

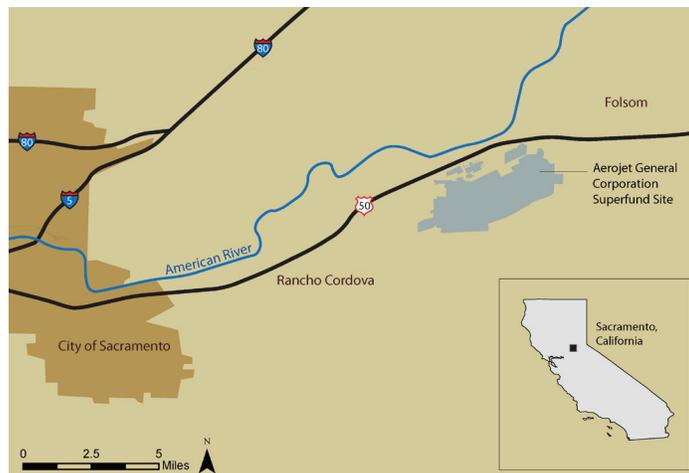
### Introduction

With renewable energy providing a steadily increasing share of the nation’s energy resources, more of the sun’s rays are being converted into other forms of energy, such as heat and electricity. At a 40-acre facility near Sacramento, 22 solar arrays track the course of the sun, generating six megawatts (MW) of power. The solar farm is the largest single-site industrial system in California and one of the largest single-site industrial installations in the United States.

This facility is remarkable for two reasons. First, it illustrates the dramatic growth of grid-connected, utility-scale photovoltaic (PV) systems in the United States. Between 2000 and 2008, the capacity of these systems nationwide grew from less than 20 MW to more than 500 MW, an average annual growth rate approaching 60 percent. Second, the solar farm is located on the Aerojet General Corporation Superfund site, a rocket propulsion development and testing facility. The U.S. Environmental Protection Agency (EPA) listed the site on the National Priorities List in 1983.

Aerojet’s solar farm is the latest and largest in a series of renewable energy facilities sited on current and former contaminated lands nationwide. Aerojet installed the solar farm to help power the site’s extensive groundwater remediation program, reducing the company’s carbon footprint and improving energy usage as part of parent company GenCorp’s Sustainability Initiative. The facility also restores the land to beneficial use as an energy-producing environmental asset.

This case study explores the key factors, tools and partnerships that led to the rapid, successful solar reuse of this part of Aerojet’s



5,900-acre facility. In particular, the case study focuses on Aerojet’s public-private partnership with developer Solar Power, Inc. and the Sacramento Municipal Utility District (SMUD), which helped enable the project’s feasibility, and its coordinated approach with EPA and state regulatory agencies to ensure the effectiveness and protectiveness of the site’s ongoing cleanup.

In the following pages, the case study discusses the evolution of solar energy reuse efforts at the site from initial planning activities in 2008 to the solar farm’s construction, operation, expansion and grid connection in 2009 and 2010. The case study is intended to provide relevant information and lessons learned from solar reuse at the Aerojet General Corporation site to companies, local governments, communities, utilities and regulators interested in supporting utility-scale PV solar development opportunities on contaminated lands.



Aerial view of the Aerojet solar farm, 2009

## Site History, Contamination and Remediation

Located in the Sacramento metropolitan area in northern California, the property was acquired by Aerojet in 1953 to develop and test solid and liquid fuel rocket propulsion systems to support national defense, space exploration and satellite deployment. The facility included significant buffer zones between testing facilities and neighboring properties.

In the 1950s, this former gold mining area was isolated, relatively distant from surrounding communities. Over time, the growth of these communities brought development closer to the site. Today, Aerojet's 5,900-acre property is surrounded by mixed residential, commercial, industrial and recreational land uses to the north and ranching, agricultural, mining and recreational land uses to the south. The American River is located approximately a half-mile from the site's northeastern edge.



*Rocket fuel test areas and facilities, 1963*

Past disposal and operation practices, including industrial chemical and pesticide manufacturing and rocket propulsion system manufacturing and testing operations, led to soil and ground water contamination at the Aerojet General Corporation site. Primary contaminants of concern include trichloroethylene (TCE), perchlorate and N-nitrosodimethylamine (NDMA). TCE is a volatile organic compound (VOC) that was used at the site for cleaning and degreasing purposes. Perchlorate is a specialized salt used as an oxidizer in solid rocket propellants. NDMA is a semi-volatile organic compound (SVOC) that was either an impurity in hydrazine-based liquid rocket fuels or formed during combustion of these fuels.

