U.S. Department of Energy - Energy Efficiency and Renewable Energy
Advanced Manufacturing Office

Case Study - The Challenge: Improving the Performance of a Waste-To-Energy Facility

Project Profile

Industry:	Refuse Systems
Process:	Resource Recovery (Solid Waste-to-Energy)
System:	Induced Draft Fan
Technology:	VFD Retrofit

Summary

The City of Long Beach, California was looking for a way to improve the operational efficiency of its Southeast Resource Recovery Facility (SERRF), a recycling and solid waste-to-energy plant. To replace inlet damper control and reduce energy consumption, variable frequency drives (VFDs) were installed on the induced draft fans of three boiler systems. As a result of the retrofit, this Motor Challenge Showcase Demonstration Project reduced facility energy consumption by more than 34 percent (3,661,200 kWh per year), and saved more than $329,500 annually. Taking into consideration a $400,000 California Energy Commission grant, the simple net payback for this project was just under 10 months.

Plant Overview

Built as part of the City of Long Beach's solid waste management strategy, SERRF began commercial operation in July 1988 using mass burn technology to reduce solid waste volume while generating electricity. SERRF processes approximately 1,290 tons of municipal solid waste each day, generating up to 38 MW of electricity. A portion of the electricity is used to operate the facility and the remainder is sold to Southern California Edison (SCE), the local electric utility. Through mid-1996, SERRF has sold more than one billion kilowatts of electricity to SCE. SERRF is owned by a Joint Powers Authority formed by the City of Long Beach and the Los Angeles County Sanitation District No. 2.

Project Background

Rapid economic development and population growth in Southern California have led to a significant increase in solid waste generation. Faced with the closure of landfills in neighboring areas that previously accepted its solid waste, the City of Long Beach developed a multifaceted, comprehensive waste management strategy. This strategy included a recycling program to reduce the volume of waste, and the construction of a solid waste management facility that utilizes three waste-burning boilers. In addition, a front-end recycling process recovers white goods (such as refrigerators and washers) prior to incineration and a back-end recycling process removes other metals from the boilers after incineration.

With the plant's immediate success in producing electricity and reducing the volume of waste requiring disposal, attention was focused on increasing the facility's operational efficiency so a larger fraction of the generated electricity could be sold. Varying operating conditions, such as solid waste characteristics, boiler cleanliness, and weather, caused the optimum operating point of the boilers' induced draft fans to vary significantly. To accommodate this wide range of operating conditions, inlet dampers were used. Since they were partially closed for much of the operating time, there was a potential to improve energy efficiency.

Southeast Resource Recovery Facility

SIC:	4953
Products:	Electricity, waste reduction

Project Team

To increase SERRF's efficiency, the City of Long Beach formed a project team to efficiently and economically implement constructive changes to the facility. The team consisted of representatives of: The City of Long Beach, Montenay Pacific Power Corporation, and the California Energy Commission. The City of Long Beach is the official lessee of the facility. Montenay Pacific Power Corporation functions as the facility's operations contractor, and the California Energy Commission provided a monetary grant to defray a part of the project's cost.

Location:	Long Beach, California
Employees:	56
Showcase Team Leaders:	Bill Cook, Montenay Pacific Power Corporation David Jones, California Energy Commission Charles Tripp, City of Long Beach
Company Energy Philosophy:	The City of Long Beach and SERRF are dedicated to handling municipal waste in an environmentally sound and energy-efficient manner.

The Old System
After trucks discharge their loads at SERRF's 5,000-ton solid waste storage pit, large cranes deposit processable waste into one of three feed hoppers, where the waste is then pushed by hydraulic rams into one of three identical boilers. These balanced draft boilers combust the solid waste, converting water flowing through the boiler tubes into steam that is used to drive a turbine-generator. Some of the electricity produced by the generator is used to power the facility, and the remainder is sold to SCE.

In addition to being equipped with one 100-hp primary air fan and one 150-hp secondary air fan, each boiler has a 500-hp induced draft fan on the exhaust side of the boiler. In the original system, the induced draft fans were controlled by throttling the flow with fan inlet dampers. While the primary and secondary fans supply the combustion air needed to burn the waste, the induced draft fans maintain a slightly negative pressure inside the boilers and draw the flue gas through a state-of-the-art pollution control system. Once cleaned, the flue gas passes through the induced draft fans before it is discharged to the atmosphere.

