Petroleum BestPractices Plant-Wide Assessment Case Study

Industrial Technologies Program—Boosting the productivity and competitiveness of U.S. industry through improvements in energy and environmental performance

Paramount Petroleum: Plant-Wide Energy-Efficiency Assessment Identifies Three Projects

Benefits

- Implemented a project that would provide independence from a local electric utility with much improved reliability
- Found annual savings of an estimated 1.2 million kWh in electricity and 99,200 MMBtu in fuel
- Identified annual savings of an estimated $4.1 million by reducing energy consumption and by implementing other productivity improvements

Application

The Paramount Petroleum plant-wide energy assessment focused on technical, economic, and reliability issues of energy-intensive applications and alternative energy sources. The assessment team evaluated 1) building and operating an electrical power and heat energy production facility and 2) improving existing systems with either fuel-burn adjustments or new drive and control systems. These cost-effective projects could be replicated in other refineries, and generally in other industries as well.

Summary

Paramount Petroleum Corporation (PPC) undertook a plant-wide energy efficiency assessment of its oil refinery in Paramount, California, during the summer and fall of 2001. One objective was to identify energy saving projects relating to electric motor applications and various direct-fired process heaters. Another objective was to explore ways of increasing the reliability and availability of the plant's electrical power supply, because California was experiencing an electrical power production and supply crisis. Based on the assessment results, the company found strong economic justification for three projects that would increase the reliability of the plant's electrical power supply and also reduce the use of electrical energy and fossil fuels.

The combined heat and power (CHP) plant, the company's largest project, will provide 5 megawatts (MW) of load relief to California's electrical power grid, provide a critically needed improvement in reliability, and save $3.8 million annually. New motor drives in the cooling towers will save 1.2 million kilowatt-hours per year (kWh/yr) or $46,000 in electricity annually. Improvements to furnace heaters will save 99,200 million British Thermal Units (MMBtu) and $291,000 in energy annually. All of the projects could be applied to other refineries and at least two of them could be applied in other industries.

DOE-Industry Partnership

The U.S. Department of Energy's (DOE) Industrial Technologies Program (ITP) cosponsored the assessment through a competitive process. DOE promotes plant-wide energy-efficiency assessments that will lead to improvements in industrial energy efficiency, productivity, and global competitiveness, while reducing waste and environmental emissions. In this case, DOE contributed $85,000 of the total $185,000.

Company Background

PPC owns and operates an oil refinery in the City of Paramount within Los Angeles County, California. The refinery produces several different grades of asphalt for paving and roofing. Other products include military diesel fuel, off-road diesel, jet fuel, and intermediate feedstock, such as untreated vacuum gas oil, naphtha, and untreated distillate. The plant operates a pair of crude oil atmospheric distillation units and a pair of vacuum distillation units. The plant employs about 200 workers. In addition to the refinery plant, PPC owns distribution companies at strategic locations.

At the start of the assessment, plant management believed that there would be significant energy-efficiency investment opportunities. A primary consideration was the unpredictable and sporadic availability and reliability of electric power from the California grid. This was unacceptable because of the very high cost associated with electrical outages at the plant.

U.S. Department of Energy
Energy Efficiency and Renewable Energy

Bringing you a prosperous future where energy is clean, abundant, reliable, and affordable

Assessment Approach

From the beginning of the assessment process, PPC planned to explore 1) the construction of a CHP facility to supply electrical power to the plant with improved reliability, as well as heat energy; 2) means of reducing the high electrical energy use in various electric motors; and 3) ways of reducing the use of natural gas and refinery gas in process burners. The assessment team, consisting of senior engineers and members from operations, considered these areas to be key in terms of cost and energy efficiency. The assessment was a closely coordinated effort between the plant's team and two industrial partners, Dana Technologies, Inc. and the Energy Nexus Group. The PPC team prepared necessary work orders, and obtained flow sheets and piping and instrumentation diagrams to support the two consultant teams.

PPC placed a strong emphasis on the CHP assessment. Because the electric utility supplies power to the company under an interruptible I-6 electric tariff, the refinery must shut down when requested by the utility during peak usage periods or pay a severe penalty. The refinery operations are extremely sensitive to power outages, so the company declined requests to curtail power during 2000 and 2001, at a cost of millions of dollars. PPC also rented diesel standby units during 2001 at a cost of $750,000 per year.