Remediation at the site began in the mid-1980s with the installation of groundwater extraction and treatment facilities to protect ground water and surface water that flows into the American River. In 1983, EPA added the Aerojet facility to the National Priorities List (NPL), the Agency's list of top-priority Superfund sites. After 2001, remediation plans were divided into nine Operable Units (OUs) to prioritize and accelerate a phased cleanup, which is ongoing. EPA and state regulators have overseen a rigorous sampling and evaluation process of contaminated ground water and soils associated with the site to ensure the protection of public health and the environment during the cleanup process. To date, site facilities have treated 102 billion gallons of water.

| Operable Unit # | Operable Unit Name                | Status  |
|-----------------|-----------------------------------|---|
| 1               | Overall Site                      | Study and remedy selection underway.  |
| 2               | American River GET                | Addressed under Perimeter Ground Water OU 5 and other operable units.   |
| 3               | Western Ground Water OU           | ROD signed in 2001.   |
| 4               | Area 41 Soil & Ground Water       | Study and remedy selection underway.  |
| 5               | Perimeter Ground Water            | Proposed Plan issued for public comment in August 2009; ROD anticipated in fall 2010. Landfill included in OU 5, with closure overseen by state and county authorities. |
| 6               | Boundary OU Ground Water and Soil | Study and remedy selection underway.  |
| 7               | Islands OU Ground Water and Soil  | Study and remedy selection underway.  |
| 8               | Eastern OU Ground Water and Soil  | Study and remedy selection underway.  |
| 9               | Central OU                        | Study underway.   |

Throughout all planning and cleanup activities, EPA and state staff meet regularly with community stakeholders to share information and updates and to incorporate community feedback into the Superfund process. The remedial investigation and remedy selection process has enabled Aerojet to reuse a portion of its property for its solar farm. In coordination with EPA, Aerojet sited its solar farm on land that is not contaminated. The company also designed the facility with adequate space between the rows of solar modules to allow for the installation of additional groundwater monitoring wells in the future, if needed.

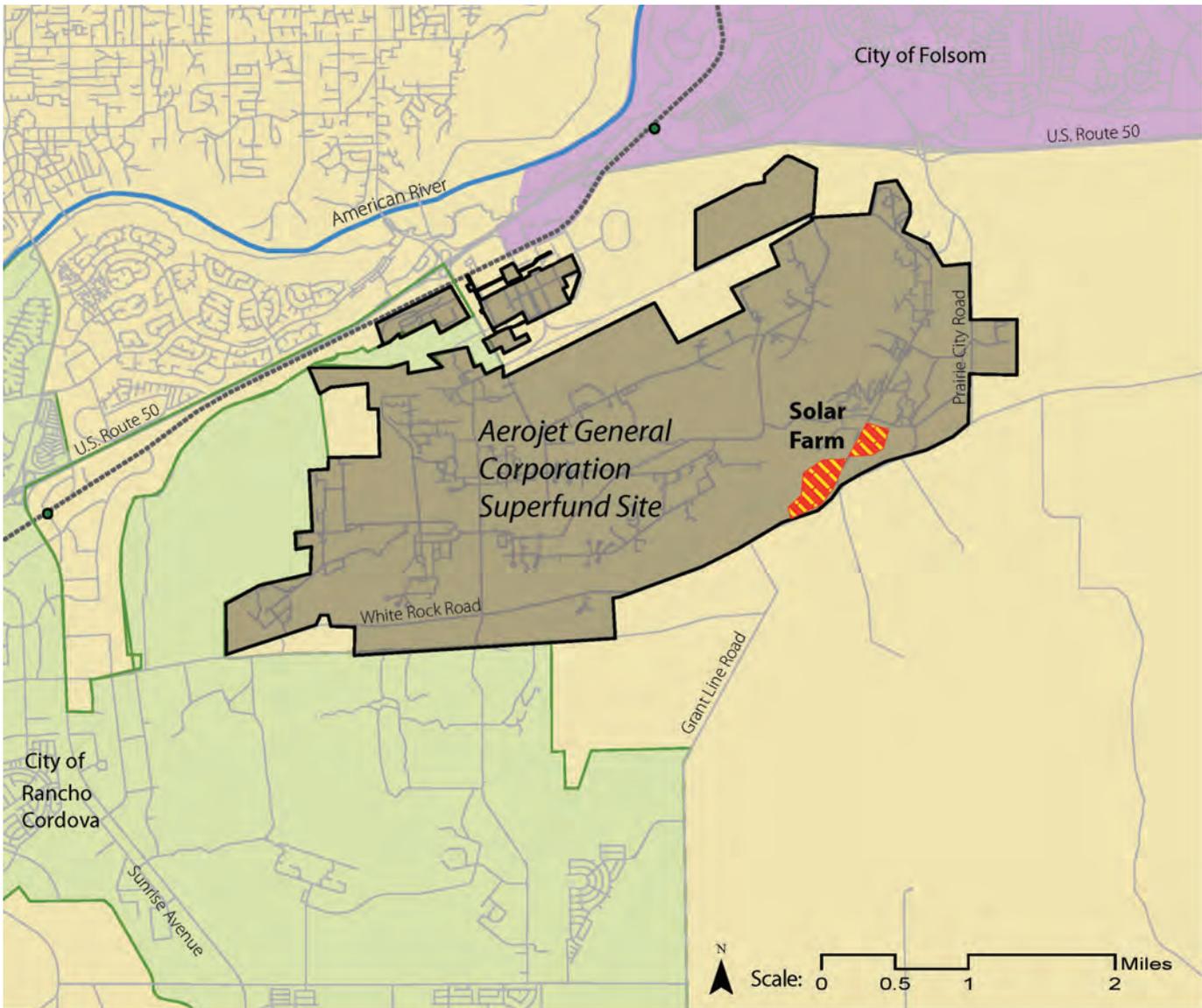
# Project History

## Early 2008 – Late 2008

### *Nurturing an Idea, Working with Public-Sector Partners*

By early 2008, Aerojet had spent several years preparing thousands of acres for redevelopment as part of its Easton development plan, a mixed-use project designed in accordance with “smart growth” principles. However, much of this land had been selected based on its proximity to surrounding communities and available infrastructure, with mixed uses and sustainability as key project criteria.

