

Solar Hot Water System Installed in Philadelphia Prisons

By Robert Eskin

Barely four months after Philadelphia unveiled its first jail-based solar panels for water heating, officials at the city's large urban jail system took steps to replicate the money-saving initiative at the Curran-Fromhold Correctional Facility (CFCF), the system's largest jail. The prototype at Riverside Correctional Facility (RCF), with 45 solar panels heating 15 storage tanks, provides domestic hot water for 768 inmates; the proposed project (with an estimated 15 month duration) would raise 248 solar panels to the roofs of CFCF's four housing buildings, providing domestic hot water to more than 2,500 inmates. Regardless of whether the project goes forward, it is borne of the enthusiasm and know-how that came out of Philadelphia's first solar jail-based rooftop array, installed last winter.

On a brisk but bright December afternoon, with sunlight streaming in from the south, Philadelphia Mayor Michael A. Nutter joined prison and solar project staff on the roof of Riverside Correctional Facility to celebrate the installation of 45 solar panels to provide hot water for the inmates below. "Making Philadelphia the 'Greenest City in America' is a hallmark challenge of my administration," Nutter announced, and praised the initiatives coming from the Philadelphia Prison System.

PPS's Riverside Correctional Facility is the first large urban jail in the country to install such a system. It will provide energy savings of 20 percent to 25 percent annually during the anticipated 25-year life of the system, saving an estimated \$1.1 million and one million pounds of carbon emissions.

"This is an investment in our future, reducing our energy usage and saving us money," Nutter said in December. "Philadelphia is actually one of the sunniest cities in the world at our latitude and solar power represents a huge opportunity for us. With this project, we are leading by example to demonstrate to our citizens and businesses the benefits of tapping the sun's energy."



Photos courtesy Philadelphia Prison System

Philadelphia Prison Commissioner Louis Giorla thanks solar project staff at rooftop dedication ceremony on Dec. 4, 2008. Philadelphia Mayor Michael A. Nutter, left, has promoted new initiatives in renewable resources throughout the city.



Fifteen Buderus hot-water storage tanks, with a maze of piping, were installed in a very confined pre-existing space in the RCF Boiler Room.

With the successful installation of the solar panels at RCF, the relative simplicity of the project and the immediate impact on energy costs, it was clear to all parties that a similar project would yield a comparable benefit at CFCF. And because the proposed project at CFCF would introduce dual-fuel boilers, PPS would be eligible for a reduction in the rate charged for natural gas usage from the local utility company. The utility benefits because it can count on CFCF switching to diesel in the event of a critical shortage. (RCF already had dual-fuel boilers, so no further reduction was available). The water heating system at RCF was centralized in one boiler room. At CFCF, four separate housing buildings — each like a jail unto itself — would support 62 solar panels apiece, heating water in four separate boiler rooms.

“We had recurring failures with our water heaters at RCF,” said Prisons Commissioner Louis Giorla. “U.S. Facilities came to us with a long-term solution that will save us money and put us in the forefront of solar applications. We are very pleased that they took the initiative on this innovative approach, led us through the development stages and, with the other project partners, helped bring it to completion.” U.S. Facilities has held the contract for facility maintenance at CFCF and RCF since 1995 and 2004 respectively.

It was a happy marriage of necessity and opportunity; the jail’s continuously fired conventional boilers — three 1,000 gallon vertical-tube direct-feed boilers that ran on fuel oil and natural gas — were exhausted and had to be replaced immediately. “The pressure vessels were still covered under warranty,” project manager John Carroll explained, “but the installation cost wasn’t covered, and that ran about \$25,000 each.”

“In order to find a long-term solution we partnered with the Herman Goldner engineering firm to review the possibilities,” said Carroll. “We settled on durable and efficient Scotch marine boiler feeding external indirect storage tanks. Once that system was agreed upon we realized there was the potential to add solar, because the tanks had that built-in capacity.”

