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CITY OF HAYWARD

Evolution of Green Power Production at the Water Pollution Control Facility

PROJECT OVERVIEW

The City of Hayward is a leader in sustainability being one of the first cities in California to adopt a Climate Action Plan (2009) demonstrating its commitment to environmental protection and sustainability. The City's Climate Action Plan goals are to reduce municipal greenhouse gas emissions by 20% below 2005 baseline levels by 2020. In 2016, the City adopted a resolution establishing that all new municipal buildings, as well as significant retrofits of existing buildings, be zero net energy (ZNE) buildings. By 2025, the City will strive to achieve ZNE for its portfolio of facilities by producing more renewable energy at City facilities, and by increasing renewable energy production at the City's Water Pollution Control Facility (WPCF). In 2014, a new Cogeneration Facility was commissioned which converted the WPCF from being the largest energy consumer in the City of Hayward to a net energy exporter. The Cogeneration Facility, along with a one-megawatt solar array commissioned in 2010, produce on average approximately 131% of the plant's total energy demands. These projects, along with future projects at the WPCF are key in the City's efforts to reduce emissions of greenhouse gasses.

BACKGROUND AND OVERVIEW OF THE WPCF

The WPCF is owned and operated by the City of Hayward and has served the City's 150,000 residents and approximately 10,000 businesses since 1952. The WPCF is rated for an average dry weather flow capacity of 18.5 million gallons per day (mgd) but is currently treating about 11.3 mgd. The facility receives and treats municipal and industrial wastewater by influent grinding of solids prior to pumping to the treatment process. Treatment consists of grit removal and primary sedimentation followed by biological treatment consisting of a trickling filter/solids contact (TF/SC) process. Following biological treatment, the flow passes through secondary clarification prior to chlorination and discharge to the East Bay

Dischargers Authority (EBDA) common outfall pipeline where it is dechlorinated prior to discharge to the San Francisco Bay. An aerial overview of the WPCF is shown in Figure 1 along with key components of the cogeneration process.

FIGURE 1 - *City of Hayward Water Pollution Control Facility Cogeneration Facility and Related Processes*

EVOLUTION OF GREEN POWER PRODUCTION AT THE WPCF

The Hayward Water Pollution Control Facility (WPCF) has long been a leader in green power production and usage having commissioned its first cogeneration facility in 1981. The 700 kW facility was designed to use bio-gas produced in the digesters to generate energy for use at the WPCF, with waste heat captured to supplement a natural gas fired boiler to heat the digesters.

In December of 2010, a one-megawatt solar installation (Figure 2) was commissioned producing enough power to satisfy 20% of the total energy demand at the WPCF. In 2013, the WPCF commissioned a fats, oils, and grease (FOG) receiving station that accepts high strength organic waste that is discharged directly into the City's digesters, further boosting gas production. In 2014, the City completed construction of a new 1.1 megawatt cogeneration facility that replaced the 33-year old cogeneration system that had reached the end of its useful life. The new cogeneration facility, along with the solar array, produces 131% of plant demand, resulting in the ability to export excess electric energy produced for use at other City facilities. Currently, the WPCF exports 3.3 megawatt hours of green power annually advancing the City's goals toward ZNE by 2025. A summary of the energy production at the plant is provided in Table 1.

	Annual Energy Produced (kWhr)	Annual Energy Produced (kWhr)	% of Total Plant Demand
Old Cogeneration Facility	3.3 million	0	40%
New Cogeneration Facility	9.4 million	1.1 million	111%
Solar Array	2.3 million	0.7 million (prior to cogeneration coming on line)	20%
		2.2 million (after project completion)	1%

TABLE 1 - *Energy Production*

FIGURE 2 - *One Megawatt Solar Array*

Figure 3 shows graphically the plant demand and energy sources at the plant. The solar facility was commissioned in December of 2010. At that time, a portion of the solar produced was used at the plant satisfying 20% of plant demand with the remaining exported to PG&E. In November 2014, the new cogeneration system came on line supplying 111% of plant demand on average, allowing nearly all of the solar to be exported to the grid. As part of the Cogeneration Project, electrical improvements were made to the plant that allowed the City to export excess solar and cogeneration energy to the grid under Pacific Gas and Power (PG&E's) Renewable Energy Self-Generation Bill Credit Transfer (RES-BCT) tariff. This agreement allows the WPCF to transfer excess generated electricity as bill credits to other City facilities. The WPCF produced an excess of 3.3 million KWH in combined solar and cogeneration energy that resulted in a total of $193,000 in bill credits for 20 other City facilities in 2016. The Cogeneration Project has not only made the WPCF self-sufficient producing all the energy it needs, but it also allows excess energy to be used at other City facilities advancing the City's goals of reaching ZNE status by 2025. At the time of commissioning in 2014, the City of Hayward's WPCF became the first publicly owned treatment works (POTW) and largest generating account in the California Public Utilities Commission RES-BCT program.

