Genentech: New Energy Efficient Pharmaceutical Manufacturing Cleanroom Facility[1]

Project Benefits Summary

Estimated Annual Energy Cost Savings	$552,800/y
Actual Incremental Project Cost	$1,783,360
Utility Incentive	$842,400
Project Payback (after incentive)	1.7 years

Facility Description

The Genentech Vacaville facility is made up of six buildings in Vacaville California. This is the second site for Genentech, the first site is located in South San Francisco, CA. Genentech is a leading biotechnology company that discovers, develops, manufactures and markets human pharmaceuticals for significant unmet medical needs.

The site's six buildings include:

1. 180,000-ft^2 Bulk Manufacturing Building with class 10K and 100K cleanroom areas and 10 air handling units (approx. 400,000 cfm)
2. 18,000-ft^2 Central Utility Plant with 3,400 tons of chilled water, 3,000 scfm of compressed air, 14,000 gpm of tower water (process and HVAC), and 70,000 lb/hr of high pressure steam
3. 40,000-ft^2 Lab/Administration Building
4. 30,000-ft^2 Warehouse
5. 20,000-ft^2 Facilities Service Building
6. A "spine" connecting all of the buildings together

Figure 1 – Bulk Manufacturing Building

The energy saving measures for the site were aimed at the entire facility. However, this study focuses only on measures that affect the cleanroom areas. In addition to internal production requirements, these areas are required to comply with Food and Drug Administration (FDA) regulations for cleanliness because the facility is intended for the production of pharmaceuticals.

Project Description

A total of twenty-two separate energy efficiency measures were performed at the Vacaville site. These measures are summarized below with a mention of estimated energy savings. The estimated savings were calculated by Genentech's energy consultant, Southern Exposure Engineering based upon baseline and enhanced energy consumption models. No measured data is currently available for these measures.

Key aspects of the energy efficiency project

DISCHARGE AIR TEMPERATURE RESET (MAKEUP AIR HANDLERS)
Control logic was implemented to reset the discharge air temperature up from 55°F to 60°F when the demand for cooling decreases. This leads to a reduction in energy use because the makeup air is not cooled all the way down to 55°F. All of the cleanrooms are regulated by the FDA, which requires that they be

[1] Based on "Recommendations Report, Volume 1 of 2, Genentech, Inc., New Facility, Vacaville, CA." Prepared by Southern Exposure Engineering and Pacific Gas and Electric Company; November 21, 1997.

supplied with a constant volume of makeup air. This temperature reduction prevents overcooling and subsequent unnecessary reheating of the supply air to the space, thereby saving chilled water and steam plant energy. This measure is expected to have annual energy cost savings of about $155,000/y and a reduction in peak electrical load of about 19 kW.

VARIABLE SPEED DRIVES FOR THE VARIABLE VOLUME AIR HANDLERS

Instead of inlet vanes for the supply and return fans, variable speed drives (VSDs) were installed on the six variable volume air handlers throughout the building including one serving the cleanroom. The VSDs reduce the horsepower of the fans to reduce flow, whereas inlet vanes reduce the flow by increasing pressure drop while the fans are still running full speed. VSD operation reduces fan motor energy use more than vanes do at low flow conditions. The annual energy cost savings are expected to be about $23,000/y with a reduction in peak load of about 40 kW.

HIGH EFFICIENCY BOILERS AND BOILER ECONOMIZERS

High efficiency boilers were installed as well as boiler economizers. The boiler stack economizers recover waste heat out of the flue gas, allowing more steam generation using the same amount of fuel. Together these measures are expected to have annual energy cost savings of about $48,700/y.

TOWER WATER FOR PROCESS COOLING

Water from the cooling towers is being used for high temperature processes that do not need the low temperatures provided by the comparatively less efficient chillers, which operate at 0.5 kW/ton efficiency, at best. The cooling towers are able to provide cooling at about 0.04 kW/ton (an order of magnitude improvement in efficiency). The cooling towers provide 75°F water for processes that do not require 40°F chilled water such as pasteurizing and cooling for the water for injection (WFI). This measure is expected to save about $62,700 annually and reduce peak load by about 455 kW.

