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Philadelphia's Grays Ferry Steams Ahead

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Steaming Ahead:

The Grays Ferry Cogeneration Project

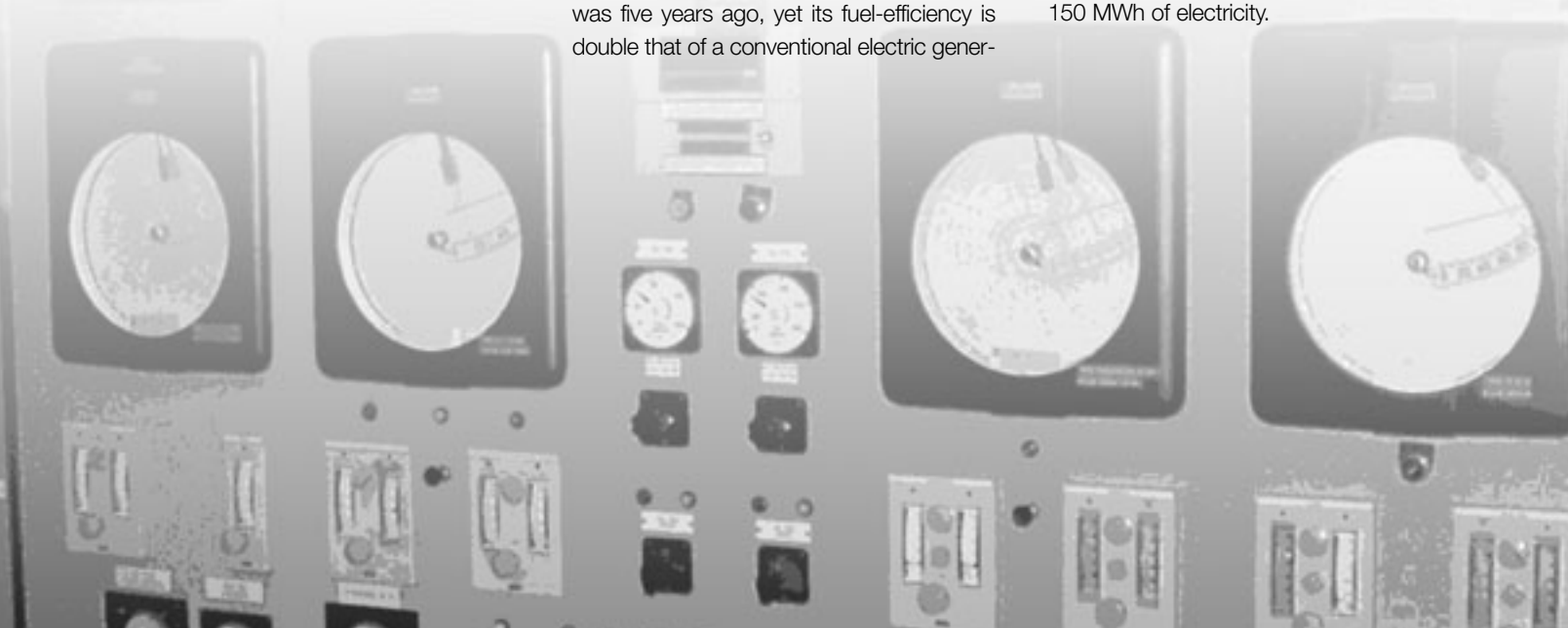
Floyd Rupple, Director of Operations and Maintenance, Trigen-Philadelphia Energy Corp.

Editor's Note: *Philadelphia is home to the Grays Ferry Cogeneration Project, which was still under construction when featured in* District Energy *magazine five years ago this quarter. This article provides an update on the plant as it enters its fifth year of actual operation. Philadelphia will be the venue and Trigen-Philadelphia will be the host for IDEA's 94th Annual Conference and Trade Show June 22-24, 2003.*

More than 300 locations throughout Philadelphia's Center City and west side rely on steam from Trigen-Philadelphia Energy Corp. Nearly everywhere you turn, steam is steadily doing its job. It heats historic locations such as Independence Hall and the Liberty Bell Pavilion, humidifies galleries in the Philadelphia Museum of Art, dries newly stamped coins at the U.S. Mint, sterilizes operating room equipment at local hospitals and keeps tenants cool in tall commercial office buildings.