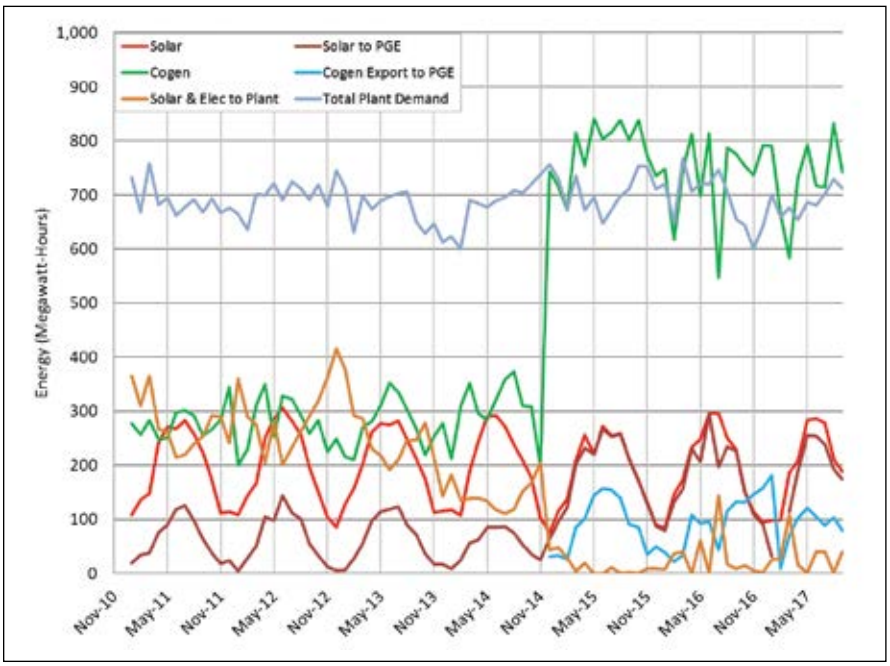

FIGURE 3 - *Plant Demand and Energy Sources*

PROJECT HIGHLIGHTS

In 2011, the City recognized the need to either significantly rehabilitate or replace the existing cogeneration system. The engines were nearing the end of their useful life, and were in need of replacement. The engines had undergone numerous rebuilds over the years, and had new emission controls systems installed as required by the Bay Area Air Quality Management District (BAAQMD) causing the efficiency rating (conversion of bio-gas to electrical energy) to be de-rated to about half of what the facility was originally intended to produce. Over the last several years of operation, the cogeneration system produced 385 kW on average, satisfying only about 40% of plant demand. Consequently, the WPCF routinely flared excess gas, and relied on natural gas in winter months to maintain the digesters at the temperatures needed for the digestion process. Given the age of the existing facility (over 33 years in service) the City decided to replace the existing cogeneration system with a new facility.

In 2011, the City engaged Carollo Engineers to perform a feasibility study, preliminary design, and final design of a new Cogeneration Facility. The project consists of a new GE Jenbacher 1,132-kW bio-gas fueled internal combustion engine (ICE) generator sized to meet the treatment plants energy demand (see Figure 3). Other key features include:

- Installation of a carbon monoxide (CO) catalyst in the exhaust gas piping designed to lower CO emissions;
- New cogeneration building sized to accommodate a second engine allowing for future expansion of the facility;
- New gas conditioning system skid designed to condition the gas (removes moisture, hydrogen sulfide, siloxanes, and other impurities) prior to use in the cogeneration engine;
- Heat recovery equipment capable of harnessing up to 3.4 million BTU/hour of useful thermal energy;
- Automatic blending of natural gas and digester gas;
- High pressure gas storage tank to improve digester gas utilization;
- Electrical equipment to support a new interconnection with the local utility grid.

