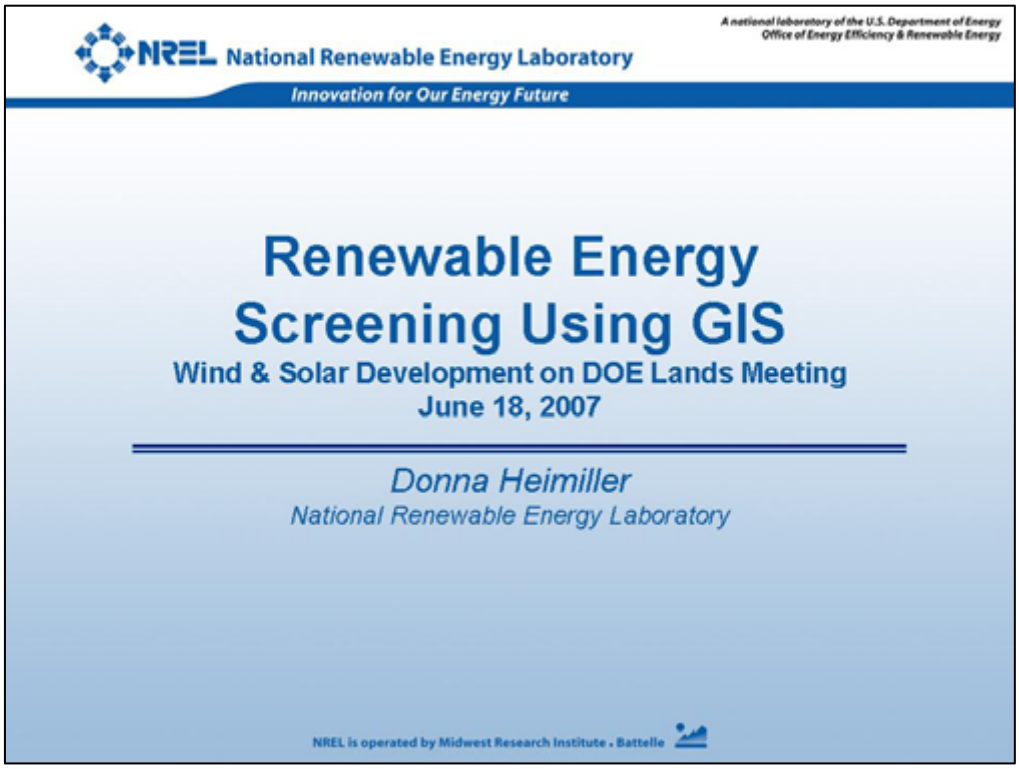
DOE is the fourth largest federal land management agency. DOE is interested in leveraging GIS based screening of high potential sites for renewable power development work from previous DOE NREL partnerships (BLM, USFS, DOD).

In today's discussions, specific DOE sites will not be disclosed in order to mitigate industry competitive advantage or potential conflict of interest.

Discussions will address:

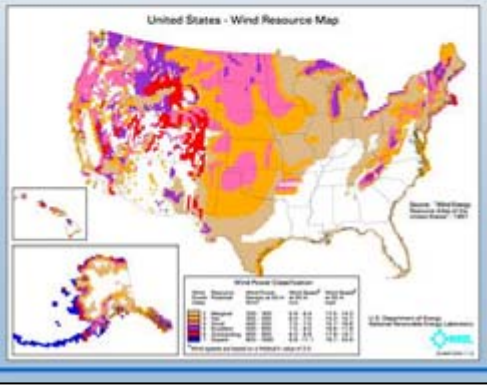
- GIS screening analysis for high potential renewable energy power development opportunities
- DOE Land Management Program goals and requirements for federal land stewardship and environmental protection
- DOE real estate policy and issues for land leasing
- Actions and next steps.

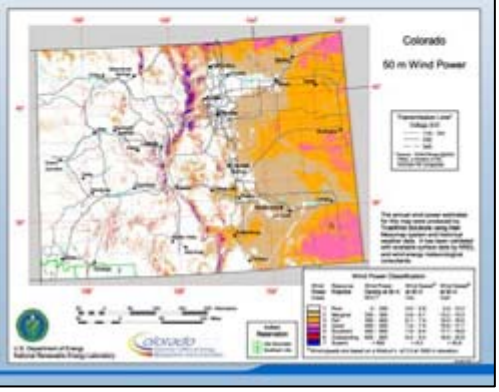
Renewable Energy Screening Using GIS, Donna Heimiller, NREL



Wind Resource Maps

- National wind data available
- Updated wind resource estimates available for most windy states





Solar Resource Maps

- National high resolution solar resource data available (except Alaska)
  - Direct normal used for Concentrating Solar
  - Flat plate tilted at latitude used for PV

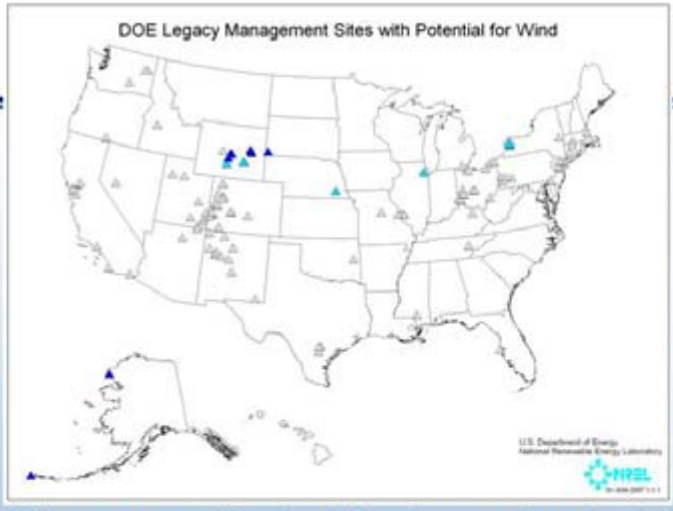
Legacy Management Sites

- Initial screening performed
- Systematic evaluation of all LM sites

NREL National Renewable Energy Laboratory

Initial GIS Screening Wind

Dk Blue: Class 4-7
Lt Blue: Class 3
Gray: Class 1-2



- Criteria for identifying areas with wind development potential:
  - At least class 3 resource, ideally class 4 or higher
  - Within 25 miles of transmission between 69 and 345 kV
  - Within 25 miles of a major road
  - No development on the disposal cell

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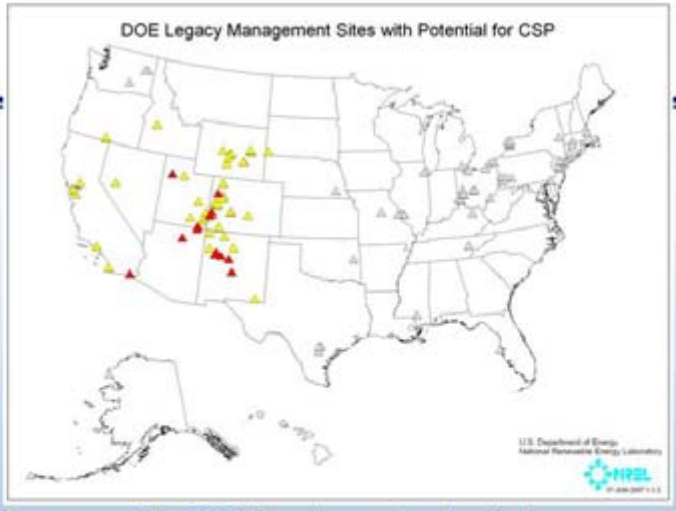
Initial GIS Screening CSP

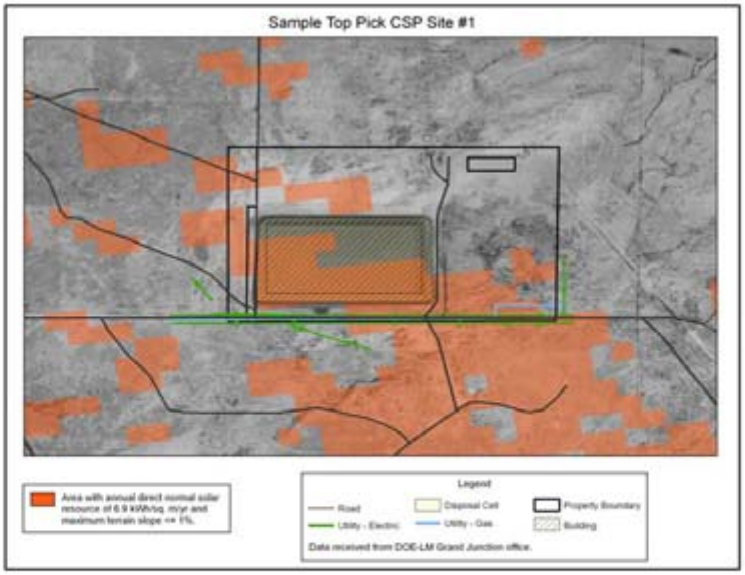
Red: >= 6.5
Yellow: 5.0 – 6.5
Gray: <5.0



- Criteria for identifying areas with CSP development potential:
  - Resource >= 5.0 kWh/m^2/day, ideally >= 6.5 kWh/m^2/day
  - Slope < 3%, ideally <1%
  - Within 25 miles of transmission between 69 and 765 kV
  - Within 25 miles of a major road or rail
  - No development on the disposal cell

Results of Screening

- First pass filter on site suitability for development
- Rank sites based on relative merits of different criteria
  - Allow rapid identification of prime candidate sites for further evaluation
- Need more detail on site characteristics



Resource potential: 13 MW

Resource Questionnaire

Point of Contact Information (name, phone number, etc.)
Site name, location description (longitude and latitude; ownership, location)
Annual solar resources (NREL)
Land slope (NREL, site info helpful)
Transmission line access and available capacity (NREL, site info helpful)
Acreage available
Distance to access roads (NREL, site info helpful)
Average wind speed (NREL)
Water resources
Distance to main natural gas pipeline (NREL, site info helpful)
Vegetation removal acceptable and no surface access restrictions:
Federal, state, tribal, and local policies supportive: (NREL)
Site allows for structures 15-50 feet high
Livestock and CPS/PV system protection possible
Light reflection at sites near major roads could be an issue for CSP only:
Closest Population center(s) (distance to city, population size - within 100 miles required)
Local utilities and peak unit power production costs

A GIS-based screening process was used to identify sites that indicated high potential for concentrating solar power and wind development.