As the company turned its attention to more remote parts of the property, renewable energy quickly became a leading possibility. “We started by asking how we could work with this otherwise encumbered property and turn it into something that would benefit both [Aerojet] and the community,” said Ronald Samborsky, the company’s Vice-President of Renewable Energy and Sustainability. “We use a significant amount of energy to pump and treat ground water as part of the site’s cleanup and were interested in reducing our energy costs. We were also looking for a way to reduce the environmental footprint of powering the site’s remedy.”



### Key

#### Boundaries

- Aerojet Site
- City of Rancho Cordova
- Sacramento County
- City of Folsom

#### Additional Features

- Solar Farm
- Roads
- Light Rail
- American River

An Aerojet workgroup conducted industry and technical surveys to build the company's knowledge of renewable energy technologies, with solar PV ultimately identified as the most proven, durable, cost-efficient option that was well-suited to the property. To help determine the project's financial feasibility, the company also reached out to the Sacramento Municipal Utility District (SMUD). The nation's sixth-largest publicly-owned utility, SMUD has a decades-long track record of supporting green energy and conservation. Aerojet is also one of the utility's largest customers.

"Without SMUD's collaboration, there would not have been a project," recalled Michael Girard, Aerojet's Sustainability Manager. "They developed a three-tier incentive program that worked for us on the financial side, but they also were extremely helpful advisors at all stages of the project." Through its incentive program, SMUD agreed to finance approximately \$13 million of the project's \$20 million cost over a 10-year period.

## Renewable Energy Initiatives in California

It is not a coincidence that Aerojet's solar farm has been developed in California. The state benefits from abundant sun and wind, and is home to some of the best renewable energy resource areas in the world. The state also has one of the nation's most ambitious renewable energy development policy and incentive programs.

In 2002, California established its Renewable Portfolio Standard (RPS) Program. With the goal of increasing the percentage of renewable energy in the state's electricity mix to 20 percent by 2017, the state's utilities pursue one of the most ambitious renewable energy standards in the country. Legislation in 2006 accelerated the goal to 20 percent by 2010, while Executive Order S-14-08, signed in 2009, required that California utilities must reach a 33 percent target by 2020.

Other renewable energy initiatives in California have included the Emerging Renewables Program, created in 1998, which provides education and outreach services, funds solar PV systems for homes and businesses, and provides incentives for utility-scale facilities powered by renewable energy. The residential portion of the program, now called the California Solar Initiative, is currently providing \$3.3 billion in incentives over ten years for citizens installing small-scale renewable systems for their homes.

Finally, in 2007, the California Energy Commission began managing the New Solar Homes Partnership, a \$400-million, four-year effort targeting the inclusion of solar systems in new residential construction.

## Timeline of Events

- 1953:** Aerojet acquires 5,900-acre former gold mining area to develop and test rocket propulsion systems. The company remains in operation today
  - Sept. 1983:** EPA lists the site on the NPL
  - mid-1980s:** Groundwater extraction and treatment systems installed
  - Jun. 1989:** Partial Consent Decree (PCD) signed for site's remedial investigation/feasibility study (RI/FS)
  - Apr. 2002:** PCD modified, site divided into operable units
  - 2002\*:** Site cleanup ongoing
  - 2008:** Internal Aerojet discussions regarding development of solar farm
  - Feb. 2009:** Aerojet selects Solar Power, Inc. to finance and build solar farm
  - Jun. 2009:** Aerojet and Solar Power, Inc. sign Solar Power Purchase Agreement and first phase, 3.6-megawatt solar installation dedicated
  - Sept. 2009:** California Governor Arnold Schwarzenegger signs Executive Order S-14-08 at the Aerojet solar farm.
- 
- Nov. 2009:** Construction of 3.6-megawatt solar installation completed
  - Nov. 2009:** Second phase, 2.4-megawatt solar installation addition dedicated
  - Jun. 2010:** Construction of 2.4-megawatt solar installation addition completed and 6-megawatt solar farm fully operational

“In California, we [utilities] are required by legislation to support the building of sustainable solar communities, and have worked closely with all of our customers on renewable energy projects for years,” said Jim Barnett, SMUD’s Principal Architect for PV Programs. “The Aerojet solar project was a great partnership for us, we had a great working relationship and we were able to identify an incentive program that supported the project’s feasibility.”

Once the workgroup had identified a physically feasible, financially viable approach for the project and the project proposal was approved by senior management, the company reached out to EPA for review and consultation.

“Under the terms of the site’s Partial Consent Decree, Aerojet is required to consult with the Agency regarding any activity that might impact the protectiveness of the site’s remedy,” said EPA project manager Gary Riley. “EPA was pleased to work with the company to make this project happen.” Kevin Mayer, EPA’s other project manager for the site, concurred. “While our priority was making sure that the solar project would not impact the site’s cleanup, we were also interested in supporting an innovative, green remediation project like this,” he said. “The Superfund program places a high value on supporting the return of sites to productive and beneficial use.”