PROCESS CHILLER WITH A SURGE TANK

A dedicated process chiller was installed in manufacturing building to provide the low temperature processes with 40°F water instead of using the chilled water from the central utility plant. A surge tank was also installed for chilled water storage to reduce the peak electric demand. The surge tank holds 15,000 gallons and provides approximately 600 ton-hours of thermal storage. Large energy savings also come from this separation of low temperature loads from the higher temperature loads. This allows the central plant to operate at 44°F, instead of 40°F, resulting in a significant improvement in its efficiency. The low temperature chiller and surge tank are expected to save about 152,000 kWh annually and reduce peak loads by about 560 kW, results in cost savings of about $36,000/y.

Figure 2 – Surge Tank

HIGH EFFICIENCY EQUIPMENT AND UNEQUAL CHILLER SIZING

A high efficiency process chiller and high efficiency central plant chillers, vacuum pumps, and motors were installed. In an effort to operate the chillers as close to full load as possible, where they are most efficient, a 600 ton chiller and two 1,400 ton chillers were selected instead of three 1,134 ton chillers. This unequal sizing method saves energy by allowing the chillers to stage up in smaller steps and operate much closer to full load. The two large chillers are run at full load while the smaller one can be run to supply any additional cooling that is needed. By selecting high efficiency equipment and unequal sized chillers, about $113,250 will be saved annually with a reduction in peak load of 296 kW.

LOW APPROACH COOLING TOWERS

Large cooling towers were installed to reduce the approach from 14°F to 8°F above the design wet bulb temperature of 71°F. In addition, the spray nozzles were reconfigured to spread the condenser water more evenly over the fill while allowing the flow to better match the required flow for the chillers. This modification of the nozzles allowed the approach to drop even further down to 4°F. There was an increase in cooling tower fan power from 102 kW to 167 kW, however, much more energy was saved by providing the chillers with cooler condenser water, which improves the ability of the chiller to reject heat. This reduction in condenser water temperature in expected to improved the efficiency of the large chillers from 0.62 kW/ton to 0.49 kW/ton (0.013 kW/ton per °F decrease in condenser water supply temperature). This measure is expected to save about $24,000 annually with a decrease in peak load of 70 kW.

Figure 3 - Cooling Towers

PUMP VARIABLE SPEED DRIVES

VSDs were installed on the condenser water pumps, primary chilled water pumps, secondary chilled water pumps, tertiary chilled water pumps, and heating water pumps. The VSDs save energy by precisely matching the flow and the pressure requirements of the system to minimize pump energy. These drives will save approximately $36,900 annually and will reduce the peak demand by 140 kW.

Applicability to the Cleanroom Industry

These efficiency measures have not inhibited Genentech from complying with strict FDA regulations for pharmaceutical plants. The plant it is expected to operate and more reliably with these modifications and, because the project had an excellent payback of 1.7 years, after the utility incentive, it will be more profitable to operate in the long run. One example of improved reliability is the surge tanks, which guarantee that process chilled water will be available when needed in case of a shutdown.

Part of the reason that this project was so successful was that the measures could be implemented in the development phases of the plant before any equipment was purchased or installed. Energy efficiency measures implemented in a new building can achieve greater and more cost-effective savings than retrofit measures implemented in existing buildings.

Project Challenges

Genentech encountered a number of challenges while trying to implement energy saving measures for this project. In a concerted effort to maintain the goal of efficient operation, Genentech worked through solutions to most problems they encountered. Some of these problems are common in the cleanroom industry and their solutions should be instructive for other facility operators and planners. The first problem was that no review period was scheduled for analysis of the energy saving alternatives. These reviews were to be included in the overall design review period, where they would probably fall through the cracks. To solve this problem, the energy consultant was integrated with the design team to provide quick feedback on ideas and recommendations to improve energy use during the design process. Secondly, no defined budget was allocated for development of energy saving ideas at the beginning of the project. However, money for actual projects was included in the overall project budget. The solution was to obtain utility funding for idea development and analysis and with utility incentives for ideas that resulted in a payback of greater than two years. A third challenge to successfully capturing the savings from energy efficiency measures lies with the building operations staff. This is being addressed through education, training and awareness of the original design intent.