Perhaps most significant, however, is that Trigen-Philadelphia's steam system is serving even more customers now than it was five years ago, yet its fuel-efficiency is double that of a conventional electric generator and its total emissions have decreased by 74 percent. The reason: the Grays Ferry Cogeneration Project (Grays Ferry), a dual-fueled, combined-cycle base-loaded cogeneration plant designed to produce 1.5 million lb/hr of steam for the system, plus 170 MW of electricity.

Grays Ferry is actually an equal partnership of Trigen-Schuylkill Cogeneration Inc., a wholly owned subsidiary of Trigen Energy Corp. and Calpine Inc. Trigen-Philadelphia has a 25-year contract to purchase up to 1.5 million lb/hr of steam from Grays Ferry to supply its existing district energy customers in Philadelphia. PECO is under a 20-year contract to purchase up to 150 MWh of electricity.



Grays Ferry had a first quarter 1998 startup, and just one year later, all parties were realizing the plant's many benefits: Grays Ferry sold 1.2 million MWh of electricity to PECO and 2.7 million Mlb of steam to Trigen-Philadelphia. Plant operations continue to optimize and grow. In 2000, Grays Ferry added electrical generating capacity utilizing power augmentation wet compression and implemented market-based dispatching methodology.

Establishing a Solid Track Record

Construction of Grays Ferry began in 1996 on the site of the existing Schuylkill Station. Trigen-Philadelphia's main objective was to replace the generating capacity of two aging Schuylkill Station boilers with a state-of-the-art cogeneration facility – thus increasing the steam system's fuel efficiency and reducing emissions. Another Schuylkill boiler from 1971 was converted to dual-fuel and retained, operating to this day.

In the year following the plant's startup, total emissions were reduced 68.8 percent from previous levels. In 1996 and 1997, prior to Grays Ferry's operation, emissions from the system's Schuylkill and Edison stations averaged 2,880 tons (fig. 1). With the startup of the Grays Ferry, however, total system emissions decreased to just 898 tons in 1998, while the system's annual fuel usage nearly doubled.

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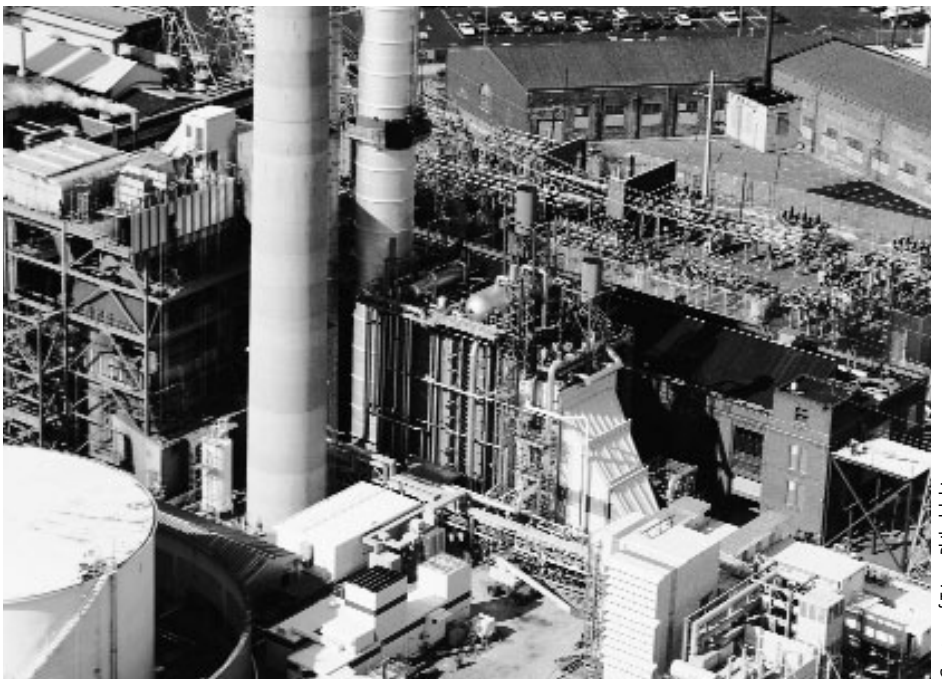
The actual operating experience has been even better than the projections made in the 1997 *District Energy* magazine article on the plant. The 1997 projections anticipated emissions of about 1,000 tons, with most of that coming from NOx. In reality, NOx emissions currently are less than half of what was projected at that time.

