Harnessing the Sun to Power the Canal Road Treatment Plant at New Jersey American Water

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ABSTRACT

To better control the escalating cost of electric power generation at its Canal Road Treatment Plant, New Jersey American Water (NJAW) decided to implement an environmentally friendly solution. The installation of a 500 kW_{dc} solar photovoltaic energy plant allows NJAW to achieve strong financial results, while providing clean, reliable, and cost saving energy to the benefit of our customers and stakeholders.

All of the power generated from this dual array ground-mounted system is utilized on site without exporting to the electrical grid. About 15% of the peak usage of the treatment plant is now supplemented by the system, reducing the amount of electricity that must be purchased from outside energy suppliers. Additionally, energy is produced at times of peak loading on the grid, decreasing stress on the grid, while creating the most valuable energy in a time-of-day rate environment.

In addition to energy savings, the system produces a new yearly revenue stream for the company via the sale of tradable solar-specific renewable energy credits that electric marketers are mandated to acquire to meet the NJ Renewable Energy Portfolio Standard.

The installation of the system has had a very positive public relations benefit by demonstrating NJAW's commitment to preserving the environment. This project is the largest ground-mounted system on the east coast and demonstrates a green energy commitment that is a high

priority for NJ and its governor's environmental agenda.

This article reports on the construction of this energy plant by NJAW and its consultant Dome-Tech Solar from conception to completion. It discusses the challenges of obtaining NJ Clean Energy rebates, obtaining planning board approval and the alterations and changes to the system required during the design and construction process. Most importantly the paper will discuss the economic, environmental and social benefits that any company can derive from the implementation of a similar system.

Keywords: Solar, photovoltaic (PV), renewable, sustainable, generation, certificate, rebate, incentive, New Jersey, clean energy, green house gas reduction, environmental, engineering.

INTRODUCTION

New Jersey American Water (NJAW) is the Garden State's largest water utility, serving more than two million residents. As the price of water continues to increase, New Jersey American Water depends on peak performance of each of its facilities' pumps and purification systems for maximum productivity. Firmly committed to energy and water conservation, NJAW routinely conducts energy audits and screening projects to ensure their facilities are energy efficient.

PROJECT INTENT

NJAW invested in solar technology at Canal Road for both environmental and economic reasons. Through the implementation of an aggressive energy reduction program over the last five years, pumps, motors and lighting were replaced with energy efficient equipment. This work will save the company and its customers millions of dollars in the years ahead as a result of reduced operating costs. Solar power was a logical step in the evolution of this program.

Solar power is now a strategic contributor to the NJAW energy resource portfolio. Not only does solar energy generate electricity without producing harmful greenhouse gas emissions, but it produces maximum output at times of peak demand, when electricity is of highest value.

A solar PV system provides many benefits for NJAW: a financial

hedge against rising fuel costs, as well as an opportunity to display environmental stewardship and reap positive publicity. Moreover, NJAW will secure a strong return on their renewable energy investment, through financial incentives such as those provided by the New Jersey Clean Energy Program and the federal government. A solar project supports the corporate responsibility goals of the company and demonstrates the company's commitment to environmental stewardship. The system also allows NJAW to continue to make progress in reducing greenhouse gas emissions. NJAW can cite these benefits as a boost to their public image as well as employee morale.

INCENTIVES

Financial incentives for the project came from New Jersey state programs, as well as the federal government, through both rebates and tax credits.

New Jersey Clean Energy Program

New Jersey's 1999 electricity restructuring legislation provides for investments in energy efficiency and renewable energy through the "societal benefits charge" collected from all electric public utility customers. In March 2001, the New Jersey Board of Public Utilities approved funding for renewable energy programs, including a customer-sited renewable rebate program administered by the state's utilities.

Eligible technologies include fuel cells, photovoltaic, small wind or sustainable biomass technologies. Systems must include at least a 5-year all-inclusive warranty.

Solar electric systems are eligible for incentives, which are paid incrementally based on the size of the system installed, for systems up to 700 kW_{dc} (for rebates secured after July 1, 2005). At the time NJAW secured a rebate for the Canal Road project, the limit was 500 kW. At Canal Road, a $1.9 million rebate was secured and paid at the end of the construction period.