EPA and Aerojet’s coordination lasted almost a year, from the project’s planning stages in 2008 through to its implementation in mid-2009. Through this partnership, Aerojet was able to adjust the solar farm’s location, siting it in an area without environmental considerations or contamination concerns, and designed the facility so that ground water monitoring wells could be located in the area in the future, as needed.

At the same time, Aerojet also shared its plans with state regulators, including the California Department of Toxic Substances Control and the California Environmental Protection Agency’s Central Valley Regional Water Quality Control Board. The agencies provided comments and later required a stormwater management plan for the facility.

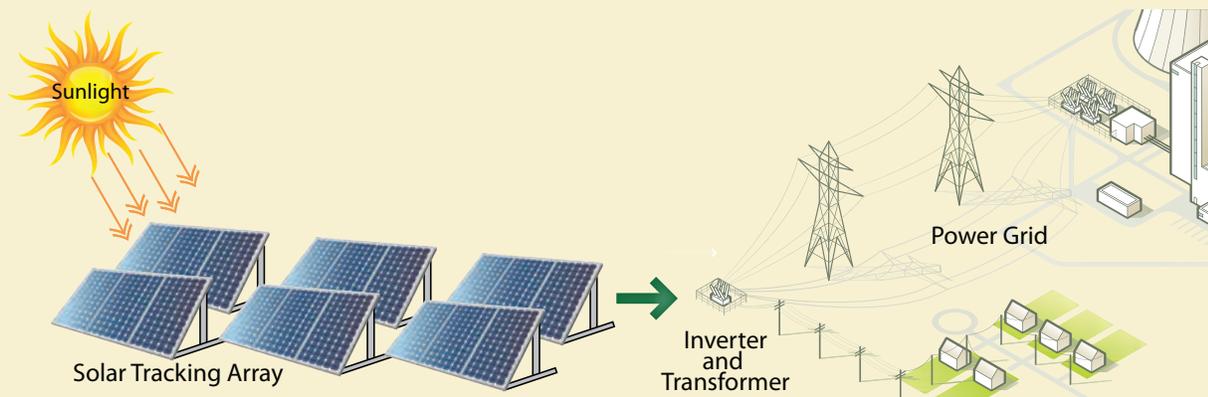
By fall 2008, Aerojet had established public-sector partnerships with EPA, state regulators and SMUD, building a solid foundation for the project. Now, it was time to find a key private sector partner, a solar energy developer who would be able to provide investor financing and build the proposed solar farm. After a five-month request for proposal process, Aerojet selected a local developer, Solar Power, Inc., in February 2009 to help make the project a reality.

## Solar Technologies

There are a variety of ways to capture or convert sunlight into useful energy. Solar technologies use the sun’s energy to provide heat, light, hot water, electricity and cooling for homes, businesses and industry. Solar technologies are broadly characterized as either “passive” or “active” depending on how they capture, convert and distribute sunlight. Active solar activities and technologies use photovoltaic panels, pumps and fans to convert sunlight into useful outputs, such as electricity. Passive solar techniques include selecting materials with favorable thermal properties, designing spaces that naturally circulate air, and aligning the position of a building to the sun.

The 40-acre solar farm at the Aerojet General Corporation site consists of photovoltaic (PV) devices, or “solar cells” that convert sunlight into energy. PV systems are one of two primary active solar technologies, along with solar thermal plants. PV systems produce two main products that can be sold in the marketplace: electricity and the green attributes of this electricity. PV systems make use of highly purified silicon that functions to convert sunlight directly into electricity. Solar cells are a familiar and widely used technology – calculators, toys, yard lights, roadside warning signs all use solar cells to convert sunlight directly into electricity. There are more than 29,000 solar cells in the solar farm at the Aerojet General Corporation site.

### Photovoltaic solar system diagram



## February 2009 – June 2009

### *Crafting an Agreement, Preparing to Break Ground*

Following a highly competitive proposal process, Aerojet selected Solar Power, Inc. for several reasons. The company had an established track record building PV solar systems and an extensive financing network for these projects. The company was committed to sustainability as a core component of its business model. Finally, the company's system design and construction approach was cost-efficient, used the latest technology and was minimally invasive, mitigating the need for large-scale excavation and earth moving.

At the same time that Aerojet was looking for a developer, Solar Power, Inc. was looking to partner with a local company to locate its first solar farm on a contaminated site. Established in 2005, the company is an international provider of PV solar systems to commercial and residential markets.

“There are so many brownfield and Superfund sites out there that could host renewable energy systems, but that have been ignored because of liability concerns and other issues,” said Todd Lindstrom, the company's Executive Vice-President. “We had several ideal conditions at the Aerojet site: a committed client, an excellent site with good access and a direct grid connection, and partnerships with the public sector in place.”

### **Aerojet-Solar Power, Inc. SPPA: Key Features**

- Aerojet: facility host and purchaser of all power generated by the solar farm
- Solar Power, Inc.: responsible for building, operating and financing the project
- 25-year property easement providing Solar Power, Inc. with access to the solar farm
- Five-year easement extension option
- Indemnification from Aerojet: Solar Power, Inc. not liable under Superfund for site's contamination or cleanup costs
- Construction process schedule and milestones

Other conditions were less than ideal. While Aerojet and Solar Power, Inc. were able to address their liability concerns as part of their eventual agreement, many investor groups were not interested in financing a project located at a Superfund site. The global financial crisis was also unfolding, severely impacting the ability and willingness of banks and private investors to lend money.

