

**Brownfields to Brightfields: A Sustainability Initiative at
DOE'S East Tennessee Technology Park Cleanup – 16120**

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ABSTRACT

As DOE works toward completing their cleanup mission at the East Tennessee Technology Park (ETTP), the ultimate goal is to return property no longer needed for government use to the community for beneficial re-use. The vision for ETTP is to transform the former gaseous diffusion facility into a commercial industrial park, leveraging the site's infrastructure to attract businesses to the site. While hundreds of acres at ETTP have been transferred for re-use, areas within the former production footprint of the site have future use restricted due to the presence of residual contamination, underground structures and utilities and/or physical features that limit their reuse potential. Brownfield redevelopment with solar energy generation has proven to be an excellent option for beneficial reuse and sustainability thanks to the flexible nature of solar photovoltaic technology and design that can address the restrictions and limitations of the site.

Developing a solar project on a cleanup site can be challenging due to a large number of stakeholders and regulatory compliance issues of the environmental legacy at DOE cleanup sites; however, the challenges can be offset by the available infrastructure and low cost property. The requirement for large amounts of land or surface area is a major constraint to the growth of photovoltaic solar systems. An average solar generating facility requires 2 or more hectares (5 acres) for each megawatt (MW) of power generated. Re-using land that is otherwise undevelopable provides a cost effective site for renewable energy generation to innovative solar developers.

At ETTP, DOE's Oak Ridge Office of Environmental Management and the community reuse organization¹ supported a local small business² familiar with the site and environmental regulations to secure a power purchase agreement with the regional electric provider³ for a 1 MW utility-scale photovoltaic solar facility. The solar facility, Powerhouse Six, was developed through a commercial partnership⁴ that worked closely with the lead ETTP site cleanup contractor⁵ and the local government.

¹ Community Reuse Organization of East Tennessee (CROET)

² Restoration Services, Inc. (RSI)

³ Tennessee Valley Authority (TVA)

⁴ RSI and Vis Solis, Inc.

⁵ URS | CH2M Oak Ridge LLC (UCOR)

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The selected site at ETPP had limitations on subsurface disturbance to 10 feet below ground surface because of utility ducts and residual contamination. Near surface relics (facility foundation remnants) were also found to prohibit ground penetration. A photovoltaic solar design using a ballasted ground mount system was developed to conform to the restrictions. The ballasted system could follow existing land contours, eliminating the need for any extensive site preparation and avoiding the risk of ground penetration.

The lead cleanup contractor's role in facilitating the completion of this project included making the necessary environmental assessment documentation available to obtain the construction notice to proceed from the regional electric provider. They accelerated the transfer of ETPP powerlines and electric demand to the city electric department to accommodate connection to the electric grid and supplied the communication connection required for metering the electric power generation. DOE's support along with their cleanup contractor's reindustrialization program and power integration group provided regular communication with the project stakeholders for more than six months to facilitate the early transfer of the utility infrastructure.

Powerhouse Six sustainability benefits:

- Generates enough clean energy to power more than 100 homes or prevents pollution equivalent to removing 240 cars from the road annually (1,141 metric tons of carbon dioxide)
- Provides Brownfield reuse/redevelopment at ETPP
- Eliminates the generation of wastes through excavation and saves money to cleanup other areas for re-use
- Supports regional electric provider's renewable energy initiative
- Offers community economic development/ jobs and property tax income to the City of Oak Ridge
- Demonstrates benefit of ETPP reindustrialization
- Provides long-term lease payments to the community reuse organization
- Supports DOE renewable energy goals
- Demonstrates collaboration between DOE and a public utility for renewable energy development



Fig. 1. Powerhouse Six 1 MW Solar Array at ETPP

INTRODUCTION

East Tennessee Technology Park is the site of the former K-25 uranium processing facility that supplied the enriched uranium used in the first atomic bomb during World War II. Construction of the K-25 plant began in June 1943 and was completed in early 1945. The original plant was expanded to cover more than 1,500 acres and employed 12,000 workers in hundreds of buildings. Enrichment operations at the site ended in the 1987. Cleanup of the environmental legacy began in the early 1990s, and it was renamed the 'East Tennessee Technology Park' (ETTP) in 1997 to begin its transition into a privately owned and operated industrial park.