Analysis of the original operating process demonstrated several key findings. First, to meet system requirements during startup, shutdown, and normal system operation, the induced draft fans' damper settings covered the entire range from closed to 100 percent open. The average fan inlet damper setting, however, was 47 percent open. Second, system resistance was much lower than the original design predicted, resulting in higher volume flows than in the original design and requiring further throttling of the fan inlet dampers to reduce flow. Finally, the existing control system allowed the fans to often exceed the 500-hp rating of the motor.

Project Implementation
In order to implement performance optimization changes to the existing system, the project team concluded that significant energy savings could be achieved by retrofitting each of the induced draft fan systems with a VFD.

VFDs Do More Than Save Energy
While often only regarded as energy-efficiency instruments, VFD uses go far beyond reducing energy consumption. For example, by permitting more precise control over industrial processes, VFDs can improve motor reliability as well as final product quality. By adjusting the power draw to coincide with the system's resistance, VFDs can also increase motor service life and decrease motor maintenance costs. VFDs are easily integrated with feedback and control systems, and can eliminate costly human error, which often plagues other control methods. Finally, because VFDs are much quieter than valves or vanes, they can significantly reduce noise levels.

The New System
To increase system efficiency, the Showcase Demonstration team retrofitted each of the three induced draft fan systems with VFDs, designed to operate with the original 500-hp induction motors. This modification enabled plant operators to continuously modulate induced draft fan speed to maintain the boiler draft set point and allowed fan inlet dampers to be opened to 100 percent, eliminating pressure drop due to throttling.

Results
To validate the savings realized, a wide variety of data was gathered.

Performance Improvement Summary

Energy and Cost Savings

Project Implementation Costs	$663,368
Annual Energy Cost Savings	$329,508
California Energy Commission Grant	$400,000
Simple Payback	9.6 months
Total Annual Emissions Reductions	
CO_2	3,189,000 lbs
Carbon Equivalent	870,000 lbs
SO_x	9,100 lbs
NO_x	10,000 lbs
PM-10	230 lbs
VOC	50 lbs
CO	840 lbs

Static pressures, flue gas density, flue gas flow, electrical input power, fan speed, and steam flows were measured over a one-month period utilizing both inlet damper control and VFD operation. Calculations based on this data showed that, as a result of the project modifications, the annual electrical energy consumption of the three induced draft fans was reduced from 10,728,000 kWh per year to 7,066,800 kWh per year, a 34 percent decrease. This reduction resulted in annual cost savings of $329,508 for the three fans (assuming $0.09 per kWh). The decrease in plant power consumption enabled SERRF to increase the amount of electricity it sells to SCE. This, in turn, reduced consumption of fossil fuel that would be needed to generate the same amount of electricity by the utility. The total cost to implement the project was $663,368. Taking into consideration the California Energy Commission's $400,000 grant, the net simple payback for the project was only 9.6 months.

Lessons Learned

In addition to the economic and operational benefits of this Showcase Demonstration project, several valuable lessons were learned that can be used to improve the performance of similar facilities and processes. First, system resistance should be determined prior to initiating an optimization program. In this case, the resistance was found to be lower than originally estimated. This resulted in higher flows and higher motor loading than expected. As part of this project, the VFDs further limited peak demand on the motors, potentially increasing motor life and reducing maintenance costs. Second, the project team found that boiler draft control was more sluggish with VFD control than with inlet damper control. Finally, when boiler load conditions were low and the fan speed required to meet these conditions was less than the minimum speed set point of the controller, the VFDs were bypassed and the damper controls reinstated.

Other Applications

VFDs are extremely versatile and can be applied to any ventilation or fan system requiring variable output to meet changing demands. Fan applications with changing demands include: climate control systems, laboratory ventilation systems, and draft fans used for boilers and furnaces. VFDs can also be used to optimize the performance of other systems, such as blowers, pumps, compressors, grinders, mills, and conveyors.

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