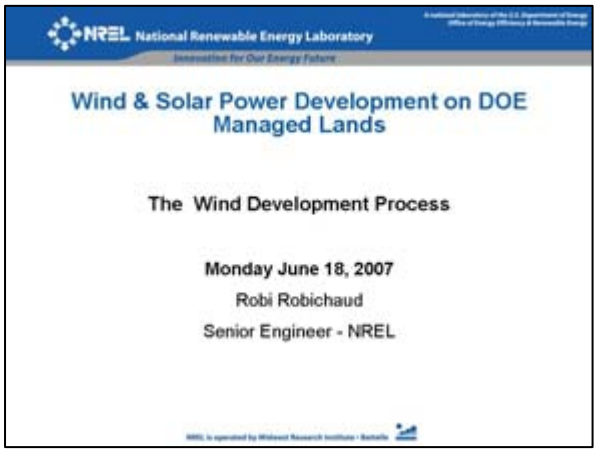
- Wind Resource maps (estimates for most windy states, provide by NREL in partnership with others)
- Solar Resource Maps (high resolution resource data for all states except Alaska)
- Legacy Management Sites (systematic evaluation of all LM sites)
- GIS Screening for Wind Criteria
  - Minimum Wind Class 3, ideally class 4 or higher
  - Within 25 miles of transmission between 69 kV and 345 kV
  - Within 25 miles of major roads
  - No development on disposal cell
- GIS Screening for CSP Criteria
  - Resource >= 5.0 kWh/m^2/day, ideally >= 6.5 kWh/m^2/day
  - Slope < 3%, ideally 1%
  - Within 25 miles of transmission between 69 kV and 345 kV
  - Within 25 miles of major roads
  - No development on disposal cell
- Results of screening allowed rapid identification of prime candidate sites, but need more detail on site characteristics
- Sample of actual high potential site for CSP development.

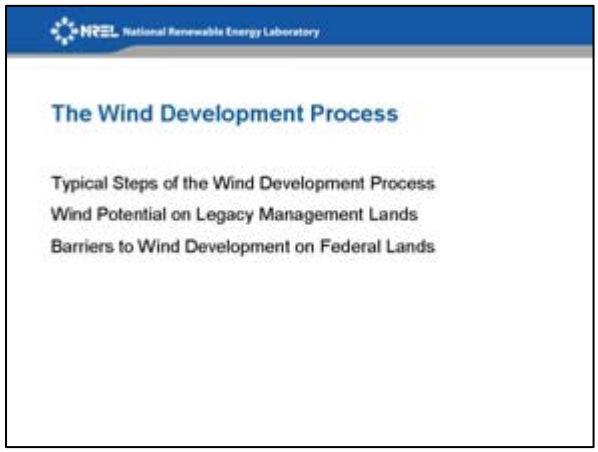
Heimiller asked what other criteria should be used for site screening. Suggestions included:

- Contiguous sites
- Wholesale electricity rates
- Surrounding BLM land.

Breakout Session – Wind

The Wind Development Process, Robi Robichaud, NREL





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The Wind Development Process

- Site Selection
- Land Agreements
- Wind Assessment
- Environmental Review
- Economic Modeling
- Interconnection Studies
- Permitting
- Financing
- Sales Agreements
- Turbine Procurement
- Construction Contracting
- Operations & Maintenance

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Site Selection

Basic steps to select a site:

- Prospecting – evidence of significant wind
- Transmission lines?
- Road access?
- Environmental concerns?
- Receptive community?
- PREFERABLY PRIVATELY OWNED REMOTE LAND

NREL National Renewable Energy Laboratory

Land Agreements:

Identify all the landowners for:

- Siting MET towers
- Potential built out wind farm
- Transmission access
- Adjacent to or otherwise affected by the wind farm

Terms of contracts, rights, compensation, reclamation, etc..

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Environmental Review

Endangered species?

Avian studies?

- Raptors
- Migratory birds
- Bats
- Other

Communicate with interested parties

- Local, state, and federal authorities
- Local Audubon society

- Wetlands review

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Environmental Review (cont.)

Visual studies

- Photosimulation

- Historical and archeological review

Communicate with interested parties
Local, state, and federal authorities
Local Audubon society

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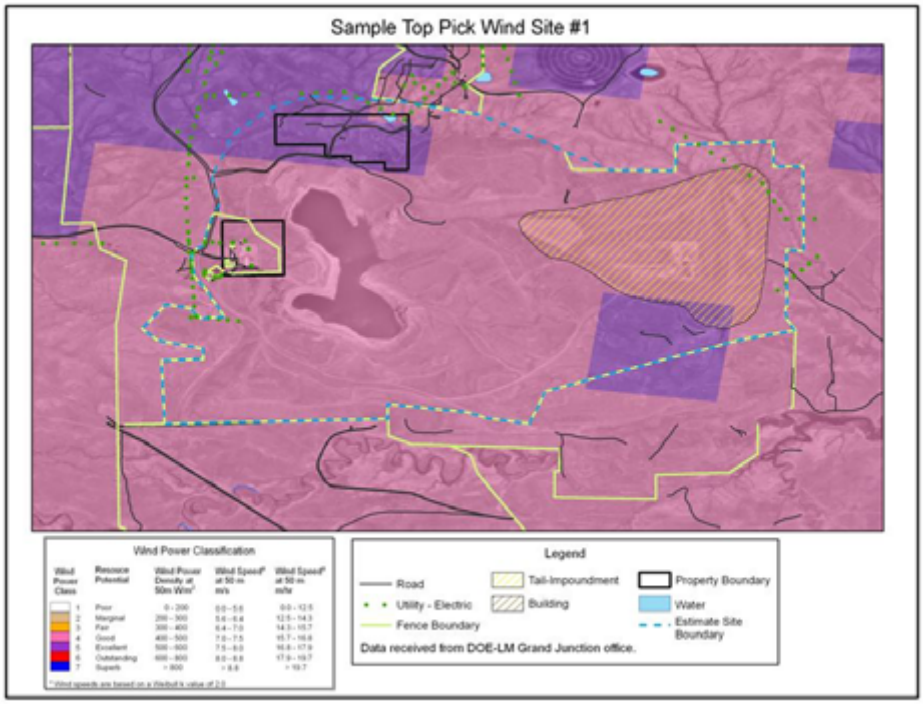
Permitting

Local, State and Federal rules/laws may apply

Public land vs. Private land – different issues and development costs and timelines

Land Use Permit

Building Permit



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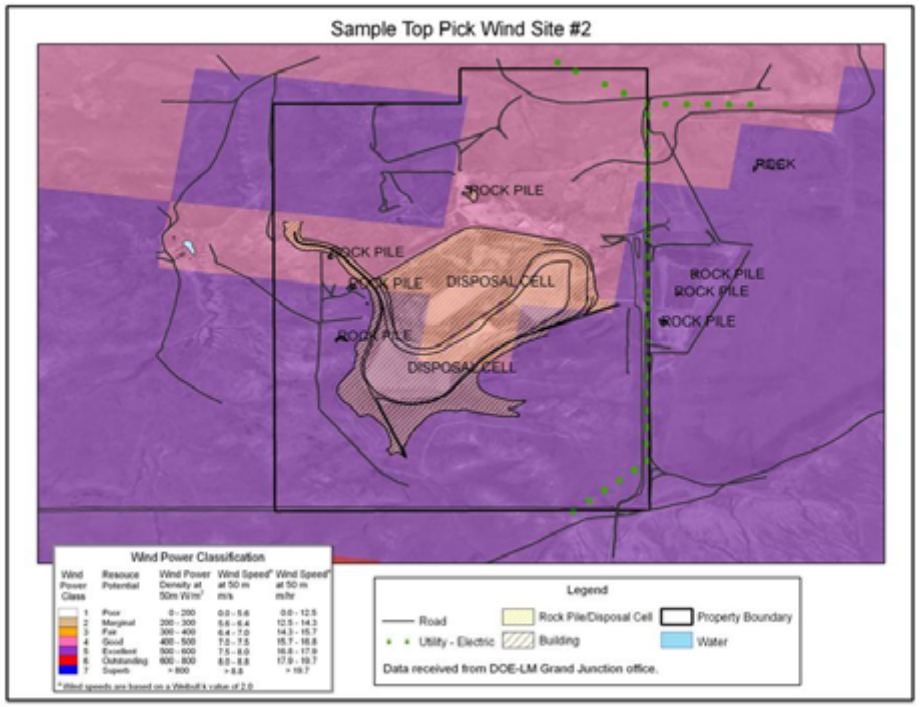
NREL Estimate of Wind Resource

- Wind Resource Data
- GIS Capabilities

Site # 1

	Installation capacity	Estimated capacity factor	Estimated annual energy
	[MW]	[%]	[MWh/yr]
Site #1	32.5	35-38%	99.6 - 108.2



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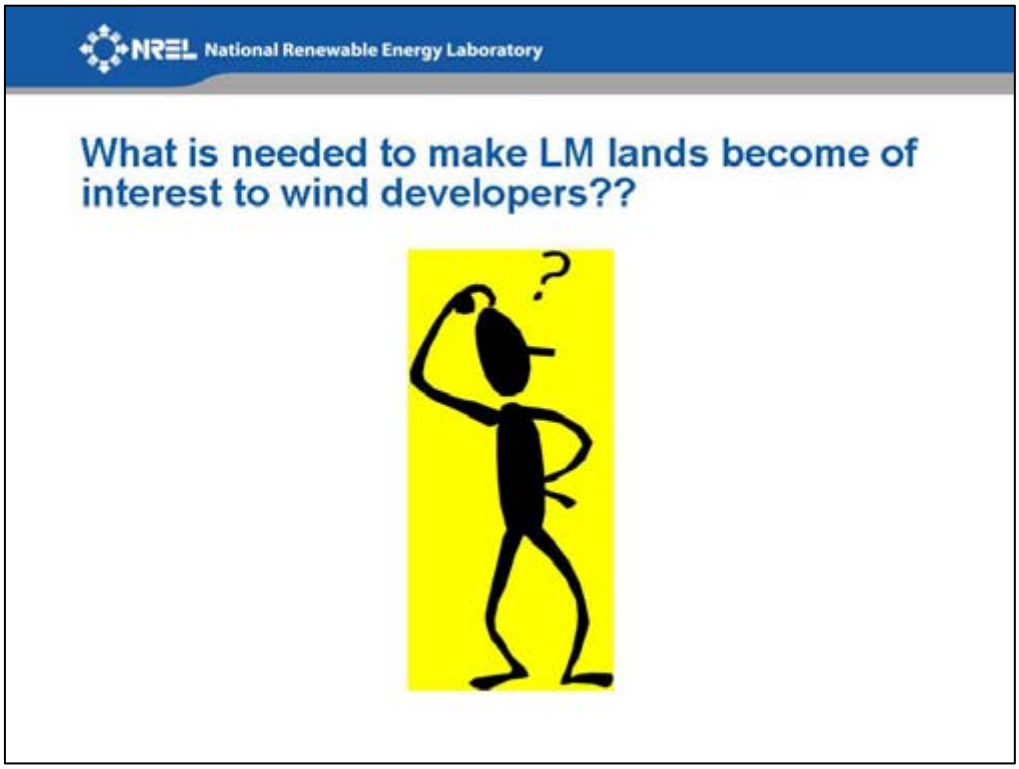
Site # 2