PPC directed Dana Technologies to conduct a Phase 1 feasibility and economic study of the potential for using a CHP plant to generate energy. PPC directed the Energy Nexus Group to conduct an overall review of plant energy usage with emphasis on energy consumption in electric motors and fuel-fired burners. The Energy Nexus Group also performed the Phase II study of the CHP plant. Both firms collected data at the plant, with support from the PPC team, and prepared in-depth analyses. The analysis models encompassed several different project scenarios that included selection of specific component upgrades and variable system sizing, plus alternative financial assumptions based on estimates of future energy costs. The subsequent implementation of the project necessarily included many efforts to satisfy numerous environmental requirements. This effort was complicated by the need to correctly interpret state environmental law, anticipate potential state actions, and predict the direction that existing statutes might take in the future.

Results

The PPC plant consumes 5 MW of electricity and spends approximately $2 million annually on electricity and $4 million on natural gas. The combined cost for these utilities represents approximately 40% of total production costs, making utilities a major component in determining the company's competitiveness.

The plant-wide energy-efficiency assessment identified three projects that show considerable promise based on potential savings and improved reliability. Table 1 provides a list of the two projects that PPC has begun to implement and a third project, involving variable speed drives (VSD), which may or may not be implemented. For each project, the table indicates expected project costs, estimated annual savings, and expected payback periods. The greatest annual energy savings will come from the CHP generation facility and this is reflected in the annual savings estimate of $3.8 million.

The VSD project's economic feasibility depends on the CHP plant. The electrical energy saved by VSDs could be relatively expensive if supplied by a California utility or could cost much less if supplied by the CHP plant. However, there are also other important considerations. For example, the Standard Performance Contracting Program is an energy-efficiency program sponsored by the California Public Utilities Commission (CPUC) and implemented by the utilities. This program provides incentives that, for this project, would reduce the payback from 2.6 years to 1.6 years (assuming that the project used utility-supplied power). PPC, however, decided to build the CHP plant and it will soon be producing electrical energy.

Table 1. Estimated Project Cost, Savings, and Payback for Projects at PPC

Project	Budget Year	Project Cost ($)	Annual Savings ($)	Payback (years)
Combined heat and power (CHP)–new generation facility	2002	9,480,000	3,790,000	2.5[1]
Gas-fired process heaters–draft/excess air improvements	2002–2004 (estimated)	48,000	291,000	0.2 (2 months)
Variable speed drives for cooling tower fan motors	To be determined	266,000	46,000[2]	5.8[2]
	Total	**9,794,000**	**4,127,000**	

[1]Assumes that full annual savings is directed toward payback (not the actual case).

[2]Varies based on cost of natural gas. Payback could vary from 4.2 to 7.7 years (5.8 years deemed most likely).

Projects Identified

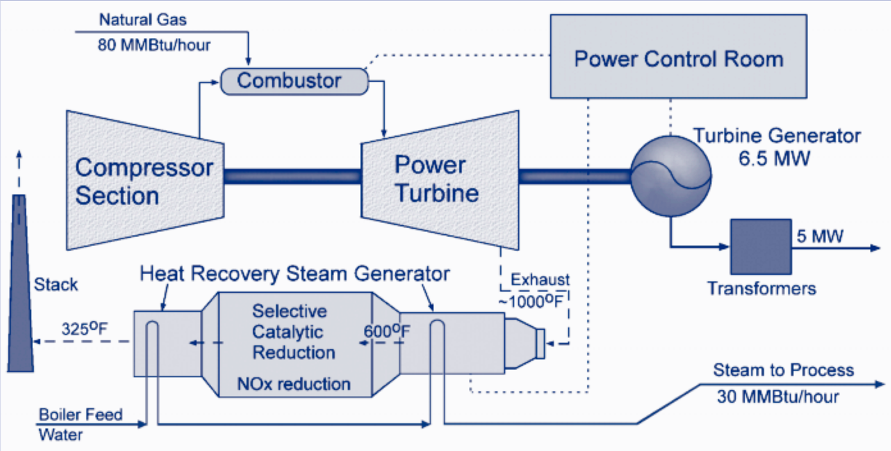
The following discussion details the selected energy-efficiency projects developed during the plant-wide assessment. Because of the similar basic processes used in oil refineries, all of the projects are highly applicable to other refineries. The projects may also be highly replicable in other industrial plants that have electric motors with variable load profiles and/or need improved reliability for electrical power.