In an effort to accelerate cleanup, DOE established the Reindustrialization Program, which helps to promote economic development by making DOE assets such as land, buildings, and infrastructure available to the private sector. The program accomplishes its goals via a unique partnership between DOE, the Community Reuse Organization of East Tennessee (CROET), community representatives, and the state and federal environmental regulators. While hundreds of acres at ETPP have been transferred for re-use, areas within the former production footprint of the site have future use restricted due to the presence of residual contamination, underground structures and utilities, and/or physical features that limit their reuse potential. Brownfield redevelopment with solar energy generation has proven to be an excellent option for beneficial reuse thanks to the flexible nature of solar photovoltaic technology and design that can address the restrictions and limitations of the site.

Developing a solar project on a cleanup site can be challenging due to a large number of stakeholders and regulatory compliance issues of the environmental legacy at DOE cleanup sites; however, the challenges can be offset by the available infrastructure and low cost property. The requirement for large amounts of land or surface area is a major constraint to the growth of photovoltaic solar systems as an average solar generating facility requires 2 or more hectares (5 acres) for each megawatt (MW) of power generated. Re-using land that is otherwise undevelopable provides a cost effective site for renewable energy generation to innovative solar developers.

THE PROJECT

What: The Powerhouse Six project was undertaken to provide a 1 MW utility-scale photovoltaic solar power generating facility as part of the sustainable reindustrialization of ETTP, the former K-25 gaseous diffusion plant. The project location was targeted for a restricted-use property that had limited re-use options due to the presence of a utility duct bank running under the site as well as several old foundations and other structures. Due to these restrictions most options for reuse of the site were restricted to considerations that required minimal subsurface disruption such as additional parking lots.

Who: Every step in the process, from securing the site to interconnection, was achieved with great cooperation. DOE's Oak Ridge Office of Environmental Management (OREM) and CROET supported a local small business, Restoration Services, Inc. (RSI), familiar with the site and environmental regulations to secure a power purchase agreement with the Tennessee Valley Authority (TVA), the regional electric provider for a 1 MW utility-scale photovoltaic solar facility. The solar facility, Powerhouse Six, was developed through a commercial partnership between RSI and Vis Solis, Inc. who worked closely with the lead ETTP site cleanup contractor, URS | CH2M Oak Ridge LLC (UCOR) and the City of Oak Ridge, TN on site restrictions and interconnection.

UCOR's role in facilitating the completion of this project included making available the necessary National Environmental Protection Agency (NEPA) documentation on the environmental impacts for the proposal to transfer property at the site. [1] This was necessary to obtain the construction notice to proceed from the TVA. UCOR worked to accelerate the transfer of ETTP powerlines and electric demand to the City of Oak Ridge Electric Department (CORED) to accommodate connection to the electric grid and they supplied the communication connection required for metering the electric power generation. DOE's support along with UCOR's Reindustrialization Program and power integration group provided regular communication with the project stakeholders for more than six months to facilitate the early transfer of the utility infrastructure.

Where: The project is located at the East Tennessee Technology Park at 209 Victorious Boulevard West, Oak Ridge, Tennessee on a 2-hectare (5-acre) parcel acquired under a long-term commercial lease agreement with CROET. The land used for the Powerhouse Six solar project, previously known as Parcel ED-5-East, is

located in the south-central portion of the ETPP (formerly the Oak Ridge K-25 Site) on the Oak Ridge Reservation in Roane County, Tennessee.

How: The project used private tax equity funding for construction funding. The engineering, procurement, and construction of Powerhouse Six was performed by Vis Solis with a licensed and North American Board of Certified Energy Practitioners-certified solar installer.

Challenges: The selected site at ETPP had limitations on subsurface disturbance to 10 feet below ground surface because of utility ducts and residual contamination. Near surface relics (facility foundation remnants) were also found to prohibit ground penetration. Interconnection concerns were raised that at low power demand generation could exceed acceptable levels and substation/facility communication upgrades were needed.

THE SITE

RSI identified a parcel at ETPP suitable for a solar installation and acquired the land under a long-term commercial lease agreement with CROET. CROET received the property through a transfer from the DOE's ETPP Reindustrialization Program.

