

## **Beneficial Reuse of DOE Legacy Management Sites and Renewable Energy Initiatives – 10276**

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### **ABSTRACT**

The U.S. Department of Energy Office of Legacy Management (LM) has pursued increasing the number of LM sites in beneficial use while also supplying more of its power consumption through renewable energy sources. All the LM sites were initially screened for potential renewable energy projects, mainly wind or solar energy. Wind energy appeared feasible on two sites in Wyoming, and solar photovoltaic (PV) systems appear feasible in western states such as New Mexico, Colorado, Utah, Arizona, and Wyoming. Three large LM sites near Grants, New Mexico (Ambrosia Lake, L-Bar, and Bluewater), and one site in Durango, Colorado, were studied in more detail. All four study sites have uranium mill tailings disposal cells on the properties.

The process of developing large-scale commercial PV systems and selling the electricity to utilities is complex and involves numerous factors, such as utility Requests for Proposal, interconnection process, and availability of grants and tax subsidies. Other factors at the LM sites include transmission line capacity, regulatory requirements (e.g., required permits, National Environmental Policy Act evaluations), land restrictions, and federal real estate regulations.

LM has already increased the use of renewable energy for the groundwater treatment system at the Tuba City, Arizona, site. The treatment system mechanically evaporates and removes high concentrations of uranium and dissolved solids so that treated groundwater is near drinking water quality. Despite challenges, a solar water heater was installed in 2008 and a 51 kilowatt PV system was constructed in 2009 to supplement electricity use.

### **INTRODUCTION**

The U.S. Department of Energy (DOE) created the Office of Legacy Management (LM) on December 15, 2003, to provide long-term surveillance and maintenance at sites where environmental cleanup has been completed. LM maintains control and custody of legacy land, structures, and facilities that remain from Cold War nuclear weapons and materials production. LM is responsible for maintaining protectiveness of these lands for their long-term use and for ensuring that the remedy remains effective.

LM manages 86 sites in 27 states and Puerto Rico; the sites vary in size from several hectares (acres) to several thousand hectares (acres). Most of these sites have disposal cells containing radioactive wastes, and land-use restrictions are in place to ensure the protectiveness of the cells. Locations of LM sites can be seen on the LM website at <http://www.lm.doe.gov/default.aspx?id=120>.

To fulfill the mission of managing DOE's post-closure responsibilities and to ensure the future protection of human health and the environment, LM established five goals. Goal 4, pertinent to

this paper, was to “manage legacy land and assets, emphasizing protective real and personal property reuse and disposition.” To accomplish this goal, LM is actively reducing the federal “footprint” and placing as much land into beneficial reuse as is prudent and practicable. LM routinely screens its sites for disposal and reuse opportunities.

Reuse options include development-related renewable energy, such as wind, solar, and biomass; commercial and industrial uses; conservation uses; and agricultural uses. In partnership with DOE’s National Renewable Energy Laboratory (NREL), LM has screened its sites for wind and solar energy development potential. The report *Assessing the Potential for Renewable Energy Development on DOE Legacy Management Lands* (available to the public at <http://www.nrel.gov/docs/fy08osti/41673.pdf>) screened and scored LM sites for their renewable energy potential for concentrating solar power, photovoltaic (PV), and wind.

Wind energy appeared feasible on two sites in Wyoming, while solar PV systems appear feasible in western states, such as New Mexico, Colorado, Utah, Arizona, and Wyoming. The sites in New Mexico were chosen for additional study on the practicality of constructing commercial-scale solar PV systems. The list of sites was then narrowed down, and LM decided to concentrate on only the largest practical facility.

## **BENEFICIAL REUSE OF SITES—SOLAR POWER**

Most of LM’s sites in the western states do not have buildings or facilities that consume power. At those sites, LM will rely on partnering with private developers to use excess DOE land and sell the power back to the utility. The process of developing large-scale commercial PV systems and selling the electricity to utilities is complex and involves numerous factors, such as utility requests for proposals, interconnection process, and availability of grants and tax subsidies. The following discussion provides background information about the growing PV industry and the economics and changes taking place.