Modified Accelerated Cost Recovery System (MACRS)

Under the Modified Accelerated Cost Recovery System (MACRS), businesses can recover investments in solar, wind and geothermal property through depreciation deductions. The MACRS establishes a set of

class lives for various types of property, ranging from 3 to 50 years, over which the property may be depreciated. For solar, wind and geothermal property placed in service after 1986, the current MACRS property class is 5 years.

Federal Solar Investment Tax Credit

The federal investment tax credit is a 30% tax credit available to commercial businesses that invest in or purchase energy property in the United States for systems that are put in service in 2006 and 2007. This incentive was 10% for the Canal Road project, which started operation in October, 2005.

NJ State Sales Tax Solar Energy Systems Exemption

New Jersey offers a full exemption from the state 6% sales tax for all solar and wind equipment.

Reduced Electricity Bills: Avoided Costs

The system is expected to produce 13.2 million kWh of electricity over the 25-year evaluation period. Electricity from the grid was conservatively forecast to increase 4.0% per year; data from the Energy Information Administration of the US Department of Energy shows a 4.6% rate over the last 30 years. The fixed price for the power from the solar generation system is an effective hedge against future price increases, which are a function of volatility in fossil fuel commodity markets.

The avoided cost of electricity is estimated to be $0.09 per kWh. While overall electricity costs at the Canal Road facility were assumed to be about $0.08/kWh, the solar generation system produces a high percentage of power during peak summer months, and during daylight hours. The avoided cost of electricity for PV systems generating in NJ, on a real time basis, has been analyzed to be 18% greater in value than average power, yielding the higher power cost shown in the analysis. Avoided transformer losses are estimated at 3%; a loss avoided by producing power without the need to reduce voltage for distribution to the facility.

Renewable Energy Credits

The State of New Jersey Clean Energy Program has created a market for tradable Renewable Energy Credits (RECs), which will be purchased by electricity suppliers that supply end-use customers located in the state. Suppliers must meet the Renewable Portfolio Standard,

which specifies the percentage of electrical energy, measured in kWh, that must be generated by a renewable source, such as solar and/or wind. Suppliers that fail to produce or secure RECs will be subject to punitive fines for non-compliance. New Jersey's Portfolio Standard is unique in that it specifies a higher class of renewables, of which solar is the major source.

The market value of Solar RECs is difficult to predict, because the market has only recently opened; suppliers must produce RECs for supply beginning June 1, 2004. Market value is capped at the penalty, which was recently set by the NJ Board of Public Utilities at $0.30/kWh. The Canal Road financial analysis assumed a sustained current market value of $0.15/kWh over the life of the system, which has been verified in the marketplace. It is possible that the early years will be more volatile, so that RECs may trade, according to the Clean Energy Office of the New Jersey Board of Public Utilities, between $0.16 and $0.25/kWh.

The combination of reduced energy costs and sale of Solar RECs is estimated to provide NJAW annual savings of about $152,000.

Solar Energy Explained

Solar cells, also called photovoltaics (PV) by solar cell scientists, convert sunlight directly into electricity. Solar cells are often used to power calculators and watches. They are made of semiconducting materials similar to those used in computer chips. When sunlight is absorbed by these materials, the solar energy knocks electrons loose from their atoms, allowing the electrons to flow through the material to produce electricity. This process of converting light (photons) to electricity (voltage) is called the photovoltaic (PV) effect.

The Canal Road PV system consists of all the equipment and materials needed to generate solar energy, including SCHOTT SAPC-175 solar modules, a supporting steel structure (fixed axis, ground-mounted), wiring, two Satcon 225-kW_{ac} inverters, revenue-grade metering and an internet-based data-acquisition system.

METHODOLOGY

Design

The project is a 502 kW_{dc} ground-mounted system, split into two arrays: one array located on the north side of the main building, and

the other to the south. Power output from the PV system is supplied into the plant's 4160-volt distribution network. All of the energy from the solar system is utilized on the site, such that there is no expectation for exporting power to the grid. An aerial view of the plant (Figure 1) shows the north and south arrays at the top and bottom, respectively, of the picture. The project required approval of the Franklin Township (New Jersey) Planning Board, which was accomplished by the design team in about 4 months. Planning Board Reviews and approvals were made by the Somerset County Soils Commission, the Historical Buildings Commission, the Delaware and Raritan Canal Commission and the New Jersey Department of Environmental Protection, as well as the town engineer and local code inspectors. At the completion of the project, the New Jersey Clean Energy Program also inspected and approved the facility, as did Public Service Electric & Gas, the local electric distribution company.