	Installation capacity	Estimated capacity factor	Estimated annual energy
	[MW]	[%]	[MWh/yr]
Site # 2	16	38-41%	53.3 - 57.5



Candidate wind power site(s) are based on:

- GIS maps site data
- Range of wind power production potential
- Industry input on renewable energy power assessment criteria and site data.

Key steps in wind development process (some of which can be done concurrently, some not):

- Site selection
    - Prospecting – evidence of significant wind
    - Transmission lines
    - Road access
    - Environmental concerns
    - Receptive community
    - Privately held remote lands (preferred).

- Land agreements – Identify all the landowners for:
    - Siting met towers
    - Potential built out wind farm
    - Transmission access
    - Adjacent or otherwise affected by the wind farm
    - Figure out terms of contracts, rights, compensation, reclamation, etc.

- Environmental Review
    - Endangered species

    - Avian studies (bats, raptors, migratory birds, bats
    - Communicate with interested parties (local, state, and federal authorities; local Audubon Society)
    - Wetlands review
    - Visual studies (photosimulation; historical and archeological review.

- Permitting
    - Local, state, and federal rules/laws may apply
    - Public lands vs. private land – different issues and development costs and timeliness
    - Land use permit
    - Building permit.

Mr. Robichaud showed a wind map: Sample Top Pick Site #1. A discussion ensued regarding the amount of land available. Robichaud indicated that there is a significant amount of class 4- and class-5 land available – about 200 acres.

Industry members recommended that researchers look into:

- The presence of any radar systems – this could be a political issue.
- The presence of any microwave communication systems – particularly in Nevada where there are a number of locations where military planes fly over public or private lands. The military doesn't want anything on the ground with moving parts.
- The presence of power lines. For 25 MW – 30 MW you can afford to build a substation, and amortize the cost.

A dialogue ensued about how best to attract industry investors to DOE Legacy Land Management sites.

Industry suggestions included:

- The value of that site would be greater to industry if it were prequalified.
- Mapping is good, but you need wind data. Think about spending $20K to install a met tower and get the data. DOE LM would be way ahead with three to five years of data.
- For $12K per site the government could get a Phase I environmental assessment and fatal flaw analysis. This would reveal major environmental issues.
- Negotiate with neighbors to increase buildable environment.
- Streamline red tape. It's very difficult to install on federal land.

DOE response to Industry concerns:

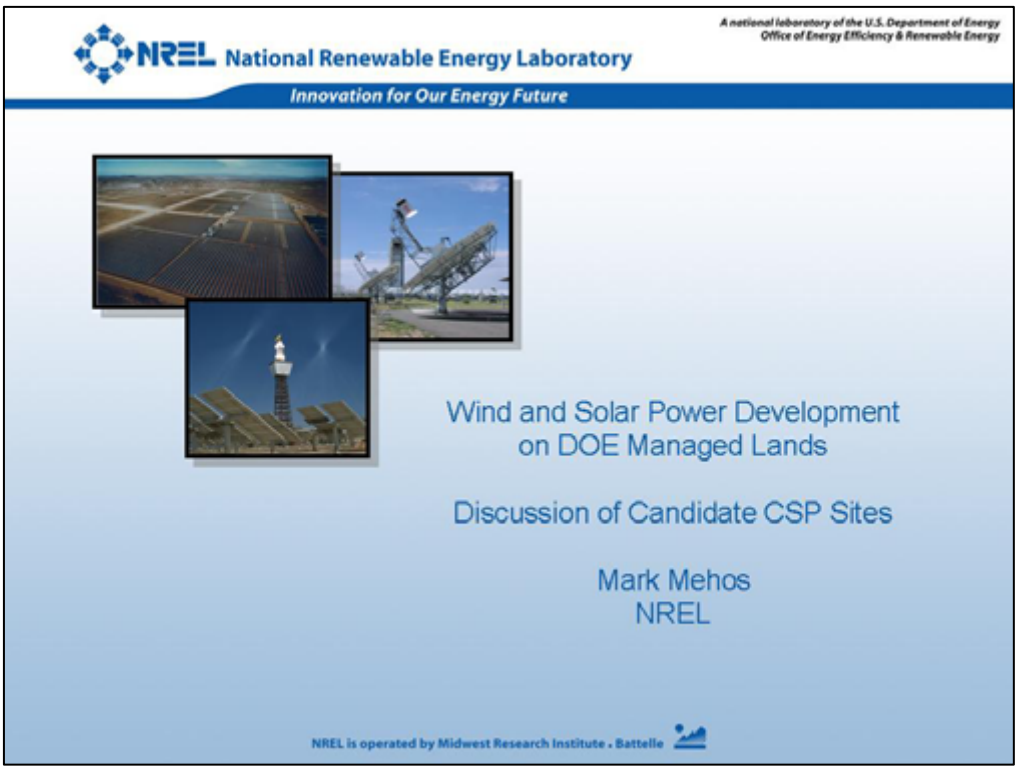
- Transmission capability. Typically there are a lot of lines coming into former mine areas.

- Easements. If the site doesn't belong to the government, but will be ultimately transferred to government, can private sector get an easement? Policy accounting would have to be engaged.

- Ground water contamination. Ground water can be avoided. Contaminated ground water is out of the boundaries of the LM property eligible for renewable energy development.

Breakout Session – Solar

Discussion of Candidate CSP sites, Mark Mehos, NREL



Siting Requirements

- Solar Resource
- Land
- Transmission Access
- Water
- Natural Gas

Topics for Discussion

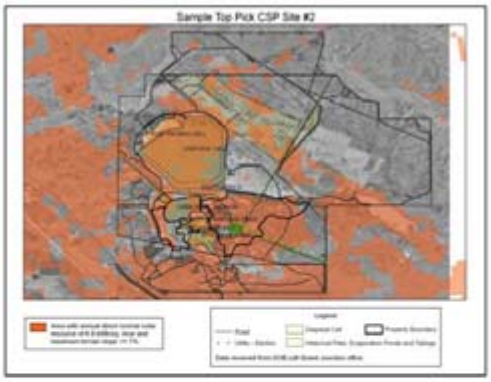
- Discussion of Siting Requirements
- Example and Discussion of Pre-screened Sites
- Discussion of LM Site Screening Checklist

Site Screening Analysis

- DNI: ideally > 6.5 kwh/m2/day
- Terrain: ideally < 1% slope
- Transmission: site within 25 miles of lines at 115-765 kV
- Access: site within 25 miles of major road or railroad
- Land use: compatible with legacy management disposal cell

Site 1 Characteristics

- Maximum Developable Land:
  - 750 acres
- Capacity/Generation Assumptions:
  - 5 acres/MW (no storage)
  - 25-30% capacity factor (no storage)
- Site Capacity/Generation Potential
  - 150 MW
  - 395,000 MWh/yr



Site 2 Characteristics

- Maximum Developable Land:
  - 64 acres
- Capacity/Generation Assumptions:
  - 5 acres/MW (no storage)
  - 25-30% capacity factor (no storage)
- Site Capacity/Generation Potential
  - 13 MW
  - 34,000 MWh/yr

LM Site Screening Checklist (see handout)

LM Site Screening Checklist for Private Sector Concentrating Solar Power (CSP) or Large scale Photovoltaic (PV) Land Reuse for Energy Generation **July 06 DRAFT**

Site-Specific Screening List

LM Site Lead Name: _____

Site name, location, description; regulatory drivers, LM transfer date:

Possible site-specific energy needs and costs during LTSM: None.

Land slope: The topography is variable throughout the site, but generally has a 1-3 % slope in the unoccupied portions of the site.

Acreage available and .25 mi adjacent land ownership and usage: The site is approximately 3,300 acres, and the cells occupy approximately 320 acres in the western third of the site. The site is surrounded by private undeveloped land used primarily for grazing.

Distance to access roads or rail:

Water resources or restrictions: No surface or ground water sources are available at the site or in the vicinity of the site. Municipal or private water supplies may be available within 20 miles of the site.

Distance to main natural gas pipeline: Unknown. A natural gas transmission pipeline of unknown size crosses the site.

Vegetation removal acceptable and no surface access restrictions: There are no protected vegetation species on the site. There are no surface access restrictions to the site, but several utility rights-of-way cross the site.

Site allows for structures 15-50 feet high: Overhead power lines cross the site. There are no other restricting structures.

Livestock and CPS/PV system protection needed: The site is fenced and grazed by wildlife. A grazing license with a local rancher is pending.

Light reflection at sites near major roads could be an issue for CSP only:

Closest Population center(s) and info:

- Checklist sent to site managers
- Information from checklist compared against screening criteria
- Other attributes needed to attract industry interest???

Reviewed CSP siting requirements:

- Solar resource, preference >6.5 kWh/m^2/day
- Developable land area – 5acres/MW – GIS data on site allowed estimate of developable land
- Transmission access
- Water for steam cycle and mirror cleaning
- Natural gas for hybrid system and dispatchability.

Reviewed Candidate CSP Site #1

- Maximum developable land – 150 acres
- Capacity/generation assumptions
    - 5 acres/MW (no storage)
    - 25%-30% capacity factor (no storage)
- Site capacity/generation
    - 150 MW
    - 395,000 MWh/yr.