### **Background of the Solar PV Industry**

The solar industry has changed in recent years with decreasing cost of panels, increasing efficiencies of generating electricity, and increasing subsidies from governments and utilities to construct clean power sources, such as solar power. The number of larger, utility-scale systems has increased over the last few years; systems as large as 60 megawatts (MW) have been installed in Europe. Over 170 PV systems have been built worldwide with a capacity over 5 MW. The largest solar facility operating in the United States is a 14 MW system at Nellis Air Force Base, Nevada. Several larger solar facilities are currently under construction in Florida. Recently, the U.S. Army, partnering with ACCIONA Solar Power, announced that a project under way in the Mojave Desert would provide 500 MW of solar PV power and would take 13 years to construct. Although the cost of PV panels is decreasing, and the cost of generating solar power is approaching the cost to generate peak power loads, in general solar PV projects still require subsidies through incentives and higher purchase rates to make the projects economical.

The easiest solar project to implement is that of a residential or small commercial system. Utility companies and many states have incentives and rebates for building systems of 25 kilowatts (kW) to 100 kW. In an arrangement called net metering, utilities will buy the power back when it

is not being consumed in the building. Some utilities favor a number of smaller systems that have less impact to the grid rather than several larger systems that might have a greater impact.

New Mexico's 2004 Renewable Energy Act, as amended in 2007, requires Public Service Company of New Mexico (PNM) to produce or buy increasing amounts of renewable energy. Renewable energy must make up 6 percent of the utility's retail sales in the 2008–2010 time frame, 10 percent in 2011, 15 percent in 2015, and 20 percent by 2020. The rule also established that after 2011, 20 percent of the renewable energy must come from solar resources.

The Renewable Energy Act contains provision to establish a Reasonable Cost Threshold (RCT). The utility is not required to add renewable energy to its portfolio as a cost exceeding the RCT. The RCT is based on a rate impact analysis. To purchase renewable power, PNM put out a Request for Proposal (RFP) in 2008 for companies to bid on. A queue was established based on the date and acceptability of the applications. PNM currently has 31 large projects (over 20 MW) and 7 small projects in the queue.

Connections to the utility grid are regulated by the Federal Energy Regulatory Commission. The interconnect processes for the Fast Track Process (less than 2 MW) and the study process for projects between 2 MW and 20 MW are controlled by the Small-Generator Interconnection Procedures. Large-Generator Interconnection Procedures for projects over 20 MW are set by the transmission provider. Connecting to the utility with any system over residential size falls into one of these processes.

The Fast Track Study Process for projects up to 2 MW requires the project to meet applicable codes and standards and prove to the utility company that it is safe to operate. Minor modifications to the electrical infrastructure may be required, the cost of which will be passed on to the developer.

Projects between 2 MW and 20 MW require additional studies, including:

- A feasibility study, which identifies potential adverse system impacts.
- A system impact study, which details all electrical system impacts if the system is tied to the grid.
- A distribution system study, which identifies impacts to the distribution system.
- A facilities study, which estimates cost of equipment, engineering, procurement, and construction to implement the improvements.

### **Grants and Incentives**

Numerous grants and tax incentives are available for renewable energy projects. The net cost of energy generated from a renewable energy project is highly dependent on the type and quantity of the renewable resource, size of the project, and incentives available. Most large-scale projects are owned by tax-paying entities, so they can take advantage of the tax incentives. The following are some of the primary grants and incentives available nationally and in New Mexico:

- The American Recovery and Reinvestment Act (stimulus package) provides for an investment tax credit equal to 30 percent of the capital cost of the project, if construction

begins by the end of 2010. The stimulus package also expanded a loan program that is administered by DOE. Loans guarantees are available for up to 80 percent of the capital cost of the project.

- The U.S. Department of Agriculture has grants and loan guarantees available to agricultural producers and rural small businesses. Grants are limited to 25 percent of a proposed project's cost, while loan guarantees may not exceed \$25 million. The combined loan and grant cannot exceed 75 percent of the cost.
- Tax benefits have been extended for renewable energy projects, and now costs can be depreciated over 5 years instead of 20 years.
- The State of New Mexico also has an energy tax credit against corporate or personal income. The amount of credit varies from year to year from 1.5 cents per kilowatt-hour to 4 cents per kilowatt-hour.

### **New Mexico Solar PV Project**

Most of the LM sites in the west have uranium mill tailings disposal cells on the properties. The disposal cells were created to dispose of mill debris, tailings, and remediated soils in which concentrations of radium-226 exceeded standards. In most cases, more land was set aside than what was needed for just the disposal cell. The excess land may have groundwater restrictions, but in most cases no surface restrictions are required.

Three large LM sites near Grants, New Mexico (Ambrosia Lake, L-Bar, and Bluewater), shown in Fig. 1, were studied in more detail by assessing the available acreage outside the disposal cell and other site constraints, developing a conceptual layout of a PV system and the costs, and describing the utility interconnect process.