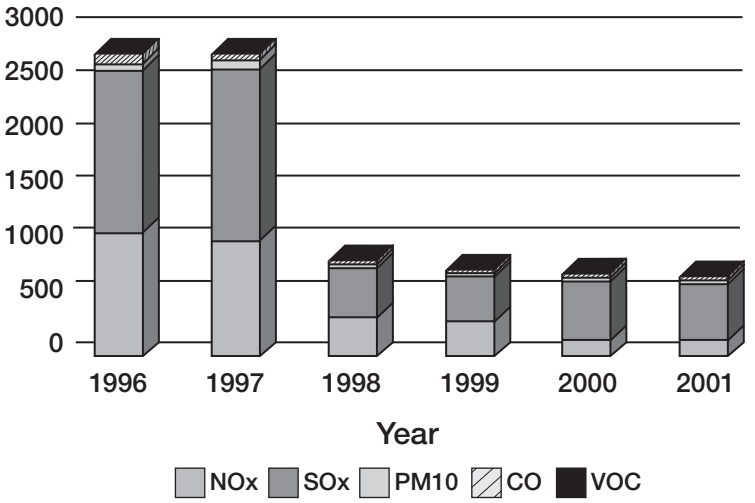
The equipment used to achieve these new efficiency levels are a 118 MW Seimens-Westinghouse 501D5A combustion turbine, a Nooter/Eriksen heat recovery steam generator (HRSG), a 54 MW Siemens-Westinghouse condensing steam turbine with controlled extraction and a Cerrey 700,000 lb/hr standalone boiler.



Courtesy of Trigen-Philadelphia.

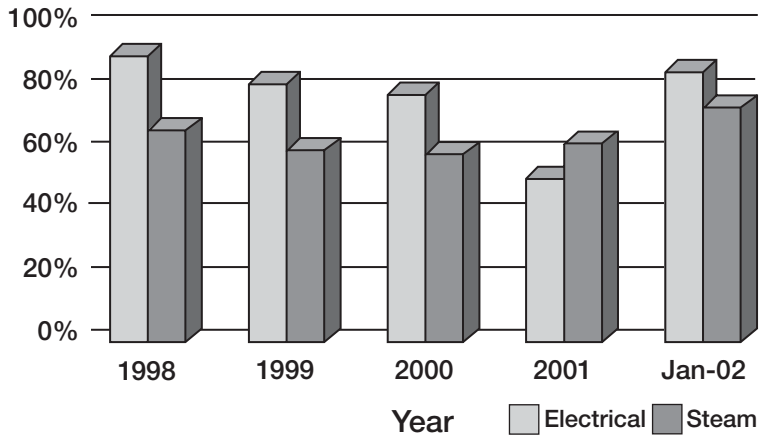
Grays Ferry Cogeneration Project began operation in 1998 and today provides 86 percent of the steam for Trigen-Philadelphia's district heating system.

Figure 1. *Grays Ferry Cogeneration Project Total Emissions, 1996-2001.*



Source: Trigen-Philadelphia Energy Corp.

Figure 2. *Percent of Electric and Steam Output Supplied for Trigen-Philadelphia Energy Corp. by the Grays Ferry Cogeneration Project, 1998-January 2002.*



Source: Trigen-Philadelphia Energy Corp.

The facility uses natural gas as its primary fuel, with low-sulfur diesel for backup. Grays Ferry has the capacity to store approximately 50,000 barrels of liquid fuel.

