Energy Efficiency Upgrades for Fermilab Infrastructure

Utility energy service contracting provides needed plant improvements.

Utility Services Case Study

Overview

The U.S. Department of Energy's (DOE's) Fermi National Accelerator Laboratory (Fermilab) has replaced old equipment and reduced energy consumption through a partnership with its electric utility, Commonwealth Edison. Fermilab upgraded the centralized cooling system and separated the system into two segments—a "comfort system" to cool the employee office space and a "process system" for the equipment and accelerators. Backup cooling capacity is provided and cooling can be shifted between the process and comfort systems when necessary. The new 4500-ton cooling system is expected to use 40% less energy and is free of ozone-depleting chlorofluorocarbons (CFCs).

The $3.5 million project ($2.8 million before financing costs) has total projected energy savings of 20 million kilowatt-hours (kWh), which will result in cost savings of $900,000/year and a payback of less than five years. Installation was completed in April 1999. Actual savings have been higher than projected, in part because variable-speed drives are running at lower speeds than anticipated. Throughout the project, the DOE Federal Energy Management Program (FEMP) provided support through training, advice and consultation, and proposal/contract review.

Background

The Fermi National Accelerator Laboratory was originally built in the 1960s. Most of the equipment had not been replaced or upgraded since construction and was sorely in need of enhancements to meet increasing loads. In the early 1990s, Fermilab completed about $8 million in energy efficiency work through DOE's In-House Energy Management program (IHEM).

In 1996 Fermilab developed a plan to upgrade its centralized cooling system. By then the IHEM funding had been eliminated and there were no appropriations available to implement the Lab's plan; therefore, Fermi had to search for other funding sources. One of the sources proved to be Utility Financing.

DOE competed the work for Fermilab between its electric and gas utilities. The electric utility, Commonwealth Edison, won the competition. Commonwealth Edison completed the work under its existing areawide contract.

Project summary

The project involved the replacement and separation of process and comfort chillers, pumps, and other related central-cooling-system equipment, as well as pumping configuration changes to accelerator heat rejection systems. The five-year contract was financed at a 7% interest rate, bringing the total cost with financing to $3.5 million. Fermilab's only out-of-pocket costs were for the preliminary design and project oversight.

Energy savings of 20 million kWh and a demand reduction of about 2.5 megawatts are expected, which will result in estimated cost savings of $900,000/year. Approximately $150,000 of these savings result from the demand reductions. Additional savings anticipated, but not included in the contract economic analysis, include $7,000/year from avoided operations and maintenance costs, $245,000 from repairs that would have been necessary had this equipment not been replaced, and avoided programmatic costs that would have resulted from shutdowns due to cooling system failures.

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Project Coordinator Steve Krstulovich with Fermilab's new 1400-ton, high-efficiency chiller.

The chillers serving the entire facility were originally interconnected into a single system in the Central Utility Building. The result of this centralization was that on occasion the accelerator would be shut down due to problems with the "comfort system." The chillers had become increasingly less reliable because they were past their nominal rated useful life of 25 years. The bearings were worn and many condenser tubes were plugged, resulting in reduced chiller efficiency. The chiller capacity control systems were failing as well. The degraded condition of the chillers became apparent when one of them failed during project installation. The failed

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chiller was fixed using parts from one of the chillers that had just been replaced. This kept it running for another two months until its replacement was brought on-line.

Before the energy efficiency upgrades, the cooling pumps always ran at full flow. Installation of variable-speed drives allowed Fermilab to eliminate ten pumping stations. Actual savings to date have met or exceeded design parameters. The comfort cooling and accelerator heat rejection systems are performing as designed; the process system is doing slightly better, and the system has been running 15% to 25% more efficiently than anticipated.

Not only are the new chillers approximately 40% more energy efficient, they are also more environmentally friendly because they do not use CFCs. Fermilab was one of the first DOE sites to comply with the DOE directive from Energy Secretary Richardson to replace all pre-1984 chillers using Class I CFCs such as R-11.

Commonwealth Edison's affiliate, Unicom, served as the project manager. Subcontractor work was competed among at least three bidders.

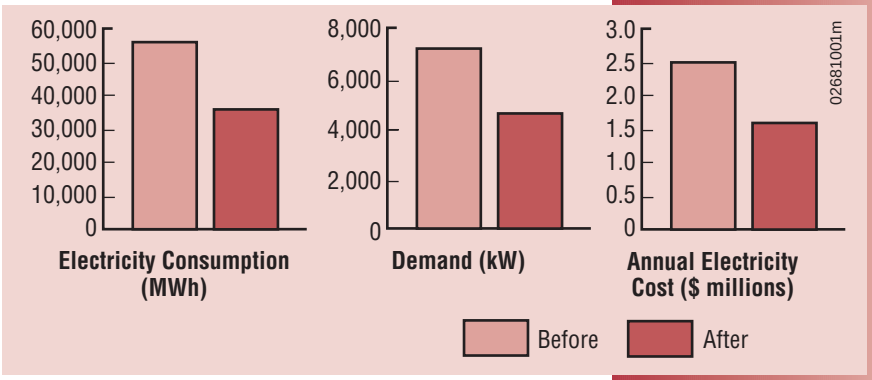
Benefits of utility contracting

Commonwealth Edison's energy-related expertise, extensive project experience, and industry contacts and influence, allowed them to efficiently and effectively complete the necessary work at an even lower price than anticipated. The utility was extraordinarily responsive to facility requests and Fermi staff feels comfortable that the utility will continue to be responsive because of its long-term and continuing relationship with the site. The utility brought the additional benefit of established relationships with subcontractors.

Equipment dependability was increased significantly due to the retrofits. The Fermilab personnel felt that the utility contracting vehicle was a very flexible method for completing their energy efficiency project. For example, the ability to take title of the equipment immediately after the work was complete simplified post-construction contract administration.

Lessons learned

Coordination and planning partnership—Coordination and planning were necessary in order to minimize shutdown of the chilled-water, high-voltage distribution, and other systems. The facility and utility learned to work together to find common, win-win solutions to problems as they arose.



Competition benefits—It was helpful to take advantage of the opportunity to compete between the serving gas and electric utilities. This provided an added incentive to the utilities to look for ways to keep prices down.

Change Order mechanism—Because Change Orders can be costly and time consuming, it would have been beneficial to set up a streamlined mechanism to deal with contract changes. It would also be helpful to have funds equivalent to approximately 5% of the construction cost included in the initial project financing, against which Change Orders could be written if necessary. At the conclusion of the construction phase a single contract modification could be written to reduce the contract price by the amount of funds left unused.

Looking ahead

Both the gas and electric utilities have offered to complete free comprehensive audits for the entire Fermilab site. Based on the audit results, they will have feasibility studies conducted for the most cost-effective energy conservation measures (ECMs). The utilities will integrate the Lab's list of identified ECMs (and related upgrades) from former IHEM studies into future projects. Proposals will be evaluated based on prices, technical capabilities, and the utility's approach to work. It is expected that the energy upgrades will be an ongoing, 10-year process.

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