Screening criteria used for siting the PV system included:

- Land slope not exceeding 5 percent.
- Free of arroyo channels and waterways.
- No potential shading.
- Availability of access and nearby infrastructure.

All three sites met the screening criteria, although L-Bar has a number of arroyos that would at least need stabilization or rechanneling. In addition, L-Bar is remote and has had security issues over the years. The Ambrosia Lake site has good potential and is also in a fairly remote area. All three of the sites have previously had uranium mills and tailings piles on them. Because the uranium mills needed electricity, all the sites have some electrical infrastructure either on the site or nearby.

Excess land at each site was analyzed for the largest potential PV facility. Conceptual designs resulted in PV systems of 3 MW at L-BAR, 9 MW at Ambrosia Lake, and 20 MW at Bluewater. Although the Bluewater site is large enough to place an even larger facility, 20 MW was used because of the lengthier utility interconnection process for Large Generator Projects over 20 MW.

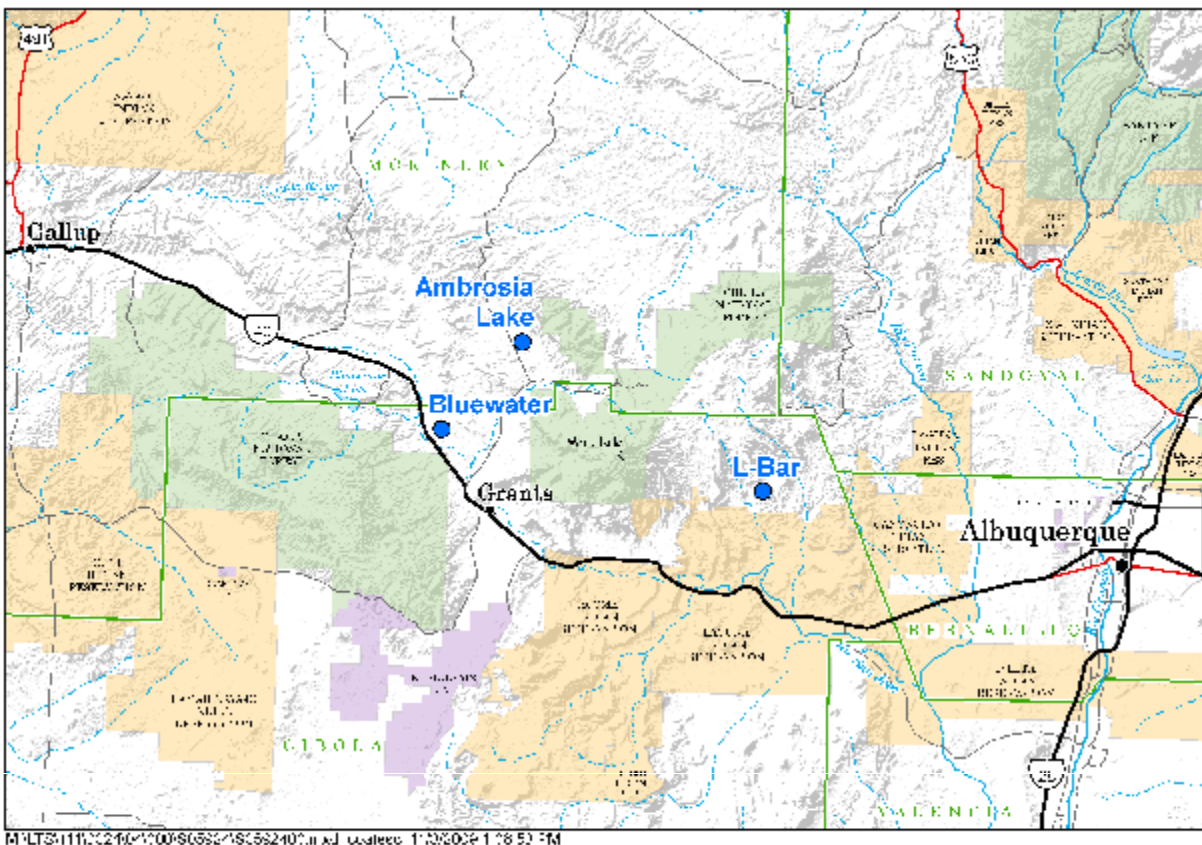


Fig. 1. LM Sites in New Mexico.