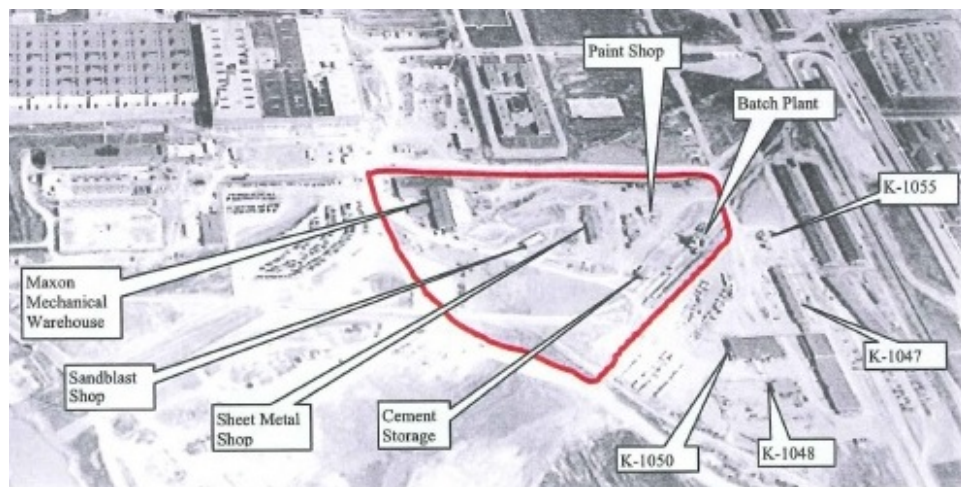


Fig. 2. Aerial photograph of the Parcel ED-5 East study area in 1951. Photo: DOE

The parcel is underlain by utilities that restrict excavation. Running beneath the parcel is a series of duct banks that consist of an underground 13.8 kV power transmission system between the former K-704 Switchhouse in the Powerhouse Area and the K-27 Switchyard in the main plant area at ETPP. The duct bank, constructed in 1944 and abandoned in the early 1970s, consists of 13 concrete ducts, each containing a group of six transit conduits that held three conductor, paper-insulated, lead-sheathed copper feeder cables. [2]

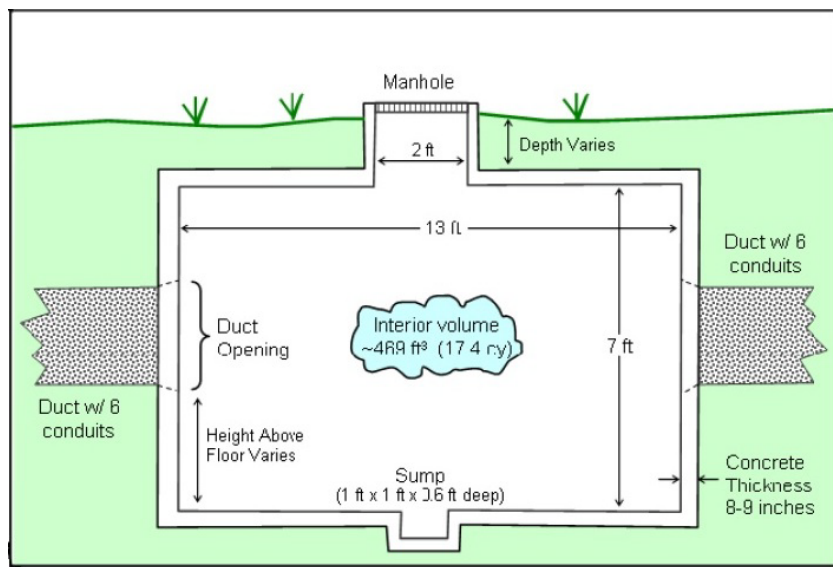


Fig. 3. Section View of Vault. Photo: DOE



Fig. 4. Grouting duct row (left) and concrete-filled vault adjacent to creek (right).
Photo: DOE

STUDIES

A series of studies to identify potential issues were undertaken including soil, interconnection and communication studies performed before the final design was completed.

Soil Conditions

Engineers performed pull-out and lateral load testing for the project to assess general site subsurface conditions, monitor test pile installation, monitor test pile load testing, and record the associated pile deflection.