The indirect storage tanks would be dual-coil Buderus tanks — one coil to handle heat transfer from a conventional boiler, a second coil to connect with a solar heating system. The insulated tanks preserved water heated to 260 degrees, with a reported heat loss of only 0.5 of one degree per hour.

U.S. Facilities approached the RCF’s administrators with a proposition: make full use of the Buderus tanks’ dual capacity, invest upfront in the solar panels and reap the financial rewards down the line. The dual capacity would also allow facility managers to meet one of the basic challenges of the project: to provide uninterrupted service while the installation was ongoing.

Cities are not known to be nimble-footed when it comes to capital projects, but in this case, fast action was motivated by compelling necessity; like heat, light and safety, hot water is a fundamental expectation for a correctional program. The prison administrators were sold, but the cost of the project exceeded the available funds in the maintenance budget. The city’s Capital Budget Office jumped on board immediately and it brought in the managing director’s office and the city’s new Office of Sustainability.



Aerial view of roof-top solar array at Riverside Correctional Facility. The 80 year-old brownstone House of Correction is immediately behind, and the Detention House is visible in the distance.

The opportunity to move forward came from the Office of Sustainability, which signed on to help fund a demonstration project that would serve as a model for future system upgrades. Not only did the Office of Sustainability provide cash (from a small fund of “seed money” to promote green projects throughout the city), it provided the persuasive analysis of the project’s viability, and fast-tracked the process of approval.

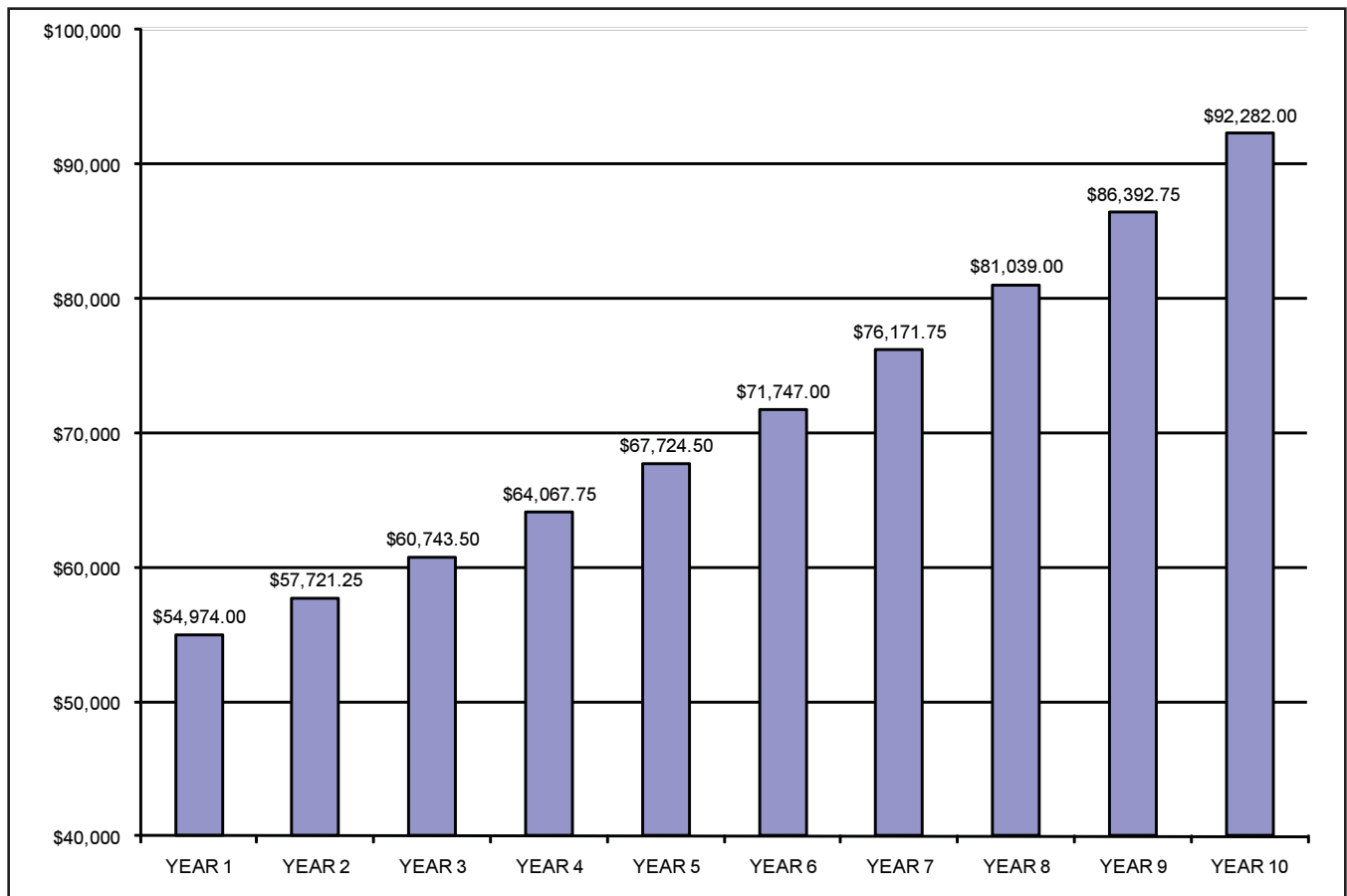
In the meantime, U.S. Facilities was pulling out the old boilers. One of the challenges of this project was the transition from oil- and gas-fired water heaters to solar heat without any interruption of water service to RCF’s staff or its 800 inmates, who need access to hot water for personal hygiene, laundry, cooking and cleaning. “While we were doing this, the third boiler was starting to fail,” said Carroll. “We were under pressure to not only get the job going but to get it going before the final boiler failed. We had to phase in the new boiler and storage tanks while we phased out the old.”