The system consists of 2,871 solar PV modules that were manufactured by RWE SCHOTT Solar. Each module is rated at 175 watts, +/- 4% for a total direct current (DC) output of 502,425 Watts (minimum).

The solar module mount/frame systems are freestanding and mount on vertical pipe supports that are mounted in the ground. The solar panels are tilted at a 25 degree angle facing south to maximize the

Figure 1. Aerial View of Plant

solar collective properties of the system. The northern array is shown in Figure 2 and 3.

Power feeds from the inverters (located adjacent to the solar array field) and the plant switchgear (located in the main building) will be

Figure 2. Northern Array

Figure 3. Power feed from solar array

operated using available spare duct banks. A 225-kW Satcon inverter is shown in Figure 4. System design, integration and commissioning were performed by RWE SCHOTT Solar and Dome-Tech.

Supply

The 502-kW ground-mounted arrays are mounted to the ground using a galvanized steel post and rail system that will be installed by Dome-Tech Solar. The panels are mounted at 25 degrees to maximize the real time value of power produced.

A DC disconnect switch rated for 600 volt is provided for each inverter. PV array combiner boxes are included in the array configuration. Each combiner box includes over current protection. The combiner boxes also facilitate the safe operation and troubleshooting of the array by providing easily accessible test points.

The electrical installation conforms to the applicable portions of the 2005 National Electrical Code. UL listed components are used where available and all DC related hardware is rated for DC applications.

Construction

Installation consisted of a standard site preparation scope, that required leveling of the two array areas, building underground conduit runs and forming the drainage paths required by the County Soils Con-

Figure 4. Satcon Inverter and Transformer

servation Committee.

Holes were drilled to an average depth of about 4.5 feet, and square, galvanized steel structural tubing is installed in a post-and-rail configuration. Each bank holds 33 panels, three series strings of 11 panels each.

After building the steel structure, panels were mounted, wired and grounded. Transformers and inverters were installed on concrete pads located alongside each array, to reduce production losses from long electrical runs.

RESULTS

Budget

The implementation cost of the Canal Road project was about $1,600,000, after a $1,900,000 rebate from the New Jersey Clean Energy Program was secured. Most of the cost of the project is in the solar panels, which make up about 2/3 the overall capital cost of the project. The balance of the capital cost is for other equipment (inverters, transformers, AC and DC disconnects, internet data acquisition system and wiring/conduit) as well as engineering, installation labor and overhead. The project was completed on budget, with the only addition being the engineering time required to support the Planning Board approval process. The system will provide a simple economic payback of less than 5 years.

Operation

Operation of a photovoltaic system is virtually maintenance-free. The panels do not require washing and only the inverter requires more than a visual inspection for preventative maintenance. The inverter is function-checked semi-annually to ensure proper control and operation. The ground was finished with weed block covered with river rock, to prevent vegetation and eliminate the need for grass-cutting maintenance.

The PV system output is recorded and verified against expected production, taking into account the sun's intensity (via "solar irradiance"), the ambient temperature of the panels and the local wind speed. Taken together, these parameters predict an output that is checked against actual kW_{ac} production to verify that the system output is at an expected level.

Performance

As a result in delays in obtaining Planning Board approval, the project was placed into operation in October 2006. After approximately 8 months of operation, the PV system was 13% ahead of the expected production. A graph of monthly output is shown below in Figure 5.

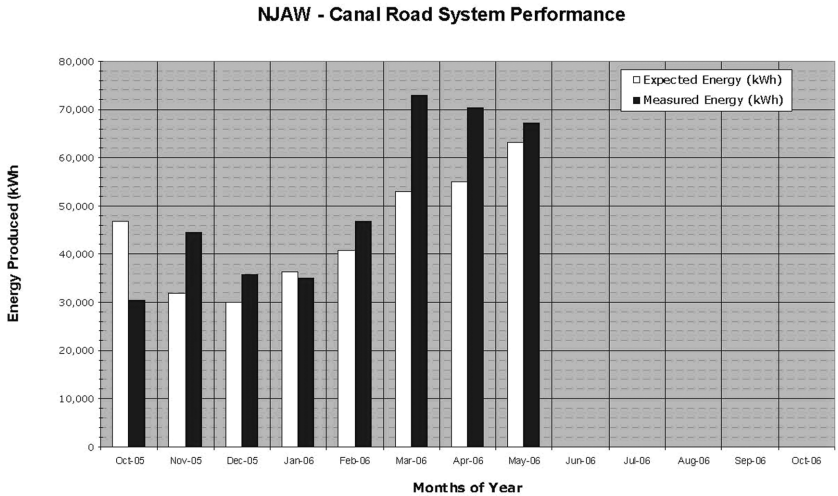

Figure 5. Canal Road Photovoltaic System—Monthly kWh Output (Dome-Tech Solar, 2006)