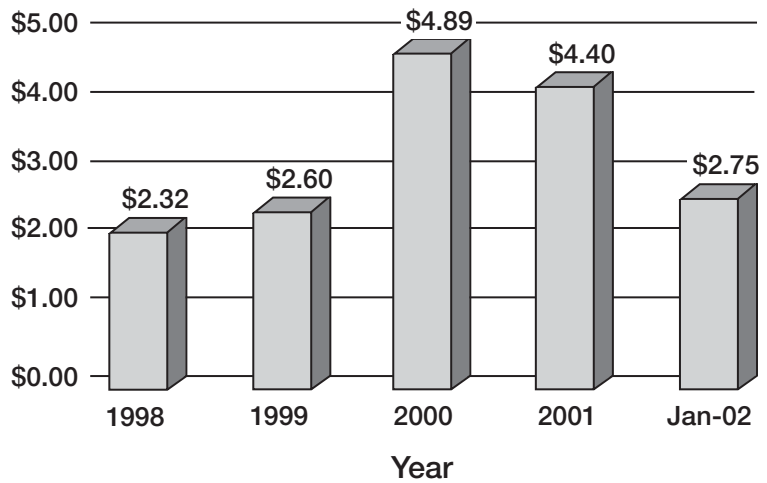
During its first three years of operation, Grays Ferry experienced a few growing pains – including a slightly delayed startup resulting primarily from the inherent challenges encountered when integrating a new facility with 50-year-old infrastructure. Both Schuylkill Station and Grays Ferry maintained their own control systems, preventing the automation of some processes.

These challenges were overcome, and by 2001, Grays Ferry was producing 62.8 percent of Trigen-Philadelphia's steam requirements, with the balance coming from the Schuylkill and Edison stations. (See fig. 2.) Electric capacity at Grays Ferry dropped to 59 percent in late 2000, however, caused by rising gas prices (fig. 3) and a shift to market-based operation. But by January 2002, Grays Ferry was supplying 86 percent of Trigen-Philadelphia's steam requirements, and electric capacity had increased to 75 percent. The plant is playing a major role in the supply of steam and electricity to the Philadelphia area, and it is well-prepared to support Trigen-Philadelphia's steam distribution in the future.

The Grays Ferry plant has earned national recognition as a model of efficiency and environmental performance. In late 1999, *Power Magazine* presented Grays Ferry with its Power Plant of the Year Award. The honor acknowledged the plant's successful transformation from aging power station to a modern district heating facility and significant source of electrical generation to the PECO territory.

In summer 2000, when Vice President Al Gore was running for president, his campaign utilized Grays Ferry as a backdrop for announcing his National Energy Modernization Strategy. The project was again highlighted as a state-of-the-art, efficient facility.

Figure 3. *Price of Natural Gas in United States, 1998-January 2002.*



Source: Trigen-Philadelphia Energy Corp.

Adding Electrical Capacity

After two positive years of operation and with power prices reaching record levels during the summer of 1999, Grays Ferry accelerated its efforts to take advantage of the increasing demand for wholesale electric in the Pennsylvania-New Jersey-Maryland region. Grays Ferry was required under a long-term contract to supply 150 MW of Grays Ferry's output to PECO through 2017. The contract with PECO was structured with a base-loaded period providing for fixed rates through the end of 2000. Market-based pricing was to begin in 2001.

Grays Ferry began evaluating options to increase the facility's electrical output shortly after initial commercial operation. Power augmentation wet compression was one technology considered. Dow developed the wet-compression technology in the early 1990s, with the first full-scale version installed in 1995.

Wet compression increases combustion turbine output by injecting demineralized water into the combustion turbine's air stream. The water is injected by atomizing the water to provide a water vapor at the compressor inlet. The water fog evaporates in the compressor, increasing the compressor efficiency and thus, the electrical output. Additionally, the mass flow through the turbine section is increased, resulting in additional electrical output.

Wet compression's additional benefits include about a 2.3 percent heat-rate improvement, nitrogen oxide reduction and increased steam production. Increased steam production is a direct result of passing approximately 3 percent more mass flow through the HRSG at 1000 degrees F.

Grays Ferry installed the wet-compression system in spring 2000, looking to leverage increased electrical demand over the summer months. By installing the wet-compression system, Grays Ferry was able to increase the plant's electrical output by 19 MW when the ambient temperature exceeded 50 F. During 2000, Grays Ferry took advantage of the increased output of Grays Ferry by producing 7450 MWe

above the PECO contract. Although the increased production was less than anticipated in 2000; the wet-compression installation prepared the plant for the added benefit resulting from the new equipment, which would be realized beginning in 2001. In 2001, Grays Ferry was able to produce 15,650 MW in excess of the original design, during high demand periods.