All three sites are located in the Grants uranium district, which was once the largest uranium-producing area in the United States. New projects for new uranium mines and uranium mills near both L-Bar and Ambrosia Lake have been proposed over the last few years. Although the price of uranium has dropped, and there is less activity in the industry, the future potential for new mills and mines is very high, and these new facilities would create heavy electrical demand in the region. However, until that occurs, PV-generated electricity would be conveyed on existing transmission lines toward Albuquerque.

### **Bluewater, NM, PV System**

As a result of the study, the Bluewater site near Grants was chosen for further study because of its proximity to transmission lines, good access, and sufficient flat land for siting a 20 MW PV system. The site comprises 1214 hectares (3000 acres) and has nearly 324 hectares (800 acres) of flat land with 1 to 3 percent grade. A Tri-State Generation and Transmission Association (Tri-State) substation and high-voltage transmission lines cross the property. Several high-pressure natural gas lines have rights-of-way across the property; however, they will not interfere with the PV site. The Bluewater site falls within the service area of Continental Divide Electric Cooperative, which provides service to two counties and is one of 44 members of the Tri-State family of power companies. Continental does not generate any power and purchases all of its power from Tri-State.

The site has fairly good access from County road 334, which connects to Interstate 40 and Highway 122. The open flat land has sparse grasses and shrubs, depth to groundwater is more than 30 meters (100 feet) below ground surface, and the site is not near any major waterway. The closest ranch house is 0.8 kilometer (0.5 mile) to the south.

Although the site has all of the attributes needed for building a large solar facility, major hurdles still have to be managed:

- The utility RFP
- Interconnection studies and process
- Sufficient transmission line capacity
- Working through land restrictions and federal real estate regulations to lease land to another entity

A photograph of the area where a 20 MW system could be built is shown in Fig. 2. Approximately 40 hectares (100 acres) are required for a fixed-tilt panel system. Electrical infrastructure includes inverters to convert current from DC to AC, transformers to increase the voltage to line voltage, and a power line to convey the power to the substation.



Fig. 2. Photograph of the Bluewater site.

As stated, power from a large system cannot be connected to the utility without a utility RFP bid solicitation process, placement in the queue, and numerous studies to assess the impacts. Communication with PNM and Tri-State indicated that PNM would be the likely utility to connect to. The New Mexico Renewable Energy Act requirements do not apply directly to Tri-State; however, Tri-State is interested in purchasing renewable power to help its customers meet requirements.

One of the problems with the RFP process and resulting queue is that the date of a valid application determines its position in the queue, the resulting order of the required studies, and the time it takes to move applications through the system. A project's position in the queue can affect whether transmission capacity is available. Consequently, if an area such as McKinley County/Grants has the potential for numerous large solar facilities, and if there is little capacity in the transmission lines, PNM will be committed to the first projects in the queue. Once the transmission capacity is reached, the next project in line has to pay for costly improvements that would also provide capacity to others that connect after them. Utilities are recognizing the concern and are proposing changes to the system so that regional areas can be studied rather than individual projects.

Also, because of the low cost for a proposed project to enter the queue, the amount of proposed megawatts in the active queue is usually overstated and produces study results that could estimate higher network upgrade costs.

Despite the presence of high-voltage lines and an electrical substation on the site, excess capacity is not readily available. Bidders in previous queues have already tied up the remaining capacity. The current system of the Federal Energy Regulatory Commission does not require due diligence or deadlines for the developers to meet in building their projects. Although upgrades to transmission lines required to handle the increased load from the Bluewater PV system may cost a few million dollars, the utility company's policy is to upgrade in a larger increment. This cost in the case of Bluewater would be tens of millions of dollars, making the project no longer feasible. LM will need to work with the utility companies to determine if there are other options available.

Because land is relatively inexpensive in New Mexico—its cost is less than 1 percent of the project cost—to attract potential bidders, LM must minimize regulatory requirements and the negative perception of individuals having to work with the federal government.

The concept for teaming with the private developer would be to outgrant property (i.e., grant another party temporary use of government property) through a long-term lease for minimal or no cost. Lease terms would identify insurance and bonding requirements, require the developer to disturb only the land necessary for the facility, revegetate disturbed areas after completing the work, remove all hardware when the project is terminated, and abide by all applicable rules and regulations. Although the PV site is far enough away from the disposal cell and drainage channels, a fence will be required to segregate the PV facility.