Project 1—Combined heat and power (CHP)

Dana Technologies prepared a preliminary feasibility study in Phase I for three different-sized CHP generation plants. PPC's management selected the smallest size, which produced up to 6.5 MW of electricity and 30 MMBtu per hour (MMBtu/hr) of steam, because it was the lowest-risk choice after CPUC ended open access for private power generators desiring to export power. In Phase II, the Energy Nexus Group performed a cost study that compared the cost of an operational CHP plant under three different tariff scenarios. The turbine will consume 80 MMBtu/hr of natural gas but will allow the company to avoid purchasing 37.5 MMBtu/hr of boiler fuel. Although there were several other complex considerations, such as gas prices, bond servicing surcharges, and long-term electric rates, the base case for all three comparisons produced attractive internal rates of return of 32%, 26%, and 27%. Furthermore, after-tax net annual

Project 1 - Newly Completed Combined Heating and Power Plant

savings would be roughly $1.9 million based on 764,000 MMBtu average annual energy savings. The company has aggressively pursued project implementation undaunted by California's stringent environmental regulations. The company has sought the best-available control technologies that include selective catalytic reduction for nitrogen oxides, an ammonia degradation catalyst, and a carbon monoxide oxidation catalyst.



Project 1 - Combined Heating and Power Plant Flow Diagram

Project 2—Gas-fired process heaters

This assessment evaluated six direct-fired process furnace heaters that burn a mixture of natural gas and refinery gas. The assessment team's analysis provided justification for improving draft control and excess air combustion. The draft control is important because it regulates the exact amount of air allowed into the bottom of the burner to ensure complete combustion. Two technicians working about 3 days per heater (twice per year) can adequately maintain the desired draft control. The adjustments to the process heaters will produce an annual energy savings of about 99,200 MMBtu.

Project 3—Variable speed drives for cooling tower fan motors

PPC operates six evaporative cooling towers that supply cooling water to process equipment. The fixed-speed fan motors range in size from 40 horsepower (hp) to 125 hp, and operators control them manually. Surveys by the Energy Nexus Group found that the cooling tower fan motors were properly sized for summer conditions but oversized for cooler months. Nexus performed computer simulations that reduced the fan speed as a function of ambient wet bulb temperature, while still maintaining the cold-water outlet temperature at 85°F. A follow-on economic analysis verified that VSDs would reduce energy costs significantly if the drives were set to maintain the cold-water temperature design set point. By using VSDs on all six motors, the company could save 1.2 million kWh each year.

BestPractices is part of the Industrial Technologies Program, and it supports the Industries of the Future strategy. This strategy helps the country's most energy-intensive industries improve their competitiveness. BestPractices brings together emerging technologies and energy-management best practices to help companies begin improving energy efficiency, environmental performance, and productivity right now.

BestPractices emphasizes plant systems, where significant efficiency improvements and savings can be achieved. Industry gains easy access to near-term and long-term solutions for improving the performance of motor, steam, compressed air, and process heating systems. In addition, the Industrial Assessment Centers provide comprehensive industrial energy evaluations to small- and medium-size manufacturers.

Project Partners

Paramount Petroleum Corporation
Paramount, CA

Dana Technologies Corporation
San Juan Capistrano, CA

Energy Nexus Group
Carlsbad, CA

For Additional Information, Please Contact:

Industrial Technologies Clearinghouse
Phone: 800-862-2086
Fax: 360-586-8303
clearinghouse@ee.doe.gov

Visit our home page at
www.oit.doe.gov

Industrial Technologies Program
Energy Efficiency
and Renewable Energy
U.S. Department of Energy
Washington, DC 20585-0121

A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy technologies.

DOE/GO-102003-1681
July 2003