During spring 2009, the two companies developed a Solar Power Purchase Agreement (SPPA) to guide the project. SPPAs are a common financial arrangement used for PV solar systems in the United States (see text box below).

### **Solar Power Purchase Agreements (SPPAs)\***

A Solar Power Purchase Agreement (SPPA) is a financial arrangement in which a third-party developer like Solar Power, Inc. owns, operates and maintains the photovoltaic (PV) system, and a host customer like Aerojet agrees to site the system on its property and purchases the system's electric output from the solar services provider for a predetermined period. This financial arrangement allows the host customer to receive stable, and typically lower-cost electricity, while the solar services provider or another party acquires valuable financial benefits such as tax credits and income generated from the sale of electricity to the host customer. SPPAs are common in both the public and private-sector PV marketplace.

With this business model, the host customer buys the services produced by the PV system rather than the PV system itself. This framework is referred to as the “solar services” model, and the developers who offer SPPAs are known as solar services providers. SPPA arrangements enable the host customer to avoid many of the traditional barriers to adoption for organizations looking to install solar systems: high up-front capital costs; system performance risk; and complex design and permitting processes. Bottom line: SPPAs can provide host customers with solar power at an affordable price. As a result, the majority of PV financing agreements in the United States are now SPPAs.

### **Benefits & Challenges of SPPAs**

#### **Benefits for host customer**

- No upfront capital cost.
- Predictable energy pricing.
- No system performance or operating risk.
- Projects can be cash flow positive from day one.
- Visibly demonstrable environmental commitment.
- Potential to make claims about being solar-powered.
- Potential reduction in carbon footprint.
- Potential increase in property value.
- Support for local economy and job creation.

#### **Challenges for host customer**

- More complex negotiations and potentially higher transaction costs than buying PV system outright.
- Administrative cost of paying two separate electricity bills if system does not meet 100 percent of site's electric load.
- Potential increase in property taxes if site is reassessed.
- Site lease may limit ability to make changes to property that would affect PV system performance or access to the system.

Please see the **Sources and Resources** section for more SPPA information.

*\* Information provided by EPA's Green Power Partnership.*

It took months of investor education and outreach for Solar Power, Inc. to line up an investor group. In summer 2009, the company underscored its commitment to the project by financing the project's first-phase construction. By building the facility, the company illustrated its viability; the project's investors were finalized shortly before the solar farm went live in November 2009.

"This project likely wouldn't have been able to happen at that time if it wasn't for [Solar Power, Inc.'s] ability to work creatively and flexibly on the financing," said J.D. Roberts, Aerojet's Executive Director for Renewable Energy Power Projects. "Pulling these projects together financially can be a real art form."

Finally, for one other key area – permitting and inspections – the Aerojet solar farm was far ahead of the game. As part of Aerojet's plans for its Easton development project, the company had completed all necessary environmental reviews several years before the solar farm was even on the drawing board. The site's Superfund status meant that the company's comprehensive assessment of the site's physical and environmental conditions provided the information needed for the land development permitting process.

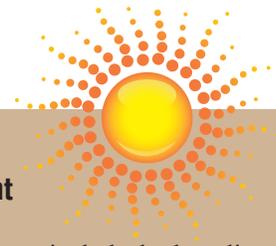
"From the outset of planning, we knew where we could potentially locate the solar farm, avoiding sensitive environmental areas like wetlands, and where we could build without being located over source areas of contaminated soil," said Chris Conley, Aerojet's Vice-President for the Environment, Health and Safety. EPA RPM Gary Riley noted that Superfund sites are among the most-documented areas of land in the United States. "This detailed information is what enables EPA to protect human health and the environment at contaminated sites," he said, "but it can also be very helpful from a redevelopment perspective."

The permitting and inspection process was also expedited by Aerojet's Building Permit and Inspection Agreement with Sacramento County. Aerojet's staff are trained and authorized by the county to inspect buildings and provide permits for facilities that meet county code standards. At the end of each year, the company reviews the permits with the county to ensure compliance.

"We provide the community with regular updates on our real estate development plans, and ask for any feedback that people may have," said Aerojet's Ron Samborsky. "With the solar project, we have received nothing but encouragement, from the outset all the way through to the groundbreaking ceremony. It just seems like a project that makes sense to everyone."

With these key pieces – the SPPA, project financing, permits and inspections, and community outreach – coming together, Aerojet and Solar Power, Inc. were ready to move forward with

the project. In June 2009, construction of the first, 3.6-megawatt portion of the PV system began.



## Policies and Incentives for Solar Energy Development

Solar energy development incentives include both policy requirements (e.g., renewable portfolio standards) and financial incentives (e.g., tax credits and rebates).

Federal and state policies continue to play a major role in creating markets favorable for solar energy deployment. Solar energy's cost premium has declined in recent years due to technology improvements and the increased cost of fossil fuel-based energy generation. At the same time, a nationwide public policy focus on carbon-free, renewable energy has created a range of financial incentives to further lower costs.