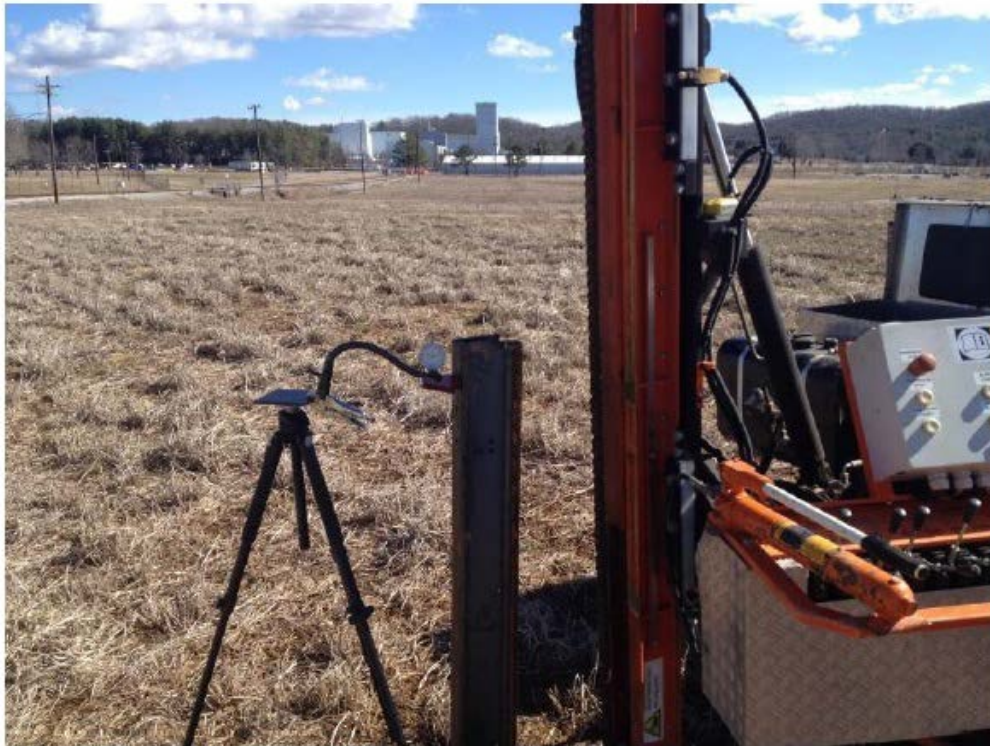


Fig. 5. Pull-out and lateral load testing at the Powerhouse Six site to assess soil conditions. Photo: RSI

Interconnection Studies

A System Impact Study for a Co-Gen Facility was conducted to analyze the effect on the City of Oak Ridge's electric system from a 1MW solar installation. The IEEE 1547™ Standard for Interconnecting Distributed Resources with Electric Power Systems, developed by the Institute of Electrical and Electronics Engineers, provided the primary baseline for the analysis using a set of criteria and requirements for the interconnection of distributed generation resources into the power grid. [3]

A follow up Relay and Communication Study was undertaken to investigate feasibility options for new communications from substations to the solar field

project. Options were evaluated to determine capabilities of each system to effectively communicate breaker status and transfer trip from substation to solar array.

NEPA Requirements

In October, 2011, the DOE issued an Environmental Assessment and Finding of No Significant Impact – Transfer of Land and Facilities within the East Tennessee Technology Park and Surrounding Area, Oak Ridge, Tennessee. [1] Under the mixed use Proposed Action alternative, which DOE is currently implementing, “power plants, including renewable energy generation” were one of the permissible listed uses. The site of the proposed Powerhouse Project solar farm is within the area evaluated in the 2011 DOE EA. TVA reviewed this EA and determined that it adequately evaluated many of the potential impacts of the construction and operation of the proposed solar farm. TVA independently reviewed and adopted the DOE EA and Finding of No Significant Impact by the solar project.

CHANGES AND MODIFICATIONS

After the completion of the various studies three major changes were made from the original plan to accommodate site and interconnection challenges of the project. All three required cooperation from key partners in order to make the project successful.

1. Ballasted Racking

Due to the complex and difficult underground barriers, designs were revised to incorporate an above the ground ballasted mounting system that limited ground penetration of the project using the GameChange Racking® Pour-in-Place™ racking system. [4] The ballasted ground mount system followed existing land contours, eliminating the need for any extensive site preparation and avoiding the risk of breaching underground utilities. [5]



Fig. 6. Powerhouse Six racking system sitting on the GameChange® Pour-in-Place™ ballasted system. Photo: RSI

2. Accelerated Asset Transfer

One of the results of the Feasibility Study on Interconnection flagged concern by CORED that at low demand changes the amount of power going into the lines might exceed acceptable levels. The UCOR Reindustrialization Program facilitated the project by accelerating the property transfer of the ETP power lines to CORED. The UCOR power integration group met routinely with the project stakeholders for more than six months to facilitate the early transfer of the utility infrastructure (i.e., power lines) and power demand (i.e., load) required for connecting the system to the electric grid. The actions by the UCOR reindustrialization team and the power integration group were essential in making this project successful.