As previously noted, before commissioning the new Cogeneration Facility, the WPCF routinely flared excess bio-gas, wasting a valuable renewable resource. Since coming on-line, the plant rarely needs to flare excess gas as the new cogeneration engine is capable of using virtually all the gas that is produced in the plant. In addition, a high-pressure gas storage tank is used for storage when the digesters produce more gas than the engine can use, and modulates gas back to the cogeneration engine when gas production in the digesters is lower than what the engine needs. The tank provides 33,000 cubic feet of gas at 140 pounds per square inch pressure. The ability to store, as well as use virtually all the gas produced at the plant has resulted in the reduction of flaring to less than 2% of the time since facility startup including times when the engine is off-line for routine maintenance.

"THE COGENERATION PROJECT HAS NOT ONLY MADE THE WPCF SELF-SUFFICIENT PRODUCING ALL THE ENERGY IT NEEDS, BUT IT ALSO ALLOWS EXCESS ENERGY TO BE USED AT OTHER CITY FACILITIES ADVANCING THE CITY'S GOALS OF REACHING ZNE STATUS BY 2025."

FIGURE 4 - *Cogeneration Engine*

Waste heat from the new cogeneration system is captured and used to heat the City's anaerobic digesters. The new cogeneration system is capable of producing 3.4 million BTU/hr of useful thermal energy which is more than the plant needs to heat the digesters. Prior to the new facility coming on line, the plant relied on a natural gas fired boiler to heat the sludge during colder months of the year. Since commissioning the new facility, the boiler has only been operated periodically to maintain its readiness to serve as a backup source of heat should the cogeneration facility be down for maintenance.

RELATED PROJECTS

Fats, Oils, and Grease Receiving Station
In 2013, a 19,000 gallon Fats, Oils, and Grease (FOG) receiving station was installed at the WPCF. The station started accepting cooking oil separated water along with traditional FOG prior to sending to the digesters. Today, over 200,000 gallons per month of FOG is collected generating between $5,000 to $6,000 per month in tipping fees, as well as providing fuel to boost the production of bio-gas.

Digester Improvement Project
The City is currently completing a digester improvement project which includes a new sludge blending tank, digester feed pumps, and automated digester feed valves. Prior to the improvement project, the various feed stocks (FOG, scum, and thickened sludge) were independently valved to feed to the digesters through a complicated piping network. FOG could be fed to any of the digesters, however scum feed was directed exclusively to one digester, and thickened sludge was conveyed to another. Valves were manually turned once or twice a shift, with feed conveyed independently to the digesters. Because of the variable nature of the sludge feed to the digesters, the process was subject to occasional upsets. The sludge blending tank now provides the ability to combine all the digester feed stocks (FOG, scum, and thickened sludge) into a single tank where they are uniformly mixed before feeding to the digesters. New digester feed pumps and automated valves provide the ability to proportionately feed each digester based on volume, with valve cycling based on an operator adjusted setpoint to the various feed locations. In addition, the sludge feed point was moved from inlet boxes located on top of each digester to feed into each digester's respective sludge mixing pump discharge piping providing better distribution and mixing of the sludge feed within the digesters. These enhancements are expected to boost digester gas production further. An added benefit of the new tank is it provides additional storage capacity allowing the WPCF more flexibility to increase FOG deliveries if desired in the future.

FUTURE GREEN POWER PLANS AT THE WPCF

Looking forward, there are plans to add an additional 2-megawatt photovoltaic system, and a second cogeneration engine at the facility ultimately boosting the WPCF's green power production and advancing the City's goals toward zero net energy and reduction of green house gases.

AWARDS

The Cogeneration Facility has earned numerous awards including:

- 2015 winners of the EPA's prestigious Green Power Leadership Award for on-site generation – Award based on the WPCF producing 10,747,000 kWh of on-site green power (129% of plant demand) via biogas and solar. Hayward is currently number 30 on the EPA's Green Power Partnership Top 30 On-Site Generation List
- In 2015, the City of Hayward was honored by the Institute for Local Government with a Silver- Level Beacon Award and Beacon Spotlight Awards for reductions in municipal greenhouse gas emissions, community greenhouse gas emissions, and a variety of sustainability best practices.
- 2015 CWEA San Francisco Bay Section Plant of the Year.
- 2016 CWEA Engineering Achievement Award