At the state level, renewable portfolio standards (RPSs) are a powerful policy tool requiring that retail electric providers in a given political jurisdiction include a minimum amount of renewable power in their energy mix. As of 2009, 24 states plus the District of Columbia have RPS policies in place. Together, these states account for more than half of the electricity sales in the United States. Solar energy development is expected to grow primarily in the 14 states, including California, that have established an RPS with a solar share.

### Financial Incentives and Structures

#### *State and Local Governments*

- systems benefit charge (SBC) funds
- issuance of energy bonds
- clean renewable energy bonds (CREBs)
- federal renewable energy production incentives (REPIs)
- state or utility cash incentives and rebates
- solar renewable energy certificates (SRECs)
- net metering (banking excess electricity production for future credit)

#### *Private Parties*

- federal investment tax credit (ITC)
- accelerated depreciation under the federal Modified Accelerated Cost Recovery System (MACRS)
- state tax incentives and rebates
- state or utility cash incentives and rebates
- solar renewable energy certificates (SRECs)
- net metering

Please see the **Sources and Resources** section for more information.

**June 2009 – April 2009**  
**Installing the Solar Farm ...**



*The Aerojet solar farm, prior to construction, 2009.*

Following a ground-breaking ceremony for the solar farm, its construction proceeded at a rapid pace. “It was quite something to watch,” recalled Aerojet’s Michael Girard. “Solar Power, Inc. has a virtual assembly line process, so we went from site preparation to infrastructure installation to construction in a couple of months’ time.”

Once the site was graded, Solar Power, Inc. used specialized equipment to press vertical support beams deep into the ground with high-speed vibration, minimizing the need for earth moving and soil disturbance. Once the vertical supports were installed and aligned, a steel tracking system



framework was put in place. The solar modules were then installed in the tracking system. Other important activities included programming the tracking system to track the daily path of the sun and connecting the solar farm to Aerojet’s electrical grid.



Construction of the 3.6-megawatt system was completed and the system went live in November 2009. California Governor Arnold Schwarzenegger signed Executive Order S-14-08, with the Aerojet solar farm as the backdrop. The Executive Order calls for 33 percent of energy consumed in California to come from renewable resources by the year 2020.

### ... Expanding the Possibilities

With major challenges like liability and financing considerations having been addressed, enabling the construction of the solar farm, another significant challenge fell by the wayside during summer 2009. As the cost of solar system components decreased over time, it became feasible for Aerojet to pursue a second phase for the project. Aerojet worked with partners Solar Power, Inc. and SMUD on a 2.4-megawatt addition that would bring the solar farm's total capacity to six megawatts, enough to provide more than 20 percent of the power needed to operate Aerojet's extensive ground water remediation program.

"Through its Sustainability Initiative, Aerojet is dedicated to reducing our overall environmental footprint," said Aerojet's Ronald Samborsky. "We recognize that our company uses a significant amount of energy, and our goal is to use the best combination of tools and approaches possible to reduce our overall footprint and rely on as much renewable energy as possible."

Solar Power, Inc. broke ground on the 2.4-megawatt addition to the solar farm in November 2009. Similar to the first phase of construction, the process took several months; the addition was completed in April 2010. In conjunction

with the completion of the entire six-megawatt facility, SMUD also worked with Aerojet and Solar Power, Inc. to connect the solar farm with the electrical grid. As of June 3, 2010, the facility was fully operational.

Looking back, the project was guided and spurred by a spirit of innovation, creativity and exploration; coordination with public and private sector partners; technical, legal and financing expertise; and supportive state and federal policies and incentives. The outcome was the successful development of the Aerojet solar farm.

#### Terms to Understand

**Kilowatt (kW):** Unit of measure for the amount of electricity needed to operate given equipment.

**Kilowatt-hour (kWh):** Unit of measure indicating the amount of electricity consumed over time. One kWh means one kilowatt of electricity supplied for one hour.

**Megawatt (MW):** 1,000 kW or 1,000,000 watts. According to the California Independent System Operator, one MW of utility-supplied power is sufficient to power 750 average homes.



# Lessons Learned

Participants agree that a combination of significant factors have contributed to the successful development of the 40-acre solar farm at the Aerojet General Corporation Superfund site.

- The site's size, flat topography, proximity to the power grid and available daily solar resources met basic feasibility criteria for locating a utility-scale solar farm.
- Aerojet energetically pursued the development of the solar farm to help power the site's ground water remediation program, motivated by economic and environmental considerations to put in place the requisite resources, partnerships and expertise.
- Aerojet worked with private and public sector partners to develop a project approach that addressed liability concerns, provided requisite financing and incentives, and resulted in a minimally invasive installation connected to the electrical grid.
- EPA and state agencies were engaged partners with thorough knowledge of the biology, geology and chemistry of the location and they supported Aerojet's green remediation goals in the context of the site's cleanup.
- All parties involved were patient and flexible, recognizing that the development of the solar farm was a complex process reliant on available incentives, multiple parties, market conditions and other factors.
- EPA had selected a remedy that would be consistent with the property's reasonably anticipated future land uses.