Reviewed Candidate CSP Site #1

- Maximum developable land – 64 acres
- Capacity/generation assumptions
    - 5 acres/MW (no storage)
    - 25%-30% capacity factor (no storage)
- Site capacity/generation
    - 130 MW
    - 34,000 MWh/yr.

Reviewed LM Site Screening Checklist

- Site characteristics acquired from site managers
- Checklist data compared against screening results
- Mr. Mehos asked participants about other criteria to add to CSP candidate site checklist. Recommendations:
    - Wind Speed an issue – ground wind speed may be available as many sites have met stations
    - Potential of reduced solar resource due to haze (particulate matter)
        - Surrounding industrial or agricultural activity.

Other Discussion Items

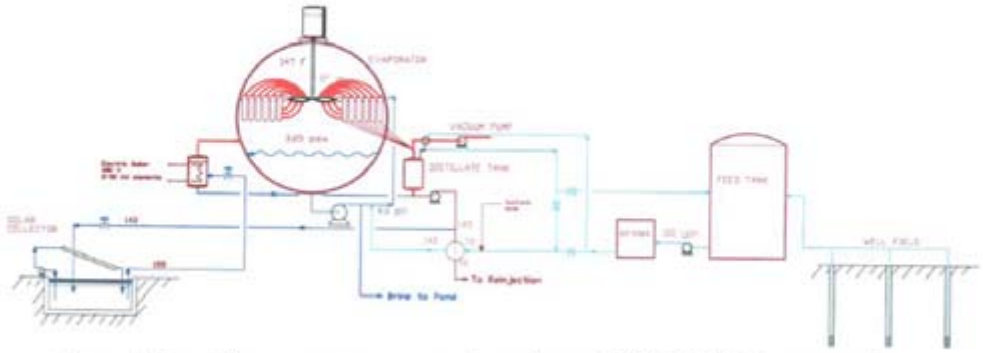
- CSP industry interested in larger developable lands area – 1000 acres or larger
- Consider slope of 3% for GIS screening criteria
- Desire for Solar resource monitoring at site
    - Cost of met station with radiometer - $15K.

Tuba City LSTM – Photovoltaics and Solar Thermal, Andy Walker, NREL; Carl Jacobsen, S.M Stoller Corp.

Tuba City LSTM
Photovoltaics and Solar Thermal

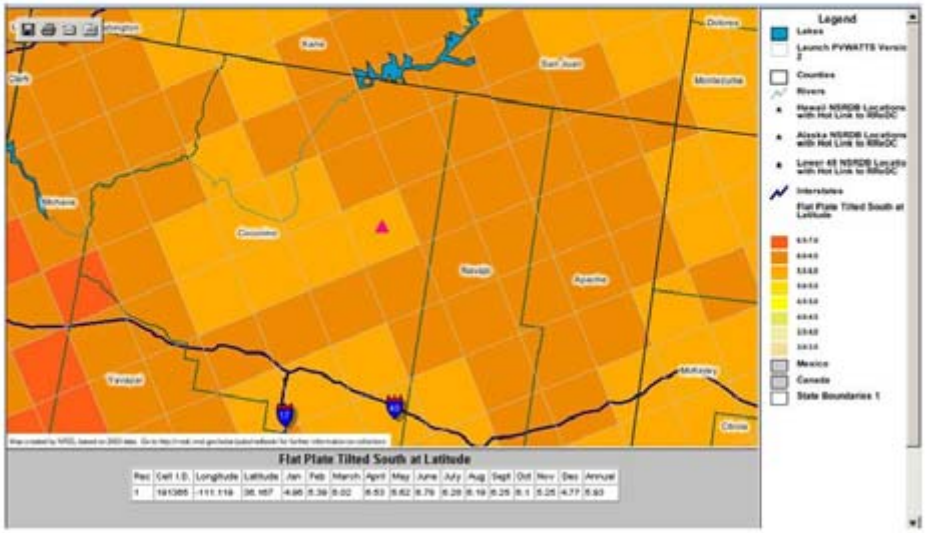
Andy Walker, NREL
Rich Bush, DOE LM
Carl Jacobsen, S.M. Stoller Corp.

Tuba City LTSM



Annual baseline energy use and cost are 1825 MWh/year and $165,000/year.

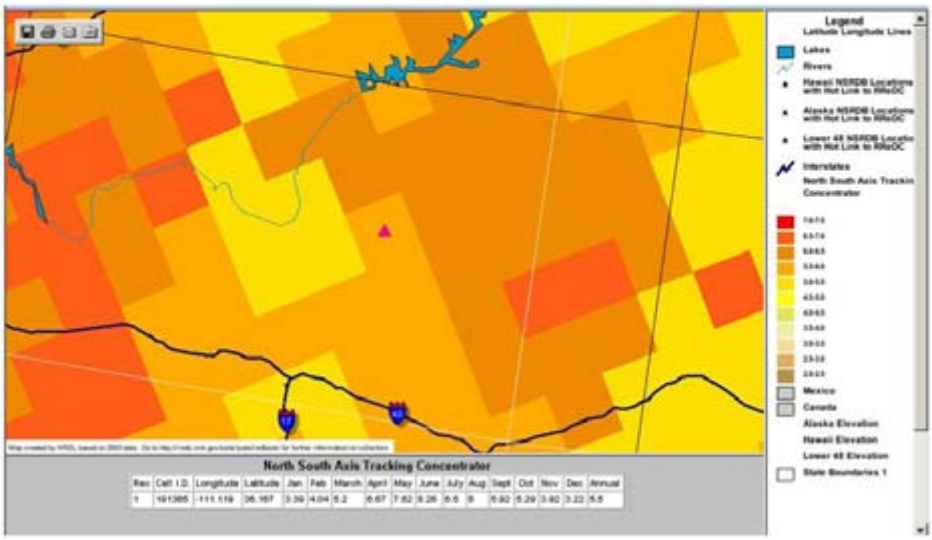
Monthly and Annual (5.93 kWh/m2/day) Solar Resource on Flat Plate Tilted at Latitude (36 deg).



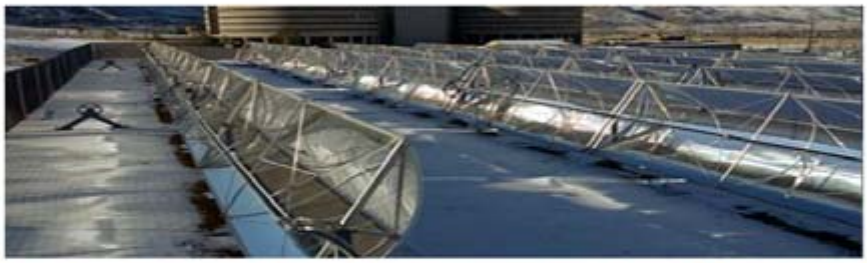
Photovoltaics

Photovoltaics Size (kW)	PV Initial Cost ($)	PV Initial Cost w/incentives ($)	Avoided Cost ($/kwh)	PV Annual Energy Delivery (kWh/year)	Capacity Factor ()	PV Annual Utility Cost Savings ($)	PV Annual O&M Cost ($/year)	PV Payback Period (years)
200	$1,745,960	$749,554	0.02	333318	19.0%	$30,165	$2,000	26.6

Monthly and Annual (5.5 kWh/m2/day) Solar Resource for N-S Concentrating Solar Thermal Collector.



Solar Thermal



Solar Thermal Area (ft2)	Thermal Energy Delivery (therms/year)	Solar Thermal Initial Cost ($)	Thermal Annual Utility Cost Savings ($/year)	Production Incentive ($/year)	Solar Thermal Cost w/incentives ($)	Solar Thermal O&M Cost ($/year)	Solar Thermal Payback Period (years)
3,712	7,798	$267,631	$15,733	$15,998	$162,342	$2,690	5.6

Life cycle cost comparison of solar PV and solar thermal alternatives, and both bundled together.

	Basecase	200 kW PV system	3712 sq ft solar thermal system	Both PV and Solar Thermal Combined
Energy Use (kWh/year)	1,825,000	1,491,682	1,557,369	1,224,051
Energy Cost ($/year)	$165,163	$134,997	$140,942	$110,777
Capital Cost ($)		$749,554	$267,631	$1,017,185
Annual O&M cost ($/year)		$2,000	$2,690	$4,690
Production Incentive ($/year)			$15,998	$15,998
Life Cycle Cost ($)	$2,857,311	$3,119,606	$2,616,000	$2,878,294

Mr. Walker presented Tuba City unique water distillation process where concentrating solar hot water (155°F) reduces fan power in evaporator. PV can be utilized to reduce electrical power for fan and pump power.

Proposed solar system

- CSP hot water optimum size of 3712 ft^2
- PV system size 200kW.

Economic analysis conducted to estimate installation cost and annual electrical cost savings.

- Arizona has Renewable Portfolio Standard requiring Arizona Public Service (APS) to increase renewable energy use
    - Production incentive for solar thermal and PV.
- With APS incentives economic payback periods
    - CSP hot water – 5.6 years, capital cost $267 K
    - PV – 26.6 years, capital cost $749 K
    - Bundled CSP and PV ~20 years.

Discussion of bundled CSP + PV project consideration for private financed development through Federal Energy Savings Performance Contracting (ESPC)

- 20-year payback too long for private financing
- CSP only option, better potential for private financing, but investment too small for Energy Services industry interest
- DOE LM considering funding CSP project.

Plenary Session – Overview of Legacy Management Program and Requirements, Bob Baney and Panel (Ray Plieness, Rich Bush, Steve Scheisswohl)

This session included a discussion of the following:

- Land Management and Administration requirements
- Land reuse objectives
- NEPA Compliance
    - DOE Expectations for EIS Development (adopted BLM Wind PEIS)
    - Other Environmental Issues
- Indemnification and other issues.

DOE Office of Legacy Management

- Mission:

  Manage the Department's sites post-closure responsibilities and ensure the future protection of human health and the environment. LM has control and custody for legacy land, structures, and facilities and is responsible for maintaining them at levels consistent with Departmental long-term plans.

