Executive Summary: Draft PA No. 6 – Energy Audit Recommended Improvements at Santa Cruz WWTP

Description

Several recommended improvements to equipment at the Santa Cruz Wastewater Treatment Plant (WWTP) identified as part of a recent United States Department of Energy (USDOE) energy audit would save energy and reduce indirect GHG emissions. Although the WWTP is owned by the City of Santa Cruz Public Works Department, the SCWD or the SqCWD could potentially provide funding for a portion of these improvements and receive the GHG reduction credit.

Amount of GHG Reduction

The energy savings from the improvements recommended in the energy audit would correspond to an annual GHG reduction of approximately 334 MT CO_2e and total of 6,679 MT CO_2e of the project life. This project could reduce approximately 50 to 80% of the potential GHG reduction goals for SCWD, and 20 to 25% of the potential GHG reduction goals for SqCWD.

Project Life and Sustainability

Implementation of the recommended improvements would continue to provide energy savings and GHG reduction for the 15 year life of the project. The project would be sustained by normal maintenance and repair.

Project Cost

This project would result in an overall benefit over the project life. The average annual net cost of the project is approximately -$66,000 per year, because the savings from reduced energy use is greater than the cost to install and run the project. Since the project results in a net benefit, the project lifecycle GHG reduction cost per metric ton (approximately -$250 per MT CO_2e) also provides a net benefit to the WWTP operations.

Table ES-1: Energy Audit Recommended Projects Summary

Life (yr)	Average Annual GHG Reductions (MT/Yr)	Capital Cost ($)	Average Annual Net Cost ($/Yr)	Lifecycle Energy Cost ($/KWh)	Lifecycle GHG Reduction Cost ($/MT)
15	329	$801,000	-$66,000	-$0.064	-$215

Draft Project Assessment No. 6 – Energy Audit Recommended Improvements at Santa Cruz WWTP

Description

This assessment estimates the energy savings and GHG reduction potential from implementing improvements recommended in a recent United States Department of Energy (USDOE) energy audit conducted at the City of Santa Cruz (City) Wastewater Treatment Plant (WWTP).

Background

The San Francisco State University School of Engineering (with a grant from USDOE) completed an Energy Conservation and Waste Management Report in December 2010 for the City of Santa Cruz. That report made a recommendation to upgrade or replace a number of pieces of electrical equipment at the City WWTP in order to reduce overall electricity consumption at the plant. The report identified nine (9) Energy Efficiency Measures (EEMs). The EEMs are listed in Table 1 as described in the report. Note EEM No. 4 (Digester Mixing Improvements) has been addressed as part of Project Assessment No. 5, Improved Digester Mixing System at the Santa Cruz WWTP; therefore any potential energy and GHG savings from EEM No. 4 is excluded from this assessment. The applicable EEMs are listed below.

Table 1: Summary of Energy Efficiency Measures

EEM No.	EEM Description	Total Energy Savings (kWh/yr)	Average Demand Savings (kW)	Type of Fuel Reduced
1	Turn Off the Boilers	161 MMBtu/Yr	0	Natural Gas
2	Install VFD on Carbon Scrubber Fans	263,696	30	Electricity
3	Install a New VFD Air Compressor in Place of the Grit and DAFT Compressors	176,835	0	Electricity
4	~~Replace Gas Compressor Mixing with Pump Mixing System in Anaerobic Digesters~~ [1]	~~1,207,354~~	~~195~~	~~Electricity~~
5	Replace One Centrifugal Dewatering Unit with a Screw Press Dewatering Unit	53,227	42.9	Electricity
6	Replace the Standard Efficiency Lighting with High Efficiency Lighting	109,176	18	Electricity
7	Install Lighting Control in Various Areas	42,698	6.5	Electricity
8	Replace Aeration Blower #1 with a High Efficiency Turbo Blower	272,290	31.1	Electricity
9	Replace one of the Interstage Pumps with a VFD Controlled Pump, and Use the Smaller Interstage Pump as Backup	182,403	15.6	Electricity
Total Energy Savings		**1,100,325**	**144**	

[1] EEM. No. 4 addressed in Project Assessment No. 5.

EEM No. 1 - Turn Off Boilers

The facility has two boilers (pictured in Figure 1) which heat water for the digesters if the cogeneration system is unable to provide sufficient heating. According to facility personnel, the cogeneration system normally provides the necessary heating and the boilers are rarely used, except for maintenance. Usually the plant has sufficient time to start-up the boilers in case of cogeneration failure, but the boilers are kept warm in the interim, resulting in natural gas consumption. It is recommended that the boilers be turned off to decrease the annual natural gas consumption of the plant.

Figure 1: Digester Boilers

EEM No. 2 – Install Variable Frequency Drive (VFD) on Carbon Scrubber Fans

Foul air from the trickling filters is conveyed through activated carbon filters to reduce the emission of noxious odors. The filter/scrubbers are shown in Figure 2. Each fan associated with a trickling filter is designed for approximately 13,000 cubic feet per minute (cfm). With seasonal demands, the number of fans online can range from two to four. It is recommended that the fan motor on each carbon scrubber be equipped with a VFD controller, and that all four fans run during the whole year, to provide the same amount of flow. The VFD will vary the speed of the fan to provide only the necessary air flow rate, based upon the number of trickling filters in operation.