In addition, with eight standalone boilers and the heat recovery steam generator, Trigen-Philadelphia needed a method to evaluate the most cost-effective operating mode consistent with the market-based electrical contract. (Trigen-Philadelphia defines an operating mode as that combination of boilers required to maintain cost-effective reliability while taking advantage of the electric market.)

Leveraging Market-Based Operation

The benefit of Grays Ferry was realized throughout the first three years of commercial operation. In the remaining years of the contract, Grays Ferry's operation will follow the market-based electric rates unless specifically called on by PECO to supply 150 MW. During the remaining contract term, PECO is limited to 50 16-hr periods where Grays Ferry was required to supply electricity. All other operating periods under the PECO contract present operations staff with new challenges as fuel and electric prices increase in volatility due to market deregulation. Establishing a real-time dispatch policy that accurately predicts the most cost-effective mode of operation and maintaining a proper balance between electric and steam sales are necessary for optimal system use.

In late 1999, engineering staff began developing a real-time dispatch model. Implementation and training began in summer 2000. Initially, the dispatch model was developed to predict the best mode of operation from manual inputs. The operator was required to manually input ambient temperature, gas price, steam sales and electric price. From these inputs, the model would provide the operator with information on the most cost-effective operating mode.

Since Grays Ferry's electric power contract would convert from base-loaded to market based beginning in 2001, the development team knew the model would need to be updated to meet the increasing need for real-time evaluations of operational and pricing data. With data spread across three distinct platforms – (1) Scan 3000, for PLC-based systems; (2) Westinghouse Distributed Processing Family (WDPF) Historian for Grays Ferry; and (3) Microsoft Access – for all manually collected data, real-time consolidation was considered nearly impossible.

Grays Ferry and Trigen-Philadelphia evaluated several methods of consolidating this data and providing real-time performance numbers. There were three key factors involved in selecting the most timely and accurate method. First, the data would need to be consolidated into a single platform that could be accessed by the dispatch models. Second, the platform would need to provide historical data for evaluation. And finally, the information would require easy access across the local area network for engineering evaluation as well as operator use.

Grays Ferry and Trigen-Philadelphia selected OSI Software Inc.'s PI System to collect and store data from all systems. The PI System is a set of server and client-based software programs designed to fully automate the collection, storage and presentation of plant information. PI provides a seamless interface among SCAN 3000, WDPF historian and Microsoft Access. It is a single repository of information that allows for easy access by anyone in the company.

The backbone of the PI System is the PI Data Archive, which allows for efficient data storage and retrieval. Not only does the system collect and store data from the existing systems, the historical data from all three platforms is easily converted and stored in the PI System. This not only allows real-time data access, but allows historical data to be evaluated from the same platform.

Shortly after the PI System's installation in February 2001, the model was ready for real-time updating. This allowed the four manual inputs to instead be provided by the PI system, including real-time pricing from the PJM Interconnection LLC Web site.

Throughout 2001, the model was enhanced to provide operators with the most accurate dispatch information possible. The model provides real-time information, which allows staff to enhance operations and leverage Grays Ferry's equipment and benefits.

Courtesy of Trigen-Philadelphia. Photo by Floyd Rupple.

Operations of Grays Ferry required the operators move from conventional controls to state-of-the-art computerized controls.

As Grays Ferry enters 2002, it has completed four excellent years of operation. It has met its goal of providing an energy efficient method of producing steam for the Philadelphia district heating system, producing cost effective electrical energy and providing a continued benefit to the surrounding community business.

Floyd Rupple *is director of operations and maintenance for Trigen-Philadelphia Energy Corp. Rupple began his tenure in 1996 as operations manager and now has responsibility for operation and maintenance of the Schuylkill Station, Edison Station and the Grays Ferry. Prior to joining the firm he was employed by Siemens-Westinghouse as an operations manager. Rupple holds a bachelor of science degree in business administration from the University of Phoenix and will be graduating from the Executive MBA program at St Joseph's University in May.*