- Meet the Energy Policy Act of 2005 and the Secretary's initiative to maximize renewable energy projects on DOE sites (Transformational Efficiency Management)

2

LM protects human health and the environment through efficient and cost-effective surveillance and maintenance at ~90 sites

- Restored and closed sites transfer to LM from private sector or governments after State and Federal environmental regulators approval of cleanup and LM's long-term surveillance and maintenance (LTSM) plans.
- LTSM includes:
  - Routine inspections of sites and engineered disposal cells that contain residual uranium or other low-level, long-lived radionuclide wastes from mining, milling, weapons manufacturing or scientific research wastes
  - Monitor and maintain controls for in-place engineered and monitoring systems and ground water treatment systems
  - Ensure protective land uses

3

LM manages legacy land and assets, with an emphasis on the protective reuse or disposition of real estate

- 50% of LM-owned sites have other uses: agriculture, grazing, commercial, conservation reuse
- LM supports many types of beneficial reuse on sites: development of renewable energy resources, agriculture, recreation, education, and reindustrialization
- **28 sites are LM-owned**
  - Most LM-owned sites have disposal cells with many acres of surrounding buffer lands that offer surface uses
  - 8 sites allow buffer land use for agriculture (grazing, lumber, hay production)
  - Weldon Spring, MO has multiple reuses (community, conservation, education, recreation)
  - Most LM-owned lands can be leased with environmental regulator approval

4

LM Sites Through Fiscal Year 2015

5

LM's Uranium Mill Tailings Radiation Control Act (UMTRCA) Sites For Renewable Energy Power Production Use

- LTSM Plan development or revision may be required by regulators
- NRC leasing permit: 10 CFR 40.28(d) and DOE's general license: NRC can issue use permit of surface…estates transferred to DOE or State. Transferee has right of first refusal to "this" use of the "land."
- Current owner closing their operations may want to stay in business for renewable energy power production. NRC would amend their license. States can take ownership and care of sites.

6

Issues and Options: Environmental UMTRCA Sites

- Permit application must demonstrate:

(1) "Proposed" action doesn't endanger public health, safety, welfare or environment;

(2) Site maintained and/or restored to meet requirements in Appendix A of Part 40 for closed sites; and

(3) Adequate financial arrangements are in place to ensure byproduct materials will not be disturbed, or if disturbed, that the applicant is able to restore the site to a safe and environmental sound condition.

7

Issues and Options: Environmental
NEPA

- Addressing site-specific requirements for wind and solar development – delineate scope of projects
- EA required for DOE actions like renewable energy development
  - May have significant impact or not excludable
- Programmatic EIS
  - Would cover general approaches, site specific EA tiered off

8

Issues and Options: Environmental
NEPA

- Wind and Solar

  NEPA approach
  - Individual EAs
    - May work for small program in diverse settings, no cumulative impacts
    - LM references PEIS BLM in EAs for wind power?
    - Site specific EAs
    - Relatively quick
  - Pilot programs
    - Potentially excludable

9

Issues and Options: Realty
Wind and Solar

- Cost recovery and retention of leasing proceeds legislation for BLM permitting, etc.
- DOE's U.S. Title 40 Chapter 10, Subchapter 2, Section 485 4601-4605 and 1965 Land and Water Conservation Act
- Royalty calculators for wind and solar
- DOE UMTRCA leasing requirements
- Land disposal option to State for solar/wind farm

11

Issues and Options: Environmental
Additional issues?

- Wind Turbines and Solar Panels:
  Migratory and other birds and raptors
  - Current technologies
  - USFWS consultations
  - Identify Best Management Practices

  Other:
  - Compatibility with other uses (e.g. grazing, agriculture, wildlife) on site or adjacent lands
  - DOE vs. company responsibilities
  - Public acceptance
  - Solar: visual intrusion from sun on mirrors

10

Issues and Options: Realty
Wind Specific

- Right of Way Policy for Wind Energy Development 2 Oct 2001-138
- 3 years for wind monitoring meteorological towers
- 30+ years permit
- Reclamation bond collected for wind farm development to cover turbine removal, rehab for roads and revegetation ($2,500 per turbine)

12

Issues and Options: Other

- LM LTSM program requirements
- DOE indemnification from safety/liability issues
- Industry (not DOE) must prospect site

13

DOE Office of Legacy Management

- Mission: Manage Department's post-closure responsibilities and ensure the future protection of human health and the environment. LM has control and custody for legacy land, structures, and facilities and is responsible for maintaining them at levels consistent with departmental long-terms plans.

- Meet the Energy Policy Act of 2005 and the Secretary's initiative to maximize renewable energy projects on DOE sites (Transformational Efficiency Management).

- LM protects human health and the environment through efficient and cost-effective surveillance and maintenance at~90 sites.

- Restored and closed sites transfer to LM from private sector or governments after state and federal environmental regulators approval of cleanup and LM's long-term surveillance and maintenance (LTSM) plans.

- LTSM includes:
    - Routine inspections of sites and engineered disposal cells that contain residual uranium or other low-level, long-lived radionuclide wastes from mining, milling, weapons manufacturing or scientific research wastes.
    - Monitor and maintain controls for in-place engineered and monitoring systems and ground water treatment systems
    - Ensure protective land uses.

LM manages legacy land and assets with an emphasis on the protective reuse or disposition of real estate

- 50% of LM-owned sites have other uses: agriculture, grazing commercial, conservation reuse.

- LM supports many types of beneficial reuse on sites: development of renewable resources, agriculture, recreation, education, and reindustrialization.

- 28 sites are LM-owned.
    - Most LM-owned sites have disposal cells with many acres of surrounding buffer lands that offer surface uses
    - Eight sites allow buffer land use for agriculture (grazing, lumber, hay production)
    - Weldon Spring, MO has multiple reuses (community conservation, education, recreation)
    - Most LM-owned lands can be leased with environmental regulator approval.

Can't sell land, but can lease to commercial organizations (probably). Very few sites are clean enough to dispose of.

LM's Uranium Mill Tailings Radiation Control Act (UMTRCA) Sites for Renewable Energy Power Production Use

Why do we have these sites in the first place? Most of the materials in disposal cells have been removed, but there are restrictions on these sites in most cases. At the same time, we also want to open them up and develop long-term surveillance plan.

- LTSM plan development or revision may be required by regulators.

- NRC leasing permit: 10 CFR 450.28(d) and DOE's general license: NRC can issue permit for surface development of estates transferred to DOE or State. Transferee has the right of first refusal to "this" use of the "land."

- Current owner closing their operations may want to stay in business for renewable energy power production, NRC would amend their license. States can take ownership and care of sites.

Issues and Options: Environmental UMTRCA Sites

- Proposed application must demonstrate:
    - "Proposed" action doesn't endanger public health, safety, welfare of environment
    - Site maintained and/or restored to meet requirements in Appendix A of Part 40 for closed sites
    - Adequate financial arrangements are in place to ensure byproduct materials will not be disturbed, or if disturbed, that the applicant is able to restore the site to a safe and environmental sound condition.

Issues and Options: Environmental NEPA

- Address site-specific requirements for wind and solar development—delineate scope of projects
- EA required for DOE actions like RE development
    - May have significant impact or not excludable
- Wind Programmatic EIS
    - Would cover general approaches, site specific EA tiered off.

Issues and Options: Environmental NEPA

- Wind and Solar – NEPA approach
    - Individual EAs
        - May work for small program in diverse settings, no cumulative impacts
        - LM reference PEIS BLM in EAs for wind power
        - Site specific EAs required
        - Relatively quick
    - Pilot programs
        - Potentially excludable.

Discussion: Wind assessment will take a year, then two years down the road the site is transferred, then there would be NEPA concerns.

Environmental assessment for an existing site–would only apply to DOE. BLM (covers 11 western states).

Issues and Options: Environmental – Additional issues?

- Wind Turbines and Solar Panels: Migratory and other birds and raptors
    - Current technologies
    - USFWS consultations
    - Identify Best Management practices.

Discussion: There's controversy over whether or not migratory patterns are a problem. Wind turbines present an insignificant problem to migratory birds. However, there is a law that protects birds, so what's reasonable is not the issue. Migratory Bird treaty/NEPA put together best practices management to minimize collisions with their turbines. (Negotiate with fish and wild life. BLM instituted a technical advisory committee.) Mortality rates didn't get high enough to be a concern.

- Other:
    - Compatibility with other uses (e.g. grazing, agriculture, wildlife) onsite or adjacent lands
    - DOE vs. company responsibilities
    - Public acceptance
    - Solar: visual intrusion from sun or mirrors.

Discussion: A ten turbine project is small in the west, but is considered large in the east and economical in New England where Renewable Energy Certificates can generate in excess of $500/MWh. Sounds like it's not insurmountable but needs some research.

Agricultural and ranching communities are the largest owners of wind farms because their enterprises are compatible with wind. The footprint is small relative to the blade sweep.

Who does NEPA? Contractor or Gov? In the case of BLM, cost re-imbursement for BLM employees to process right of way.