DISCUSSION

Challenges

Three major unexpected challenges were faced following approval by NJAW. First, it became apparent that the global shortage of solar panels could impact the project schedule. The project team identified a supplier that could meet the budget and schedule required, and panels actually arrived on site a few months earlier than required.

The second challenge was to bring a new technology to the County Planning Board. This is always a test in perseverance because the process opens the project up to review by many local and state agencies. Each agency was allowed to comment, and many hours of expediting were required to keep the project moving. The Planning Board's extensive approval process—which required 30-day drawing review periods, for example—delayed the project several months.

The third unexpected challenge was unanticipated shale rock under the surface of the Southern Array, which ultimately required a well-drilling machine to break through. This was unidentified in previous core-boring data, but was an issue only in about 25% of the holes.

Overall, the project went forward quite smoothly.

Economic Benefits

The project derives economic benefit from several sources. They are described under the Incentives section of this report. The result is a 5-year payback, and a hedge against future energy costs. That hedge is created because the solar PV system is not exposed to fuel price volatility. As oil reaches new highs in the marketplace and electricity costs follow, the production from the PV plant will be produced with free fuel from the sun. As such, the kWh cost of the solar PV system is based solely on the cost of capital when installed. As electricity costs continue to rise, the economic benefit also rises.

Environmental and Social Benefits

Renewable energy technologies are clean sources of energy that have a much lower environmental impact than conventional energy technologies.

By producing 585,000 kWh per year, this equivalent energy does not have to be produced by other traditional electric generation, such as equipment fired by coal, natural gas, or oil. The result is avoided pollution, 700,000 pounds per year of carbon dioxide.*

This is the environmental equivalent of planting 94 acres of tree seedlings, preserving 2.6 acres of forest from deforestation, preserving 36,000 gallons of gasoline, or preserving 13,200 propane cylinders used for home barbeques.†

CONCLUSIONS

NJAW is pleased with the solar installation and has recently completed an expansion of the plant by an additional 87 kW, an increase

*U.S. Environmental Protection Agency (2006) Power Profiler web-based software available at www.epa.gov.

†U.S. Climate Technology Corporation (2006) Greenhouse Gas Equivalencies Calculator available at www.usctcgateway.net.

in capacity of 17%. Since the project was approved, electricity costs in NJ have risen dramatically. They are expected to continue to rise as fossil fuel costs increase and in the aftermath of the upcoming merger of PSE&G. Further, NJAW has received impressive positive treatment in the local press by taking a leadership position and proving that solar technology works for businesses and for the communities which they serve. The environmental benefits are significant and have been achieved as expected. In fact, with production tracking 13% higher than predicted, both the environmental benefits and the return are exceeding original estimates.

Water companies throughout the US should investigate local incentives for renewable energy as well as energy conservation as a way to lower energy costs and reduce exposure to higher electricity costs in the future.

Acknowledgments

New Jersey American Water is the state's largest water utility serving over two million people in 176 communities throughout the state. The company is a wholly-owned subsidiary of American water, the largest and most geographically diverse provider of Water services in North America. With headquarters in Voorhees, New Jersey, American Water employs approximately 7,000 people who provide high quality water, wastewater, and other related services to more than 18 million people in 29 states, Puerto Rico and Canada. More information can be found by visiting www.amwater.com. American Water is an integrated part of RWE AG (Essen, Germany), a leading utility company in Germany.

Dome-Tech Solar is a provider of solar energy systems serving commercial, institutional and industrial businesses, and is the largest North American integrator of SCHOTT Solar panels and mounting hardware. Founded in 2004, Dome-Tech Solar specializes in analysis, design, engineering, development, financing and implementation of solar photovoltaic systems. Visit www.dtsolar.com for more information.

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