## EPA and Site Reuse: Renewable Energy

Since the inception of the Superfund program, EPA has been building on its expertise in conducting site characterization and remediation to ensure that contamination is not a barrier to the reuse of property. Today, consideration of future use is an integral part of EPA's cleanup programs, from initial site investigations and remedy selection through to the design, implementation, and operation and maintenance of a site's remedy. For example, EPA is working nationwide with public and private partners like Aerojet to encourage solar and other renewable energy development opportunities on current and formerly contaminated lands.

**EPA's Green Power Partnership** is a voluntary program that supports the organizational procurement of green power – electricity produced from renewable resources – by offering expert advice, technical support, tools and resources. Partnering with EPA helps organizations lower the transaction costs of buying green power, reduce their carbon footprints and communicate their environmental leadership to stakeholders. To date, more than 1,200 organizations have joined the partnership, buying nearly 18 billion kilowatt hours of green power annually. Leading municipalities are also partnering with EPA to become Green Power Communities.

**EPA's RE-Powering America's Land Initiative** identifies the renewable energy potential of contaminated lands and serves as a resource for parties interested in reusing these lands for renewable energy development. EPA estimates that there are approximately 490,000 sites and almost 15 million acres of potentially contaminated properties across the United States that are tracked by EPA. Cleanup goals have been achieved and controls put in place to ensure long-term protection for more than 917,000 acres. Through coordination and partnerships among federal, state, tribal and other government agencies, utilities, communities and the private sector, EPA and its partners are exploring how new renewable energy facilities can be developed on these properties.

**EPA's Green Remediation Strategy** fosters the use of best management practices for green remediation at contaminated sites. "Green remediation" is the practice of considering all environmental effects of remedy implementation and incorporating options to maximize the environmental benefits of cleanups. By incorporating the use of renewable energy sources, EPA and its partners are maintaining the effectiveness of remediation methods while reducing greenhouse gas emissions from conventional power sources. At the Aerojet General Corporation site, Aerojet's solar farm provides power for its extensive ground water remediation program.

## The Bigger Picture

While these factors created an ideal climate for the successful reuse of the Aerojet General Corporation Superfund site, there are also a range of broader lessons learned that can help guide similar projects at contaminated lands across the country.

**EPA works with potentially responsible parties and other stakeholders to support green remediation and reuse projects like renewable energy development that are compatible with site cleanups.**

The Agency places a high priority on green remediation and the development of renewable energy opportunities as part of the reuse of contaminated lands. At the Aerojet General Corporation site, EPA's coordination with Aerojet enabled the siting of the facility in an appropriate location and with an appropriate design that ensured flexibility if future investigation and remediation is necessary.

**While EPA provides tools and resources to support Superfund reuse, communities and public and private sector organizations make it happen.**

EPA's mission is to protect human health and the environment. EPA relies on engaged community stakeholders to bring their future land use goals and priorities to the table so that this information can be incorporated as part of the remedial process, linking cleanup and redevelopment. In northern California, Aerojet shared its solar energy plans and worked cooperatively with EPA. When possible, future use plans should be shared with EPA as early in the remedial process as is feasible.

**Utility-scale renewable energy projects are complex undertakings. Thanks to partnerships and tools like power purchase agreements, these complexities need not deter interest in these projects.**

The development of Aerojet's solar farm required legal, technical, financial and policy expertise. Aerojet relied on developer Solar Power, Inc. and SMUD, the local utility, for much of this expertise. Through the project's solar power purchase agreement, Solar Power, Inc. built and

owns and operates the solar farm, while Aerojet purchases all power generated by the facility. Aerojet's energy and interest in making things happen were the driving force for the project.

**While utility-scale solar energy projects provide significant environmental benefits, they are higher-cost than conventional energy projects. Partnerships, incentives and supportive state and federal policies are essential to help address this cost differential.**

Aerojet was able to partner with SMUD, an experienced local utility mandated by the State of California to support renewable energy projects. SMUD linked Aerojet with state energy pricing incentives and additional incentives like the federal Investment Tax Credit (ITC), which were vital in ensuring the project's financial viability.

**The Superfund remedial process can provide information to fulfill environmental permitting and other regulatory requirements for renewable energy projects like solar farms.**

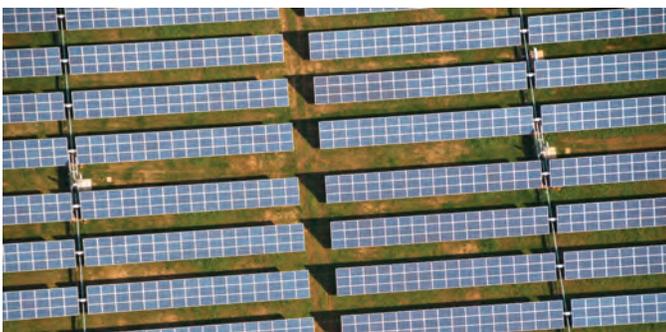
Superfund sites are among the most comprehensively documented and evaluated areas of land in the United States. Aerojet relied on detailed site investigation information from the Superfund process to address environmental permitting requirements for the site as part of its larger real estate development plans, several years before the solar farm was even under consideration. At most sites, a completed remedial investigation/feasibility study or a draft proposed plan will provide site owners and prospective purchasers with extensive site information.