3. Accelerated Utility Upgrades

A secondary finding by the Feasibility Study was the need for communication to the two local substations from the generating facility. To facilitate the success of the project, CORED accelerated their own planned communication upgrades by adding new Fiber optic cables and the Powerhouse Six team upgraded the breaker to the S&C Electric Company's IntelliRupter® PulseCloser® which provides supervisory control and data acquisition functionality and advanced distribution automation functions. [6]

THE BENEFITS

By identifying and working through the various issues and aligning stakeholder objectives all issues were resolved and the project was successful. The commissioning ceremony was held on April 9, 2015.

The value of this project to the local community was clearly acknowledged at the project commissioning ceremony—the Oak Ridge Mayor stated that the Powerhouse Six project was the result of partnerships, and it helps to diversify the city's economy and supports the city's Climate Action Plan, helping to reduce greenhouse gas emissions through energy diversification. He reported that Oak Ridge has achieved platinum status in the Tennessee Valley Authority's "Valley Sustainable Communities" program and was recognized as a Green Power Community of the Year by the U.S. Environmental Protection Agency. [7]



Fig. 7. Oak Ridge Mayor, Warren Gooch, speaks to community stakeholders at the Powerhouse Six "Plugging Inn" ceremony about the value of the Powerhouse Six project to the Oak Ridge community. Photo: RSI



Fig. 8. The Powerhouse “Plugging In” Ceremony with key stakeholders from DOE, UCOR, the City of Oak Ridge, TVA, and CROET. Photo: RSI

Powerhouse Six:

- ✓ Generates enough clean energy to power more than 100 homes or prevents pollution equivalent to removing 240 cars from the road annually (1,141 metric tons of carbon dioxide)
- ✓ Provides Brownfield reuse/redevelopment at ETTP
- ✓ Eliminates the generation of wastes through excavation and saves money to cleanup other areas for re-use
- ✓ Offers community economic development/ jobs and property tax income to the City of Oak Ridge
- ✓ Provides long-term lease payments to CROET
- ✓ Demonstrates benefit of ETTP reindustrialization
- ✓ Supports Oak Ridge renewable energy goals
- ✓ Supports DOE renewable energy goals
- ✓ Supports TVA renewable energy initiative
- ✓ Demonstrates collaboration between DOE and a public utility for renewable energy development

CONCLUSION

Brownfield redevelopment with solar energy generation has proven to be an excellent option for beneficial reuse and sustainability thanks to the flexible nature of solar photovoltaic technology and design that can address the restrictions and limitations of the site. Challenges were met by integrating stakeholder needs and addressing regulatory issues with a shared vision and many partnerships for success.