While the rooftop array of 45 solar panels provides the key visual for this project, the installation of the water storage tanks and heat transfer pumps into the limited existing boiler-room space was the primary engineering challenge. Within that fixed footprint, engineers had to install the new boiler, 15 indirect storage tanks, piping and control systems. The system also includes a mile of piping for the closed system that circulates propylene glycol from the solar panels through the roof, through the second floor to the ground-floor boiler room.

The final work on the system included balancing, purging and synchronizing controls — balancing the temperature in the storage tanks (they should all be the same); purging air out of the system, as in a radiator system; and synchronizing the controls so that temperature and draw down from the tanks is equalized.

Prior to installation, RCF consumed between \$4,000 a month (in the summer) and \$34,000 a month (during the cold of winter) in natural gas, but not all of that went to produce hot water. Natural gas also fuels the facility’s heating

Annual Cost Savings Estimate



*Based on 10 percent annual rate of increase in fuel prices

system, and both heat and hot water are on the same gas meter. The solar-panel system is expected to reduce the fuel used for hot water on average by 20 percent to 25 percent.

PPS Background

The Philadelphia Prison System is a large urban jail system, serving Philadelphia. It manages more than 35,000 new admissions a year, with an average daily population of more than 9,200 inmates in fiscal year 2008. Most of the inmates are held pretrial, for an average length of stay of 92 days. There are six major facilities on the campus, located in northeast Philadelphia.

The Riverside Correctional Facility was completed in 2004 at a cost of \$38 million and was dedicated in July of that year. It serves as the central intake facility for all women who are incarcerated in Philadelphia, providing housing, admissions and diagnostic services, classification, treatment, and case management to an average daily population of 800 inmates.

Designed by Vitetta Architects/Engineers, RCF has a three-story housing building, and a connected administration and program center that offers medical and mental health offices, admission, and release services for 4,000 women a year. The building's mechanical infrastructure is isolated in the administration building. The housing building includes four 64-bed units on the first floor and four 128-bed units on the upper floors. There is one shower for

every eight inmates on the housing units, plus four showers in the receiving room for a total of 100 shower units. Additional hot water demand comes from cleaning, laundry and scullery chores.