Because constructing a PV system would result in a land use different from that originally considered in the site Environmental Impact Statement, LM must consider its action under the

National Environmental Policy Act (NEPA). Both a Categorical Exclusion and an Environmental Assessment will be evaluated to determine which is applicable. If an Environmental Assessment is developed, up to seven Native American tribes will be consulted, and a visual resource analysis, ethnographic study, and cultural resource survey will be performed. This process will take about 8 months if major issues are not identified.

Regulatory permits do not appear to be a major hurdle for the project. A small area of cattails and saturated soils on the site could be affected by new road construction. Depending on the amount of impact, LM will determine whether a Corps of Engineers Nationwide or Section 404 permit is needed.

Because a large area will be disturbed, LM is required to prepare a Storm Water Pollution Prevention Plan and install silt fences and other runoff controls. It does not appear from a review of the county zoning code that zoning permits will be required, but the developer will still need to work with the County.

The disposal cell is included in the U.S. Nuclear Regulatory Commission's (NRC's) general license for custody and long-term care of uranium mill tailings disposal sites, which designates DOE (and consequently LM) as the long-term custodian. Specific license conditions are contained in a Long-Term Surveillance Plan approved for the site. The license requires LM to notify NRC if a change in land use occurs. Since the PV system would not impact the disposal cell, the process should not interfere with the schedule or feasibility of the project.

In PNM's 2008 RFP, the utility allowed parties to place descriptions of their land in the RFP to let bidders lease for a solar project. Initially, LM considered competitively bidding the lease, and the developer could go through the RFP and queue process. However, this results in two steps with the uncertainty and added costs if the developer doesn't make it into the queue. At the advice of PNM and a consultant, LM would place a description of the property with the RFP and let PNM's evaluation process determine the successful project and lessee.

### **Durango, Colorado**

A local business approached DOE about the possibility of installing a solar PV system at the Durango, Colorado, Disposal Site. As a result, LM is studying the site as a potential location for the project. The site initially looks favorable, because the uranium mill tailings disposal cell is on a hillside facing south, transmission lines cross a corner of the property, and the site is 0.4 kilometer (0.25 mile) from a substation. The largest flat area on the 49 hectare (120 acre) property is on top of the disposal cell. Since the disposal cell design was approved by NRC, and the site is under the NRC general license for long-term surveillance and maintenance, LM will work with NRC to demonstrate that the cell's performance will not change if a PV system is built on the cover.

The disposal cell was designed to be effective for up to 1000 years, or if that is not reasonably achievable, at least 200 years. Consequently, drainage features were designed with erosion protection against a Probable Maximum Precipitation (PMP). The top of the cover includes a 15 centimeter (6 inch) rock-soil matrix that supports vegetation. The surface was sloped at 1.5 percent to promote runoff but minimize erosion. The rock is sized to protect against the



resulting runoff from a PMP and provide protection to the underlying frost barrier, composed of silts and clay. Vegetation helps support a water balance and minimize infiltration. Side slopes of the cell are steeper (5:1 grade) with large riprap up to 64 centimeters (24 inches) in diameter and gravel bedding to protect against erosion. The challenge of using the cover for the PV system is to avoid altering the NRC-approved design. The installed system must not change the grade, disturb riprap, or penetrate below the frost barrier.

The vegetated cover, as shown in Fig. 3, provides an ideal area for solar panels because the grade is already flat—1 to 2 percent—and would not require regrading. The side slopes of the cell appear to be a better place for panels because they are already angled towards the sun. However, they are not at the ideal angle for optimal solar position for a fixed-tilt panel, which is close to the latitude of the site. This would result in adjustments in the framing or having a less efficient system. Additionally the large rock cannot be disturbed, so it would be difficult to work on.



Fig. 3. Photograph of the Durango Disposal Cell.

Panel systems typically use concrete foundations or anchors to withstand wind and other forces. Rooftop systems have been developed that don't require foundations by building ballast into the frame or by designing unique panel configurations. These systems can also be used on the

Durango cell to minimize disturbance of the cover. As much infrastructure as possible will be placed off the cell. The top of the cell has sufficient area for a 2 MW system.

The site falls within the La Plata Electric Association territory. La Plata is also a member of the Tri-State Cooperative. The high-voltage lines crossing the property belong to Tri-State, and a lower voltage line across the county road belongs to La Plata. Initial indications from the utility companies are that it would be more practical to tie into La Plata's line, as it requires a smaller transformer.

