CITY OF SIOUX CITY

KATE KENNEDY
MECHANICAL ENGINEERING
IOWA STATE UNIVERSITY

SIOUX CITY

COMPANY PROFILE

The Sioux City Wastewater Treatment Plant serves communities in three states, including Sioux City, Iowa; Sergeant Bluff, Iowa; South Sioux City, Nebraska; Dakota Dunes, South Dakota; and North Sioux City, South Dakota. The plant processes an average of 12.5 million gallons of wastewater per day. In addition to serving communities, the plant also monitors wastewater from 37 local industries. Facets of engineering, biology, and chemistry combine to form the wastewater treatment process. As authorized by the Iowa Department of Natural Resources, treated wastewater is discharged into the Missouri River.

PROJECT BACKGROUND

Initiatives at the Sioux City Wastewater Treatment Plant are currently in place to decrease the facility's ecological footprint. For example, biogas is combusted in boilers and heat exchangers to produce heat for the plant. However, inefficiencies also exist at the plant. Pumps and blowers consume large amounts of electricity. Lighting often stays on when not needed. Identifying these major energy users to reduce their consumption is the next step in the Sioux City Wastewater Treatment Plant's journey toward sustainability.

INCENTIVES TO CHANGE

Over the past few years, the Sioux City plant has completed several large-scale projects, including renovations for better odor control, repair or replacement of old equipment, and improvements to the wastewater treatment process. Following these costly changes, the plant's focus is now on updates with a significant financial return on investment. In addition, the plant seeks opportunities to minimize the cost of processing wastewater, impacting both current and future taxpayers.

RESULTS

Metal Halide to LED: One improvement opportunity for the Sioux City WWTP involves lighting. The current interior and exterior lighting relies on metal halide bulbs, which must stay on due to prohibitive restrike times. Capitalizing on advancing LED technology, the plant can combine the efficiency of the new bulbs with occupancy sensors for significant energy savings of $12,000 annually.

Occupancy Sensors on Fluorescent Lighting: Portions of the facility are subject to regular maintenance checks. The checks necessitate that the fluorescent lighting stay on at all times. Because the surveyed areas are primarily vacant, installation of new LEDs is not a cost-effective option. However, occupancy sensors installed on the existing fluorescent bulbs would provide an estimated annual savings of $5,000.

Aeration Basin Blower Leaks: The blowers are supplying an unnecessary amount of air to the system due to open valves on external pipes. As a result, the motors consume much more power than is required. The repair of these leaks could save an estimated $48,500 annually, and conserve 1,300,000 kWh of energy.

Gas Flow to Flare: A flow problem was detected that prevented the biogas from being scrubbed of corrosive compounds and flared. A theory was put forth by the intern and then tested. After surveying the combustion path, a large condensate bubble was located, which blocked the path of the biogas. After draining the bubble, the gas was then flared. In order to ensure the most ecological process possible, biogas must be combusted rather than exhausted, as the latter wields 21 times more global warming potential.

Pressure Relief Valve: Biogas is a valuable asset at the WWTP because biogas is used to run the boilers and the digester heat exchangers. One biogas leak was detected on the fourth digester's pressure relief valve. The valve leak may be caused by improper maintenance or a potential malfunction. Repairing or replacing this pressure relief valve could decrease the facility energy consumption by $9,850 during cold months.

Install Combined Heat and Power (CHP) Unit: The WWTP capitalizes on biogas during winter months, powering boilers to heat its buildings. However, biogas is flared when not needed to power boilers. The installation of a combined heat and electricity-producing unit could have a major impact on both cost savings and environmental results. While the WWTP does not have enough biogas to warrant a CHP unit currently, a feasibility study was recommended to further explore the opportunity.

CONVENTIONAL AIR POLLUTANTS AND GREENHOUSE GASES DIVERTED IN METRIC TONS
From Implemented and In Progress recommendations

TOTAL FOR ALL SECTORS								
CO_2	SO_2	CH_4	N_2O	CFC	NO_X	VOC	PM_{10}	$MTCO_2e$
		194.00						4074.00

CONVENTIONAL AIR POLLUTANTS AND GREENHOUSE GASES DIVERTED IN METRIC TONS
From Recommendations in Recommended Status

TOTAL FOR ALL SECTORS								
CO_2	SO_2	CH_4	N_2O	CFC	NO_X	VOC	PM_{10}	$MTCO_2e$
3305.00	17.00	261.00	2.02	40.67	8.50	0.68	0.45	3635.32

PROJECT	ANNUAL COST SAVINGS	ENVIRONMENTAL RESULTS	STATUS
METAL HALIDE TO LED	$12,000	188,000 KWH	RECOMMENDED
OCCUPANCY SENSORS ON FLUORESCENT LIGHTING	$5,000	95,500 KWH	RECOMMENDED
AERATION BASIN BLOWER LEAKS	$48,500	1,300,000 KWH	RECOMMENDED
GAS FLOW TO FLARE	NA	194 METRIC TONS CH4	IMPLEMENTED
PRESSURE RELIEF VALVE	$9,850	15,500 THERMS 30 METRIC TONS CH4	RECOMMENDED
INSTALL CHP UNIT	$328,000	7,008,000 KWH 110,800 THERMS	RECOMMENDED