DOE/BLM Discussion of Real Estate Approaches and Issues: Wind and Solar Energy Development Policy, Steve Schiesswohl and Walt George

Bureau of Land Management

Wind and Solar Energy Development Policy

Presented by
Walter George
National Project Manager

Wind and Solar Energy Policy

- WIND ENERGY
  - Instruction Memorandum WO-IM-2006-216
    - www.blm.gov/nhp/efoia/wo/fy06/im2006-216.htm
  - Incorporated Record of Decision from Programmatic Wind Energy EIS (12/15/2005)
    - www.windeis.anl.gov
- SOLAR ENERGY
  - Instruction Memorandum WO-IM-2007-097
    - www.blm.gov/nhp/efoia/wo/fy07/in2007-097.htm

Wind Energy Policy (1)

- Public involvement requirements
- Agency consultation (FWS, SHPO, DOD, tribes)
- Lands excluded from wind energy development
  - National Landscape Conservation System
  - National Historic and Scenic Trails
  - Areas of Critical Environmental Concern
  - Others not consistent with land use plan objectives

Wind Energy Policy (2)

- Project-level environmental review requirements
  - Established on site-specific basis by Field Office
  - Typically will be EA tiered to Programmatic EIS
- Scope and content of plans of development
  - Site plan, Construction Techniques, BMPs, Reclamation
- Adaptive management strategies
  - Tied to management goals and objectives
  - Especially in areas of avian, bat and big game effects

Wind Energy Policy (3)

- Best Management Practices (examples)
  - Preconstruction surveys of avian and bat use
  - Visual mitigation designs
  - Tubular towers
  - Minimize guy wires on meteorological towers
  - No above-ground power lines
  - Minimize surface disturbance and ensure adequate reclamation

Wind Energy Authorizations (1)

- Site Testing and Monitoring Grant
  - Granted for three years.
  - May be renewed for larger areas
  - Approved with Categorical Exclusion or limited EA
  - Annual minimum rental fee of $50/tower (small sites)
  - Annual rental fee of $1,000 or $1 per acre, whichever is greater (large sites)
  - Precludes other applications for wind energy development in granted area but no guarantee to approve development application
  - Must erect monitoring tower within 12 months

Wind Energy Authorizations (2)

- Development Grant
  - 30 – 35 year term
  - Grant covers turbines and all related facilities on site
  - Non-exclusive of other public land uses
  - Annual rental of $2,365 per installed MW, phased in over three years or until commercial operations begin
  - Due diligence requires construction in two years to discourage land speculation
  - Reclamation bonds of $2,500 per turbine
  - Competitive leasing only if provided in land use plan

ISSUES

- Resource effects
  - Avian, wildlife, visual
- NEPA process discourages public land development - - seek out private lands first
- Mixed ownership considerations
- First-come v. Competitive authorizations
- Start-up challenges
  - Valley County, MT project
  - www.dnrc.mt.gov/trust/wind/valley_county.asp

Solar Energy Policy (1)

- Must comply with BLM's land use planning, environmental, and right-of-way requirements
- High priority projects
- Using NREL insolation potential maps for Arizona, California, Nevada and New Mexico
- Addresses Photovoltaic Systems and Concentrating Solar Power Plants

Solar Energy Policy (2)

- Follows standard ROW application process
  - Separate application not required if solar system is ancillary to other facility
  - Environmental review
  - First-come, first-served application processing
  - Diligence requirements
  - Grant term typically 30 years
  - Rental based on appraisal, phased in (3 years)
  - Bond required

Solar Energy Policy (3)

- Authorization covers
  - Solar collectors, towers, and thermal storage
  - Turbine generators or fossil fired generators for hybrid systems
  - Access roads and electrical transmission facilities

Wind and Solar Energy Policy

Wind Energy

- Instruction Memorandum WO-IM-2006-216
  - www.blm.gov/nhp/efoia/wo/fy06/im2006-216.htm
- Incorporated Record of Decision from Programmatic Wind Energy EIS (12/15/2005)
  - www.windeis.anl.gov.

Solar Energy

- Instruction Memorandum WO-IM-2007-097
  - www.blm.gov/nhp/efoia/wo/fy07/in2007-097.htm.

Wind Energy Policy (1) – Public involvement requirements

- Agency consultation (FWS, SHPO, DOD, tribes)
- Lands excluded from wind energy development
  - National Landscape Conservation System
  - National Historic and Scenic Trails
  - Areas of Critical Environmental Concern
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Wind Energy Policy (2)

- Project-level environmental review requirement
  - Established on site-specific basis by Field Office
  - Typically will be EA tiered to Programmatic EIS
- Scope and content of plans of development
  - Site plan, Construction Techniques, BMPs, Reclamation
- Adaptive management strategies
  - Tied to management goals and objectives
  - Especially in areas of avian, bat and big game effects.

Wind Energy Policy (3)

- Best Management Practices (examples)
  - Preconstruction surveys of avian and bat use
  - Visual mitigation designs
  - Tubular towers
  - Minimize guy wires on meteorological towers
  - No above-ground power lines
  - Minimize surface disturbance and ensure adequate reclamation.

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- Site Testing and Monitoring Grant
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  - Approved with Categorical Exclusion or limited EA
  - Annual minimum rental fee of $50/tower (small sites)
  - Annual rental fee of $1,000 or $1 per acre, whichever is greater (large sites)

    - Precludes other applications for wind-energy development in granted area but no guarantee to approve development application
    - Must erect monitoring tower within 12 months.

Wind Energy Authorization (2)

- Development Grant
    - 30 year – 35 year term
    - Grant covers turbines and all related facilities on site
    - Non-exclusive of other public land uses
    - Annual rental of $2,365 per installed MW, phased in over three years or until commercial operations begin
    - Due diligence requires construction in two years to discourage land speculation
    - Reclamation bonds of $2,500 per turbine
    - Competitive leasing only if provided in land use plan.

Issues

- Resources effects
    - Avian, wildlife, visual
- NEPA process discourages public land development—seek out private lands first
- Mixed ownership considerations
- First-come v. competitive authorizations
- Start-up challenges
    - Valley County, MT project
    - www.dnrc.mt.gov/trust/wind/valley_county.asp.

Solar Energy Policy (1)

- Must comply with BLM's land use planning, environmental, and right-of-way requirements
- High priority projects
- Using NREL insolation potential maps for Arizona, California, Nevada and New Mexico
- Addresses photovoltaic systems and concentrating solar power plants.

Solar Energy Policy 2

- Follows standard ROW application process
    - Separate application not required if solar system is ancillary to other facility
    - Environmental review
    - First-come, first-served application processing
    - Diligence requirements
    - Grant term typically 30 years
    - Rental based on appraisal, phased in (3 years)
    - Bond required.

Solar Energy Policy 3

- Authorization covers
    - Solar collectors, towers, and thermal storage
    - Turbine generators or fossil fired generators for hybrid systems
    - Access roads and electrical transmission facilities.

Discussion Points:

- No programmatic EIS for solar at this time
- Involve public and Environmental Policy Act
- Lands excluded from wind energy development
- Technical advisory committee to evaluate mortality rate in order to re-evaluate a turbine, perhaps taking it down
- REA lines (Rural Electrification Act). Rural Electricity said the lines were too close together and electrocuting raptors.

Issues and Options: Realty Wind & Solar

- Cost recovery and retention of leasing proceeds legislation for LM leased lands.
- DOE's US Title 40 Chapter 10, Subchapters 2, Section 485 4601-4605 and 1965 Land and Water Conservation Act
- Royalty calculators for wind and solar
- DOE UMTRCA leasing requirements
- Land disposal options to state for solar/wind farm.

Discussion:
Right of refusal not part of bidding processes. Those companies would be approached first before procurement process. Competitive bidding on Title 1 sites is an option. Sole source action is most typical. Based on current landownership of adjacent lands. Have the authority to bid. BLM land adjacent to many DOE LM sites in western states. We have withdrawal applications over a year old. BLM is already managing that within the public boundary.

- Right of Way Policy for Wind Energy Development 2 Oct 2001 138
- 3 years for wind monitoring met towers
- 30+ years permit
- Reclamation bond collected for wind farm development to cover wind removal, rehab for roads and revegetation ($2500 per turbine).

Issues and Options

- LTSM program requirements
- DOE indemnification from safety/liability issues
- Industry (not DOE) should prospect site.

Discussion:

- BLM doesn't indemnify, although they have been asked to.
- DOE is precluded by law to indemnify. DOE is responsible for hazards on the site.

- If something was found on a site that is transferred out of Federal ownership, then it would have to be determined who owns it. And who is responsible. Most of the time, it's DOE's responsibility.
- Regarding the LM properties, LM would know where contaminated plumes are and where they are migrating.

Action Items/Wrap-up, Doug Dahle

Actions:

- NREL to revise report and GIS screening for recommended added criteria to include:
    - State Renewable Portfolio Standards (RPS) in place – Appendix D
    - Availability of Compliance RECs as revenue source for private developer – Appendix D
    - BLM property adjacent to DOE LM sites (expand developable land area for high potential DOE LM sites in western states) – Appendix C (includes proximity to BLM and USFS lands).

- DOE LM Real Estate Actions
    - Investigate potential to issue leases for 30-year term
    - Continue discussions with BLM on joint land project development.

Principle meeting Objective: Question to Industry on Interest in pursuing opportunities to develop renewable power on DOE LM lands

- General skepticism of opportunities, at most a niche market with limited opportunity for large scale power development
- Consider small scale wind development in Northeastern states with significant financial incentives for renewable power
- Continue DOE/BLM outreach to industry as DOE LM develops policies to encourage renewable power land reuse.

Meeting achieved an open discussion between industry and DOE LM, leading to better understanding of each party's issues and needs.

Meeting adjourned at 5:30 p.m.

Appendix F: Solar Thermal and Photovoltaic (PV) Applications for Site Operations at Tuba City, Arizona

A study was conducted by NREL's Andy Walker and S.M. Stoller Corporation's Carl Jacobsen, Site Project Manager of the Tuba City, AZ Disposal Site, to examine the potential use of distributed renewable energy for reducing energy use and costs of water distillation site operations. Proposed site operation renewable energy applications for the Tuba City site, included Concentrating Solar Thermal Hot Water and Photovoltaics.
To assist in the evaluation of solar energy alternatives at the site, NREL provided solar resource data and analysis for estimating annual hot water and electrical production, reviewed a technical savings estimate by Carl Jacobsen, and provided: sample procurement specifications; reviewed revised specifications; strategies to capture state financial and federal tax incentives through private financing of proposed renewable energy systems; and a list of providers certified by the Arizona Solar Energy Industries Association.

Site Description

The Tuba City, Arizona, Disposal Site is within the Navajo Nation and close to the Hopi Reservation, approximately 5 miles east of Tuba City and 85 miles northeast of Flagstaff, Arizona. A detailed description follows:

- Longitude: -111.134793 Latitude: 36.145483
- 145 acre site with a 50 acre uranium containment cell
- Fenced
- Unrestricted acreage available for pump and treat system: 70 to 80 acres available for solar systems
- About the southeast half of site has a very shallow slope, the upper half may be >5%
- Site adjacent to paved highway
- Water resources: 80-90 gpm of distillate available from treatment of contaminated ground water
- Site enclosed by a security fence
- Locked gates prevent access when staff is not on site
- No livestock is allowed on site.

Most LM sites have been prescreened for PV small scale applications and have adequate solar resources and transmission line access.

Base Case Energy Use for Water Treatment

A pump and treat system was placed in service at Tuba City in 2002 to remove contaminants from the ground water. A vapor-compression evaporator is used to treat 100 gpm of water to produce 90 gpm of distillate. The distillate is injected into the aquifer. Operation of the treatment system will continue until at least 2025.