Figure 2: Trickling Filter Odor Scrubbers

EEM No. 3 – Install a New VFD Air Compressor in Place of the Grit and DAFT Compressors

The WWTP currently has a 40 HP rotary screw type air compressor for the grit tank agitation, and a 30 HP rotary screw type air compressor serving the Dissolved Air Flotation Thickener (DAFT). The Grit and DAFT compressors share a common supply line, allowing the Grit compressor to serve as a back-up for the DAFT when an inline valve is opened. During periods of medium to low air demand, the compressor power consumption can be excessive, wasting significant amounts of electricity. It is recommended a single new 40 HP variable frequency drive (VFD) air compressor to replace the two current compressor units. A VFD air compressor will vary the output of the compressor to match the systems' needs. One of the present two air compressors would be retained as backup.

EEM No. 5 – Replace One Centrifugal Dewatering Unit with a Screw Press Dewatering Unit

Thickened anaerobic digester sludge is currently being dewatered with three centrifugal dewatering units. The WWTP is planning to upgrade one of the current centrifugal units due to a corroded housing and damaged drive motor. The recommendation from the report is to replace the centrifugal unit with a more energy efficient technology.

The centrifuge has a combined electrical load of 90 HP. According to the WWTP staff, the centrifugal dewatering units currently operate in batch mode 7 hours a day, 5 days a week. The recommended screw press dewatering system operates on a continuous basis. Currently the centrifugal dewatering units are run in off peak hours to avoid utility surcharges. The proposed screw press dewatering could run continuously for 96 hours during the week to process the same amount of sludge as one of the centrifugal dewatering units. The proposed screw press dewatering unit would have a combined electrical load of 9 HP. Replacing one of the centrifugal

dewatering units with a screw press dewatering alternative could amount in significant energy savings.

EEM No. 6 – Replace the Standard Efficiency Lighting with High Efficiency Lighting

A number of the areas at the WWTP are lit with older lower efficiency lightning. The report indicated that the audit team consulted with facility personnel regarding the operating hours for each area to determine potential savings. The suggested high efficiency lighting has approximately the same light intensity as standard efficiency lighting, but requires less input power and maintains a higher luminescence for a longer period of time. Energy savings can be realized due to lower power consumption of high efficiency lower wattage lamps while maintaining the same or improved lighting level.

EEM No. 7 – Install Lighting Control in Various Areas

The report indicated that the audit team observed that lights are left on in certain areas of the WWTP even though these areas were unoccupied for extended periods of time. With digital or twist timers, lights will turn off automatically after a certain period of time as set by the occupant. By installing bi-level controllers on each lighting fixture, it is possible to have the bi-level controllers bring the lights to full brightness as soon as the lighting control is turned on in the area. Installing motion sensors, light switch timers and bi-level controllers will considerably reduce the lighting energy usage and the electrical demand. These bi-level controllers are not needed if the current standard efficiency lighting is replaced with fluorescent lighting. Install lighting motion sensors, digital timers, or twist timers in various areas of the facility is anticipated to reduce lighting energy usage.

EEM No. 8 – Replace Aeration Blower #1 with a High Efficiency Turbo Blower

The facility currently has two 5,000 cubic feet per minute (cfm) centrifugal aeration blowers that provide a minimum of 2,000 cfm for channel mixing and 3,000 cfm plit between two solid contact tanks. Based on plant personnel, only one 5,000 cfm blower operates at any given time; 24 hours per day,365 days per year, for 8,760 hours per year. It is recommended that Aeration Blower #1 be replaced with a turbo-style blower, while leaving Aeration Blower # 2 as a backup. A turbo blower can provide the required 5,000 cfm and 8 psig at a fraction of the energy consumed by the current multi-stage centrifugal blower.

EEM No. 9 - Replace one of the Interstage Pumps with a VFD Controlled Pump, and Use the Smaller Interstage Pump as Backup

The facility currently has a 10 MGD constant speed interstage pump (ISP) and two 25 MGD eddy-current driven pumps that pump primary treated water from primary settling tanks to trickling filters; the first stage of secondary treatment. Based on data provided by plant personnel, it has been approximated that the smaller constant speed pump provides the trickling filters 10 MGD during low flow periods, 30% of the day; while one large ISP provides 16 MGD during the high flow periods, approximately 70% of the day. The flow through the 25 MGD ISP is controlled at 16 MGD by an eddy current drive, a type of slip controlled drive. This type of drive is generally less efficient than other control schemes, as large amount of the drive energy is lost as heat. It is recommended that one of the 25 MGD eddy clutch systems be replaced with a VFD controlled pump with similar flow characteristics. This new VFD pump will provide the required flow for both flow periods, while the smaller pump can be used if additional flow is needed.

Vendors

A number of different vendors manufacture the equipment described in the EEMs above. VFDs, lighting, and controls are available from a multitude of local vendors. Screw presses suitable for dewatering at the capacities required are only known to be available from FKC and Huber. Turbo blowers are available from manufacturers such as HSI, Neuros, and Turblex. These companies have been manufacturing blowers for over 10 years.