**PV solar systems can be located in many places, at many scales.**

Aerojet was looking for a utility-scale, grid-connected solar farm as a green remediation option to power its ground water treatment program. Other PV power systems can be as small as a few solar cells on the roof of a building, need not be connected to the electrical grid and can function in locations with average sun exposure. At many remote contaminated sites like abandoned mine lands, for example, PV systems provide power for green remediation efforts.

**Outreach and engagement with local governments and communities is important.**

Aerojet's long-standing working relationship with Sacramento County and its Building Permit and Inspection Agreement with the county facilitated the issuance of all building permits needed for the solar farm. The company's broad, regular outreach to the surrounding community also resulted in significant support for the project, from the early planning stages through to ribbon-cutting ceremonies in 2009.



# Conclusions

The development of the 40-acre solar farm at the Aerojet General Corporation Superfund site illustrates how innovative thinking, collaborative public-private partnerships, specialized expertise and creative financing can result in successful renewable energy projects and green remediation at contaminated lands.

During its first year at full power, the system will generate enough clean power to offset significant amounts of greenhouse gases and air-polluting and smog-causing chemicals that would have been emitted using power from plants burning fossil fuels. EPA's Power Profiler estimates the annual emissions saved at 4,000 tons of carbon dioxide and three tons each of sulfur dioxide and nitrogen oxide. With life expectancy of at least 25 years, the system will provide important environmental benefits while protecting the area's valuable groundwater resources.

Looking longer-term, the completion of the six-megawatt facility in 2010 represents a beginning as well as an end; the partnerships forged in 2008 and 2009 have led to new

possibilities. Aerojet has formed an Executive Sustainability Council and is working with Solar Power, Inc. and SMUD to explore potential opportunities for additional renewable energy facilities at its property in the future, which, among a range of possibilities, could provide additional power for green remediation activities or power for the company's planned Easton development project.

The project is having larger impacts as well. Area community colleges are now offering courses to train workers skilled in renewable energy technologies, using the Aerojet solar farm as a hands-on case study. Aerojet's permitting agreement with Sacramento County is now being reviewed by other area localities to identify opportunities for supporting additional renewable energy facilities in the region.

Today, the Aerojet solar farm is one of the leading examples of green remediation and renewable energy generation at Superfund sites in the United States. The solar farm is the largest single-site industrial system in California and one of the largest single-site industrial installations in the United States. When the sun rises over Sacramento County, California tomorrow, more than 29,000 solar cells will be waiting.



## Sources

Images and maps for this case study were obtained from EPA Region 9, Aerojet and Solar Power, Inc.

## Resources

### *Site-Specific*

EPA site progress profile:  
[cfpub.epa.gov/supercpad/cursites/csitinfo.cfm?id=0901718](http://cfpub.epa.gov/supercpad/cursites/csitinfo.cfm?id=0901718)

EPA Region 9 Superfund Program:  
[www.epa.gov/region09/superfund](http://www.epa.gov/region09/superfund)

Aerojet:  
[www.aerojet.com](http://www.aerojet.com)

Solar Power, Inc.:  
[www.solarpowerinc.net](http://www.solarpowerinc.net)

Sacramento Municipal Utility District: (SMUD):  
[www.smud.org](http://www.smud.org)

Sacramento County:  
[www.saccounty.net](http://www.saccounty.net)

California Energy Commission Renewable Energy Programs:  
[www.energy.ca.gov/renewables](http://www.energy.ca.gov/renewables)

### *General*

EPA Superfund Redevelopment Initiative:  
[www.epa.gov/superfund/programs/recycle](http://www.epa.gov/superfund/programs/recycle)

EPA Green Power Partnership:  
[www.epa.gov/greenpower](http://www.epa.gov/greenpower)

EPA Green Remediation Strategy:  
[www.epa.gov/superfund/greenremediation](http://www.epa.gov/superfund/greenremediation) and  
[www.clu-in.org/greenremediation](http://www.clu-in.org/greenremediation)

EPA's RE-Powering America's Land Initiative:  
[www.epa.gov/renewableenergyland](http://www.epa.gov/renewableenergyland)

EPA Power Profiler: [www.epa.gov/cleanenergy/energy-and-you/how-clean.html](http://www.epa.gov/cleanenergy/energy-and-you/how-clean.html)

U.S. Department of Energy (DOE) solar maps:  
[www.nrel.gov/gis/solar.html](http://www.nrel.gov/gis/solar.html)

DOE Solar Energy Technologies Program – PV:  
[www1.eere.energy.gov/solar/photovoltaics\\_program.html](http://www1.eere.energy.gov/solar/photovoltaics_program.html)

Solar PV project financing overview (pgs. 5-11):  
[eetd.lbl.gov/ea/emp/reports/lbnl-1410e.pdf](http://eetd.lbl.gov/ea/emp/reports/lbnl-1410e.pdf)

Renewable energy policy and incentive database:  
[www.dsireusa.org](http://www.dsireusa.org)

Solar power purchase agreement information:  
[www.epa.gov/greenpower/buygp/solarpower.htm](http://www.epa.gov/greenpower/buygp/solarpower.htm)



# Green Remediation and Utility-Scale Solar Development

THE AEROJET GENERAL CORPORATION SUPERFUND SITE AND  
SACRAMENTO COUNTY, CALIFORNIA



EPA Region 9  
75 Hawthorne Street  
(SFD-7-2)  
San Francisco, CA 94105

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