Electricity consumption could also be reduced by preheating the evaporator feed water. The evaporator operates under vacuum at about 145°F, therefore, preheated water of 150°F or higher would be useful. Solar heating of water could provide the preheating.

Skilled operating and maintenance personnel staff the facility seven days a week except for holidays.

Daily power usage for the water treatment plant and extraction wells is about 5,000 kWh. Usage is continuous with little seasonal variation. Power cost from APS is about $.0905/kWh. Thus annual baseline energy use and cost are estimated at 1825 MWh/year and $165,000/year.

Solar Energy Resource Information

For flat plate solar thermal or PV collectors the orientation is south-facing tilted up at an angle equal to the local latitude. This averages 5.93 kWh/m2/day as illustrated in Figure 1. Parabolic trough solar thermal collectors use only the beam radiation from the sun but track from east to west and the average is 5.5 kWh/m2/day for Tuba City, AZ as illustrated in Figure 11.

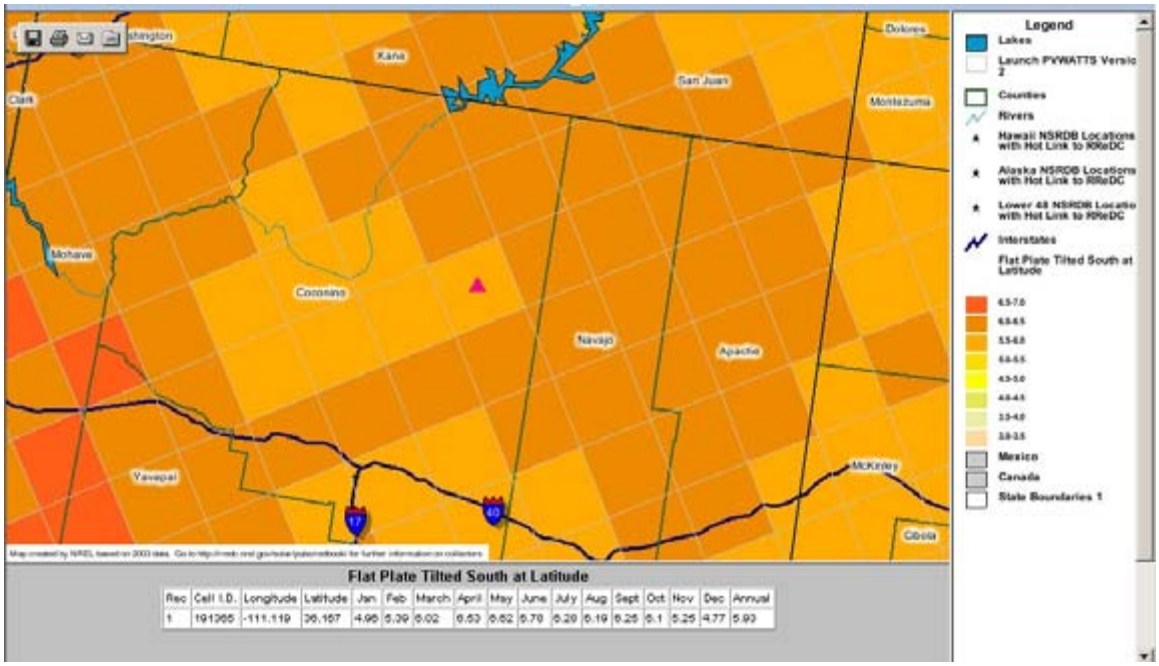

Figure F-1. Monthly and Annual (5.93 kWh/m2/day) Solar Resource on Flat Plate Tilted at Latitude (36 deg).

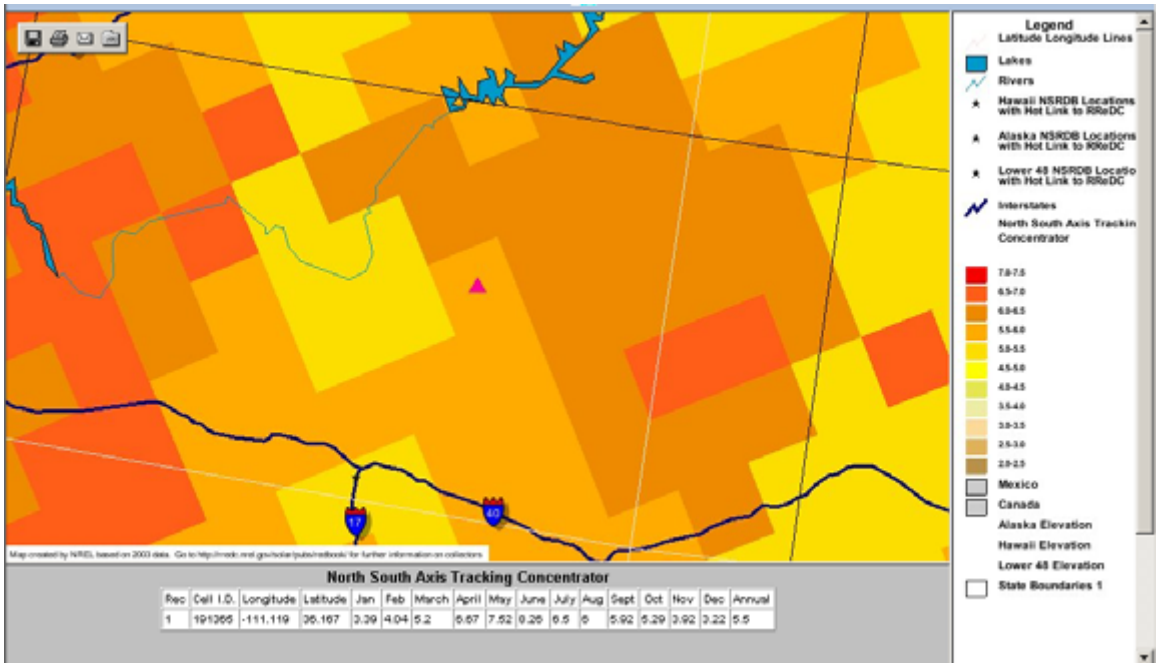

Figure F-2. Monthly and Annual (5.5 kWh/m2/day) Solar Resource for N-S Concentrating Solar Thermal Collector.

Utility and Tax Incentives

There are currently four options available for non-residential customers to participate in the Arizona Public Service (APS) Solar Partners Incentive Program.

Install a New Photovoltaic System and Receive an Up-front Incentive

Non-residential grid tied customers can receive a one-time incentive of $2.50 per installed DC watt. The maximum incentive per customer per year is $500,000. Non-residential customers can also receive incentives for system expansion. System expansion incentives are capped at 50 percent of the total cost of expansion.

Install a New Photovoltaic System and Receive a Production Based Incentive

APS has reserved a portion of the funding available for non-residential photovoltaic systems that are willing to contract with APS for credit purchase based on production (i.e. cents per kilowatt hour of production) in place of an up-front lump sum payment. This incentive type is known as a Production Based Incentive or "PBI". Term and credit purchase price for such systems are to be negotiated between the customer and APS before a reservation for the funds is made.

Install a New Large Solar Water Heating System

The minimum system size is 5,000 kWh per year estimated energy savings. This option is available to non-residential customers to replace an electric water heater or other water heating system approved by the ACC. The customer receives a production based incentive (PBI) for the thermal energy delivered by a solar water heating system of $0.07 per kilowatt hour-equivalent based on metered production. APS will make its own thermal meter readings for determining the amount of the quarterly payment. The PBI is

for a term of 10 years or 50% of the total system cost, whichever comes first. The cost associated with financing the system may be included in the total system costs (receipts or documentation must be provided to APS at the time of the credit purchase agreement execution) and the allowable finance rate is capped at the federal prime rate plus 5%. Payments are made at the end of each calendar quarter within 30 days of receipt and confirmation of thermal meter readings. The customer is responsible for providing the meter readings. APS reserves the right to inspect the system, including the meter(s), at any time. For purposes of payment, 3,412 BTUs equal a kWh.

Leveraging Renewable Federal and State Tax Incentives

If the system could be implemented in partnership with a partner with a tax liability, there is a state tax credit (capped at $25,000), and a Federal Tax Credit of 30% (not capped) along with accelerated depreciation benefits.

Payback periods are calculated assuming these incentives may be realized.

Table F-1. Life Cycle Cost Comparison of Solar PV and Solar Thermal Alternatives, and Both Bundled Together

	Base case	200 kW PV system	3712 sq ft solar thermal system	Both PV and Solar Thermal Combined
Energy Use (kWh/year)	1,825,000	1,491,682	1,557,369	1,224,051
Energy Cost ($/year)	$165,163	$134,997	$140,942	$110,777
Capital Cost ($)		$749,554	$267,631	$1,017,185
Annual O&M cost ($/year)		$2,000	$2,690	$4,690
Production Incentive ($/year)			$15,998	$15,998
Life Cycle Cost ($)	$2,857,311	$3,119,606	$2,616,000	$2,878,294

Results indicate that the solar thermal component of a project would be cost effective and may be financed at a reasonable interest rate; but the photovoltaics component is not, despite the incentives. If the two are considered together the bundled project would have a cost of over $1 million with annual cost savings and production incentive of $65k, which is sufficiently close to being cost effective to warrant further consideration.

Photovoltaics for Electric Power

Figure F- 3. This 160 kW PV system in Utah is similar in size and type to the system considered here.

Table F-2. Parameters Describing PV System

Initial Cost	$8,730.00	$/kW	RS Means Green Building Project Planning and Cost Estimating, 2006
O$M	0.006	$/kWh	Renewable Energy Technology Characterizations, EPRI TR-109496, 1997.C185
Balance of Systems (BOS)Efficiency	0.77		

Table F-3. Cost and Savings Associated with 200 kW PV System

Photovoltaics Size (kW)	PV Initial Cost ($)	PV Initial Cost w/incentives ($)	Avoided Cost ($/kwh)	PV Annual Energy Delivery (kWh/year)	Capacity Factor ()	PV Annual Utility Cost Savings ($)	PV Annual O&M Cost ($/year)	PV Payback Period (years)
200	1,745,960	$749,554	0.02	333318	19.0%	$30,165	$2,000	26.6

Solar Thermal to Reduce Electric Power Required

Figure F-4. This 4000 sf solar thermal system is similar to the size and type considered here.