History and Technical Maturity

Use of variable frequency drives on motors has become a standard practice at many treatment plants. Centrifugal dewatering units are being upgraded to lower-energy screw presses and belt filter presses at a number of facilities in Northern California. High-efficiency lighting is being installed at many facilities as part of routine plant upgrades, with many plants qualifying for energy rebates. The City of Millbrae WPCP is currently replacing their multi-stage centrifugal blowers with turbo blowers in order to reduce their energy consumption. All of the EEMs described above are well developed and technically mature.

Reliability and Operational Complexity

The EEMs described above are comprised of pumps, motors, VFDs, screw presses, blowers, and electrical equipment (motor control centers, conduit, and wires). These types of equipment have been proven to be extremely reliable throughout the United States. The City staff is accustomed to operating and maintaining the lighting, motors, and the instrumentation associated with these improvements.

The retrofit project is not anticipated to have any adverse impacts on WWTP operations. As part of EEM No. 1, the boilers used to heat the digesters would be turned off when in standby mode to reduce only natural gas usage. Staff will need to make preparations for operation of the boilers only when the cogeneration system is off-line for maintenance and the associated waste heat is no longer available. The addition of a screw press as part of EEM No. 5 is also anticipated to have a modest impact on operations. The screw press has a lower capacity than the existing centrifuges, and would therefore need to operate for a longer period of time. These systems are designed to operate unattended, so operators would only need to be on-site during start-up and shut-down procedures.

Sustainability

Improving the lighting, odor scrubber, dewatering, and aeration systems at the City WWTP would continue to provide energy savings for the life of the project. The project would be sustained by normal maintenance and repair.

Local Considerations

Economic

Implementing the energy conservation opportunities at the Santa Cruz WWTP will benefit the local community by increasing efficiency and improving operations at the WWTP. Construction

of the improvements would require approximately 12 - 16 months, with the potential for a majority of the required labor coming from the local community.

Environment

Air: EEM Nos. 2-3 and 5-9 do not have any direct impacts on air pollution emissions. EEM No. 1 would result in shutdown of the boilers, thereby reducing the amount of carbon dioxide emitted when in stand-by mode.

Land: Since this project involves replacing existing units without any increase in needed space there is no impact on land.

Water: None of these EEMs us water or discharge water, so there is no impact on water use.

Noise: Overall noise levels from the WWTP are not anticipated to increase. Turbo blowers can be somewhat louder than multi-stage centrifugals, but are housed inside a building to mitigate noise. Screw presses spin at a much slower speed than centrifuges, and therefore operate at a lower decibel level.

Aesthetic/Visual: Most improvements would be made inside buildings. The aesthetic nature of the equipment would be similar to other equipment at the plant, and not visible from outside the property, so there are no visual impacts.

Waste by-product: Rotating equipment, such as compressors, blowers, and screw presses utilize grease for bearings, and would need to be disposed of properly.

Energy Savings and GHG Reductions

The energy savings estimated below are based on implementing EEM Nos. 2-3 and 5-9. The energy savings associated with the seven improvement projects is approximately 1,148,000 kWh per year. This accounts for roughly 10% of the total energy demand for the plant (based on 11,626 MWh per year). A summary of the savings is shown in Table 2.

Table 2: Energy Savings and GHG Reductions for Energy Audit Recommendations

Project Title	Annual Energy Savings (kWh/year)	Annual GHG Reduction (MT CO_2e/year)
Energy Audit Recommended Improvements	1,100,325	329

This project could reduce approximately 50 to 80% of the potential GHG reduction goals for SCWD, and 20 to 25% of the potential GHG reduction goals for SqCWD.

Cost

The capital costs for the seven improvement projects are estimated at $907,500. There is a one-time rebate incentive from PG&E through their Customized Retrofit Incentive program in the amount of $0.09/kWh for the first year's savings, plus $100 per kW saved, not to exceed half of the total installed cost, for a total of $106,500. The resulting net capital cost in a total cost of $801,000 shown in Table 3. Operation and Maintenance costs (with the exception of energy cost) are estimated at 0.1 full time equivalents (FTE). With proper maintenance, the

improvements should last 15 years. This project's benefits (from electricity savings) exceed its costs (from the capital cost and O&M) resulting in a negative net cost.

Table 3: Estimated Energy Audit Recommendations Project Costs

Life (yr)	Capital Cost ($)	Average Annual Net Cost ($/Yr)	Lifecycle Energy Cost ($/KWh)	Lifecycle CO_2 Reduction Cost ($/MT)
15	$800,959	-$66,056	-$0.0643	-$215

Summary of Advantages and Disadvantages

Advantages:

- Energy savings and GHG reductions.
- Most of the EEMs involve equipment of which staff is already familiar.
- Better control of aeration system with very modest operational impacts.
- Screw press dewatering would offset cost of centrifuge retrofit.

Disadvantages:

- More complicated procedure for SCWD or SqCWD to fund project and receive GHG reduction credits.
- Extensive upgrades to lighting required throughout plant.