Challenges for LM to use this site will include how to provide an incentive for a developer to use the property, obtaining NRC concurrence that the panels can be built on the cover and not disturb the cell performance, and working with the local utility or Tri-State, depending on the size of the facility.

As with the Bluewater site, a lease must be used to outgrant the property to a developer, although the lease will have more restrictions than at Bluewater. The following restrictions will limit the developer's flexibility in building a system:

- The grade of the cover can't change.
- No trenching will be allowed.
- The storm water diversion systems can't change.
- Lessee will provide their own security measures, such as fencing.

A NEPA evaluation must be performed, since the original Environmental Impact Study did not evaluate another land use. The evaluation will result in either a Categorical Exclusion or an Environmental Assessment. Since all the improvements will be in the area of the site that was disturbed for construction of the cell, fewer studies will be needed.

DOE has performed work at other LM sites that are under NRC general license, including construction of a groundwater treatment plant near the Tuba City disposal cell. However, they have never proposed other improvements, or a project such as a solar PV facility to be built on top of a cover. Consequently it will take some time to work through questions from NRC.

## **OTHER REUSE INITIATIVES**

LM is also reviewing other federal agency and DOE renewable energy research and development and commercial generation efforts to see where LM land could be offered for generation of wind energy. Because wind turbine projects require large tracts of land, DOE is also considering partnering with adjacent landowners, such as the U.S. Bureau of Land Management, to create parcels that have sufficient area. According to the NREL study, LM sites in Wyoming would have the best wind resource.

LM has six sites with uranium mill tailings disposal cells in Wyoming. By using the BLM database of potential sites in conjunction with the LM Geographic Information System, LM can determine if potential projects are adjacent or near an LM site. Developers of any projects nearby

will then be contacted to determine if they would be interested in renewable energy projects on the LM land.

### **INITIATIVES TAKEN TO REPLACE EXISTING ENERGY USAGE WITH RENEWABLE SOURCES**

To comply with Executive Order 13423, *Strengthening Federal Environmental, Energy, and Transportation Management*, and DOE Order 430.2B, *Departmental Energy, Renewable Energy and Transportation Management*, LM has prepared a plan for managing and implementing various energy-related activities at LM sites. LM has performed renewable energy audits at the seven sites where electricity is purchased from a utility.

For each site, the audits determined the solar and wind resources available, the energy requirements, the operating life, and the utility's policies regarding connecting to the grid. On the basis of the audits, LM prepared a list of viable projects and generated order-of-magnitude cost estimates. Solar PV projects in Arizona, Utah, and Colorado had the best combination of resource availability, relatively expensive purchased electricity, and encouraging utility interconnection policies.

LM is already exceeding the DOE Order 430.2B goal of generating 3.75 percent of a site's electricity from renewable sources at two (Rifle, CO and Tuba City, AZ) of the seven sites. Utilities at two of the other sites—Shiprock, NM, and Monument Valley, AZ—do not allow connection of renewable energy-generating equipment to the grid. LM's largest energy user, the Fernald, OH, site, does not have good renewable energy resources, and the cost of electricity is relatively low. Thus, a large-scale renewable energy project was not recommended. However, a project is justified at the other large electricity user, the Tuba City, AZ, water treatment plant, which is located in a sunny area with higher-than-average electricity rates.

On the basis of the favorable evaluation, a 51 kW solar photovoltaic system was installed at the Tuba City site in 2009. The project will generate about 4 percent of the site's electricity usage of about 2,000 MW-hours per year. The system uses 300 solar panels arranged in four arrays to generate 480-volt, 3-phase power that is connected to the water treatment plant's electrical distribution load center. Electricity is sent to the utility when the plant is shut down.

A solar hot water heating system, as shown in Fig. 4, was installed at Tuba City in 2008 to reduce purchased electricity. Parabolic-trough mirrors track the sun and heat a propylene glycol solution that is used to heat feed water for the site's contaminated-water evaporator. The system has reduced purchased electricity usage by 10–15 percent.



Fig. 4. Tuba City, Arizona, Solar Hot Water Heating System

LM has numerous sites where smaller solar PV panels are used to power remote telemetry, air monitoring, and water pumping equipment. The installations range from simple 20 W water meters to 7 kW highly instrumented pumping systems that include batteries for 24 hours per day operation. The systems at the Rocky Flats site supply 100 percent of the energy used for field operations and for running small groundwater remediation systems. These solar PV systems are very reliable and cost effective, since utility power is normally not available at the more remote LM sites. Additional renewable energy systems will be added at LM sites when they are shown to meet project needs.