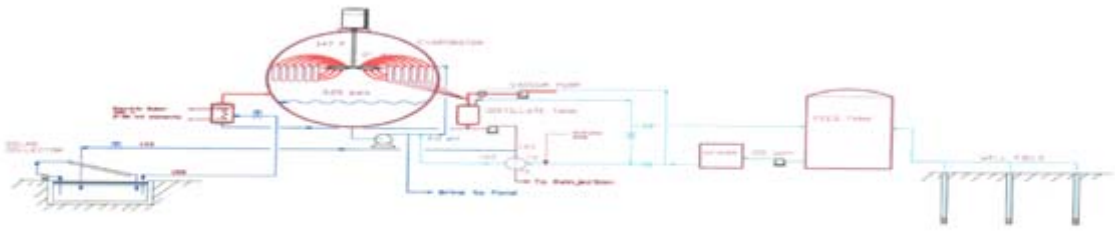

Figure F- 5. Schematic of water treatment system including solar thermal component.

Table F-4. Parameters Describing Solar Thermal System

Solar Thermal Cost	72	$/sf
O&M cost	0.34	$/therm/year
Efficiency	0.33	

Table F-5. Cost and Savings Associated with 3712 Square Foot Solar Thermal System

Solar Thermal Area (ft2)	Thermal Energy Delivery (therms/year)	Solar Thermal Initial Cost ($)	Thermal Annual Utility Cost Savings ($/year)	Production Incentive ($/year)	Solar Thermal Cost w/incentives ($)	Solar Thermal O&M Cost ($/year)	Solar Thermal Payback Period (years)
3,712	7,798	$267,631	$15,733	$15,998	$162,342	$2,690	5.6

Appendix G: References

1. Perez R., P. Ineichen, M. Kmiecik, K. Moore, R. George and D. Renne. 2003. "Producing Satellite-Derived Irradiances in Complex and Arid Terrain." *Proceedings of the ASES Annual Meeting*, Austin, TX.

Appendix H: DOE LM/BLM/NREL Contacts

DOE Office of Legacy Management

Name	Office	Phone#	e-mail address
Robert Baney	Director, Office of Site Operations, HQ	202-586-3751	robert.baney@hq.doe.gov
Rich Bush	NEPA Compliance Officer, Office Of Site Operations, Grand Junction	970-248-6073	rbush@lm.doe.gov
Tracy Plessinger	NREL Study Project Manager & Site Lead, Office Of Site Operations, Grand Junction	970-248-6197	tplessinger@gjo.doe.gov
Ray Plieness	Program Manager, Office of Site Operations, Grand Junction	970-248-6091	ray.plieness@gjo.doe.gov
Steve Schiesswohl	Realty Officer, Office Of Site Operations, Jefferson County, CO	720-377-9683	steve.schiesswohl@lm.doe.gov
Scott Surovchak	WY Site Manager, Office of Site Operations, Jefferson County, CO	720-377-9682	scott.surovchak@lm.doe.gov

BLM - Bureau of Land Management

Name	Office	Phone#	e-mail address
Walt George	National Project Manager	307-775-6116	Walt_George@blm.gov

NREL – National Renewable Energy Laboratory

Name	Office	Phone#	e-mail address
Doug Dahle	Senior Program Manager, Strategic Energy Analysis & Applications Center, Energy Management & Federal Markets Group	303-384-7513	douglas_dahle@nrel.gov
Dennis Elliott	Meteorologist, National Wind Technology Center	303-384-6935	dennis_elliott@nrel.gov
Grace Griego	Technical Editor, Program Support Office	303-275-4518	grace_griego@nrel.gov
Donna Heimiller	Electricity Systems Center, GIS Team Leader	303-275-4667 303-384-7098	donna_heimiller@nrel.gov
Mark Mehos	Program Manager - CSP Technologies, Buildings and Thermal Systems Center	303-384-7458	mark_mehos@nrel.gov
Robi Robichaud	Senior Engineer, National Wind Technology Center	303-384-6969	robi_robichaud@nrel.gov
Marc Schwartz	Meteorologist, National Wind Technology Center	303-384-6936	marc_schwartz@nrel.gov
Byron Stafford	Program Manager - PV Technologies, National Center for Photovoltaics	303-384-6426	byron_stafford@nrel.gov
Andy Walker	Senior Engineer, Strategic Energy Analysis & Applications Center, Energy Management & Federal Markets Group	303-384-7531	andy_walker@nrel.gov

Appendix I: Acronyms and Definitions

BEF – Bonneville Environmental Foundation
Biomass – Includes: agricultural crops, wastes, and residues; wood, wood wastes, and residues; animal wastes; municipal wastes; and aquatic plants
BLM – Department of Interior's Bureau of Land Management
B&O – Business and Operation Tax
BPU – New Jersey Board of Public Utilities

CEC – California Energy Commission
C_p – This term represents the limit of the amount of power that can be extracted from the wind.
CPV – Concentrating Photovoltaic
CSP – Concentrating Solar Power

DEM – Digital Elevation Model
Developable Solar Land – Land with sufficient solar resource potential (ideally at annual direct normal solar radiation least 6 kWh/m2/day) that has not been excluded due to environmental or land-use considerations.
Developable Windy Land – Land with sufficient wind resource potential (as determined by average wind speed or wind power class) that has not been excluded due to environmental or land-use considerations.
DNI – Direct normal Insolation
DSIRE – Database of State Incentives for Renewables & Efficiency
DOE – Department of Energy
DOD – Department of Defense

EA – Environmental Assessment
EPA – Environmental Protection Agency
EERE – DOE's Office of Energy Efficiency and Renewable Energy
EIS – Environmental Impact Statement
ELF – Energy Loan Fund
Energy Conversion – Refers to the replacement of fossil-fuel resources with alternative fuels or technologies
EPS – Environmental Portfolio Standard
ESCOs – Energy Services Companies
ESPC – Energy Savings Performance Contracting

Flat-plate PV systems – are nonconcentrating PV systems
FONSI – Finding of No Significant Impact

GIS – Geographical Information System

Hybrids – Plants that use fossil fuel to supplement the solar output during periods of low solar radiation

IEEE – Institute of Electrical and Electronic Engineers
IOUs – Investor-owned Utilities

kV – kilovolts
kW – Kilowatts
kWh – Kilowatt Hours

LM – Office of Legacy Management
LORI – Large Onsite Renewables Initiative
LTSM – Long-Term Surveillance and Maintenance

MACRS – Modified Accelerated Cost Recovery System
Met-Ed – Metropolitan Edison Company
MWT – Meteorological
MW – Megawatts

NEC – National Electric Code
NEG – Net Excess Generation
NEPA – National Environmental Policy Act
NESC – National Electric Safety Code
Ng – is a term used for the efficiency of a generator
NMPRC – New Mexico Public Regulation Commission
NOAA – National Oceanic and Atmospheric Administration
NRC – Nuclear Regulatory Commission
NREL – National Renewable Energy Laboratory
NYSERDA – New York State Energy Research and Development Authority

O&M – Operation and Maintenance

PECO – PECO Energy Company
PEDA – Pennsylvania Energy Development Authority
Penelec – Pennsylvania Electric Company
PG&E – Pacific Gas and Electric Co
PPA – Power Purchase Agreement
PPL – PPP&L Resources, Inc.
PSC –Public Service Commission
PTB REPs – Price-to-beat retail electric providers
PUC –Public Utility Commission
PUCT – Public Utility Commission of Texas
PV – Photovoltaics

REC – Renewable Energy Certificates
Renewable energy – A source of energy that occurs naturally or is regenerated naturally, including without limitation: biomass, fuel cells, geothermal energy, solar energy, waterpower, and wind.
REP – Retail Electric Providers
ROD – Record of Decision
ROW – Right-of-Way
RPS – Renewable Portfolio Standards
RTO – Regional Transmission Organization

SBC – System Benefits Charge
SCE – Southern California Edison
SDG&E – San Diego Gas and Electric
SEF – Sustainable Energy Funds
SEGS – Solar Energy Generating Stations
Solar energy – Includes any displacement of fossil energy use and could include solar daylighting, solar water heating, etc.
Solid Waste Conversion – Refers to the use of waste to produce energy and the utilization of such energy
SRECs – Solar Renewable Energy Certificates
III-V Solar Cells – Solar cells made principally from elements in columns III and V of the Periodic Table. These are highest-performance solar cells with conversion efficiencies greater than 28% in production and a world record of more than 36% under concentration.

TDUs – Transmission and Distribution Utilities
Thermal Efficiency Improvements – Refers to the recovery of waste heat or steam produced in any commercial or industrial processes
T&D – Transmission and Distribution
TOU – Time-of-Use

UL – Underwriters Laboratories
USDA – United States Department of Agriculture

WPP – Allegheny Power/West Penn Power Company
Wind PEIS – Wind Programmatic EIS (Environmental Impact Statements)

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Doug Dahle, Dennis Elliott, Donna Heimiller, Mark Mehos, Robi Robichaud, Marc Schwartz, Andy Walker

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This report represents an initial activity for the Department of Energy's (DOE) Office of Legacy Management (LM) to identify and evaluate renewable energy resources on LM-managed federal lands. Within DOE LM's long-term surveillance and maintenance role, a key function is the establishment of environmentally sound future land uses by evaluating potential land reuse options. To support consideration of renewable energy power development as a land reuse option task, DOE LM and DOE's National Renewable Energy Laboratory (NREL) established a partnership to conduct an assessment of renewable energy resources on LM lands in the United States. The LM/NREL team used geographic information system (GIS) data to analyze and assess the potential for concentrating solar power (CSP), photovoltaics (PV), and wind power generation on LM lands. GIS screening criteria developed with industry from previous studies for the Bureau of Land Management and the U.S. Forest Service were applied to produce tables prioritized by renewable resource potential for all federal lands provided by LM. A principal objective was to gauge the renewable industry's interest in pursuing renewable power development on LM Lands. This assessment report provides DOE LM with information to consider when assessing alternatives of land reuse options for current and future LM lands.

15. SUBJECT TERMS
NREL; Office of Legacy Management; legacy management lands; LM; wind; solar; concentrating solar power; photovoltaics; geographic information systems; Bureau of Land Management

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