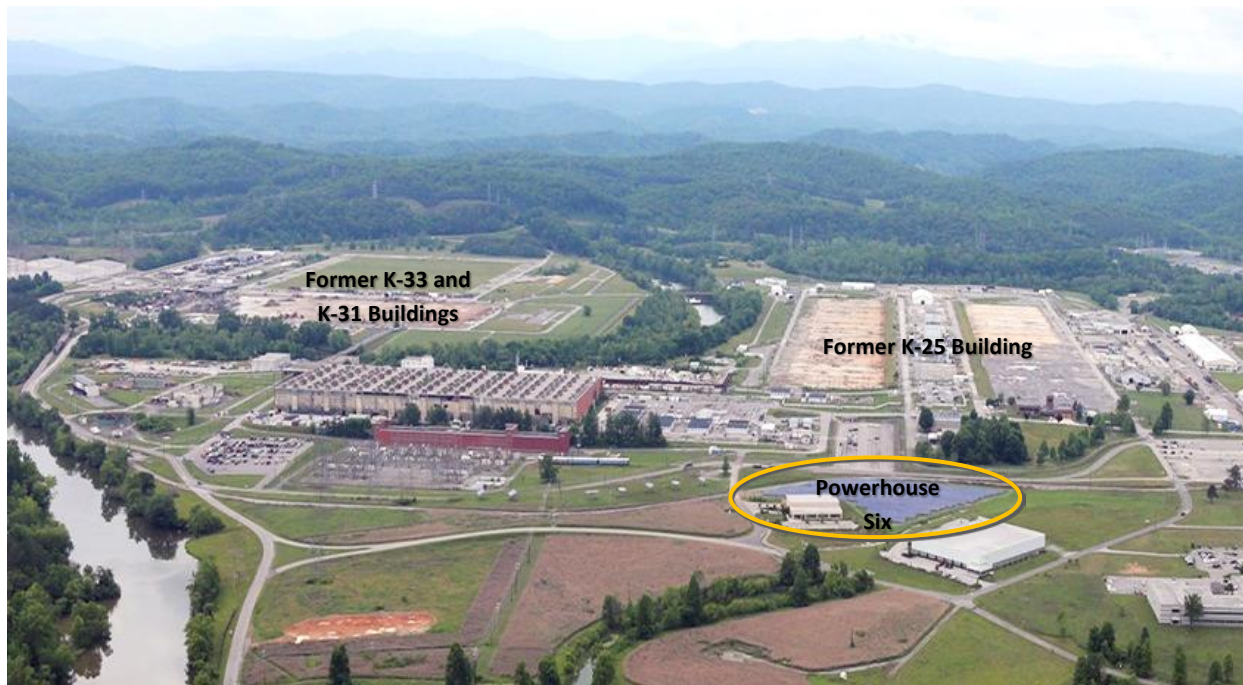


Fig. 9. Aerial of ETTP in May 2015 shows completed demolition of the K-25, K31, and K-33 buildings and the Powerhouse Six solar facility. Photo: DOE

The Powerhouse Six solar project is an excellent example of transitioning former federal restricted use sites for beneficial reuse. The Powerhouse Six team was able to work with partners to overcome obstacles and redevelop a restricted use, environmentally impacted land parcel on DOE property in Oak Ridge, TN. The Powerhouse Six solar generating facility revitalizes World War II era assets in the Oak Ridge community, supports energy goals and initiatives, provides brownfield reuse, and supplies 1 MW of clean energy to the electric grid.

RSI is leveraging this experience to develop a "Solar Advantage" approach to help industrial facilities create sustainability attributes by locating utility-scale solar generating facilities on restricted-use or unusable parcels of their development. To date, they have 5.2 MW of solar generation either constructed or under development. This clean energy is enough to provide electricity for 516 average homes, equivalent to reducing 5,654 metric tons of CO₂, or eliminate the emissions from 1,190 passenger cars.



Fig. 10. UCOR President and ETP Cleanup Project Manager, Ken Rueter, speaking at the Powerhouse Six “Plugging In” ceremony about UCOR’s commitment to reindustrialization at ETP. Photo: RSI

REFERENCES

- 1) *Environmental Assessment and Finding of No Significant Impact – Transfer of Land and Facilities within the East Tennessee Technology Park and Surrounding Area, Oak Ridge, Tennessee*. DOE/EA-1640. U.S. Department of Energy. October 2011.
- 2) *Completion Report for Remediation of the Zone 1 Powerhouse Duct Bank, Oak Ridge, Tennessee*. BJC/OR-3614. June 2011.
- 3) IEEE 1547™ 2003 Standard for Interconnecting Distributed Resources with Electric Power Systems. Institute of Electrical and Electronics Engineers. July 2003.
- 4) *Solar Installation on Restricted Use Sites*. Restoration Services, Inc. November 2011.
- 5) *Pour-in-Place™ Ballasted Ground System Tech Data Sheet*. GameChange Racking® Copyright 2015. <http://www.gamechangeracking.com>.
- 6) *IntelliRupter® PulseCloser® Fault Interrupter*. S&C Electric Company. Copyright 2016. <http://www.sandc.com/products/switching-overhead-distribution/intellirupter-pulsecloser.asp>.
- 7) Huotari, John. *New One-Megawatt Solar Array at Heritage Center Can Power 133 Homes*. Oak Ridge Today. April 13, 2015. <http://oakridgetoday.com/2015/04/13/new-one-megawatt-solar-array-at-heritage-center-can-power-133-homes/>.