Even in 2002, when construction designs were under review, no one urged the contractors to build "green." Mark Alan Hughes, director of the Office of Sustainability sees the initiative as part of the administration's ongoing drive to change the way the city does business. "When Mayor Nutter opened the new green roof on the Free Library in the fall [of 2007], the city announced our commitment to building energy efficiency. When the mayor opened the new solar thermal at Riverside in December, the city showed we intend to stay in the game and play big. ... Buildings account for over three-quarters of our city government energy use and we're aggressively moving to lower our costs while improving performance."

The fact that the boiler room was well-separated from inmate traffic reduced security concerns about a project that involved a lot of roof access by outside contractors. Under U.S. Facilities management, contractors from Herman Goldner could work without interruption or hindrance. The deployment of correctional staff to maintain security during construction was constant, but minimal. Careful scheduling and coordination of deliveries and contractors' access coupled with an established relationship of communication between maintenance and RCF Warden Kenneth Brown's staff assured that traffic was controlled, orderly and on time.

Installation Timeline

| SAVINGS | |
|----------------|--|
| January 2009 | → Active operation |
| | → Synchronizing controls |
| | → Balancing and purging |
| December 2008 | → Fill system, check for leaks |
| | → Install solar pump packages, controls and piping |
| | → Rooftop dedication |
| November 2008 | → Install all solar trim and piping below roof level |
| | → Mount solar panel frames and panels |
| | → Shop assembly of panel frames – delivery to job site |
| | → Ship solar panels, frames, lines and pump packages |
| October 2008 | → Install steel framing |
| | → Engineering review |
| | → Computer-assisted design of rooftop array |
| September 2008 | → Site visit for preliminary designs |
| | → Design review |
| | → Structural review |
| | → City approves project |
| August 2008 | → Equipment demonstration |
| | → Proposal development (selection, pricing) |

What's Next?

Prisons are huge consumers of electricity, natural gas and, potentially, diesel (the back-up generators rely on reserve tanks of diesel). Examining energy use, water use, waste-water, food waste and office waste are all important elements of a green plan for PPS. Like all city departments, PPS is aggressively looking for ways to reduce spending during an economic downturn. That doesn't foreclose the opportunity to invest in energy savings; the PPS proposal to replicate the solar rooftops at CFCF is under review.

While Philadelphia city offices began recycling in 1994 (by executive order), PPS did not effectively implement this program until 2008. With incentive programs driving collection of recyclables in inmate housing areas (paper only), and effective promotion of the program among staff (yielding office paper and plastic, predominantly), PPS now generates 5 tons of recyclables a week, reducing landfill use and tipping fees.

Composting food waste is a related initiative. The challenges include collection and cold storage of the waste for routine pick-up by a contracted partner who sells the food waste to a local farmer. The savings are very real, both in tipping fees reduced, and reduction of water use. Again, RCF is expected to be the test pilot for this initiative, with expansion eyed for CFCF. All of this is under review by PPS's recycling coordinator.

Other initiatives under review include energy performance contracting and participating in the local electric utility's Demand Response program. Universities and other large organizations have turned to energy performance contracting, in which private companies make the upfront investment, contract the work and share in the energy savings. Some of the low-hanging fruit has already been picked; the installation of energy-efficient lighting and movement sensors in office space to turn off lights is one example.

Demand Response offers savings (similar to those in dual-fuel price reductions offered by natural gas providers) in which the rate charged for electricity is substantially lowered if PPS agrees to use back-up power generation for its facilities in a power emergency. PPS has the back-up generation capacity in place, and would realize savings even if it is never used.

There is the promise of new technology; the obligation to do better; the incentive of cost savings; and the challenge of finding the investment dollars to achieve these goals. PPS is operating in a complex environment, where new technologies and their promoters offer cost savings, energy savings, reductions in the system's carbon footprint, reductions in landfill use, and cleaner air and water. At the same time, like all city departments, PPS is challenged to exploit the opportunities available by finding incentives and investment dollars up-front in tough economic times. RCF has begun to meet these goals.

Robert Eskind is public information officer for the Philadelphia Prison System.