

Cut Energy Use Through HVAC Improvements

Many plants routinely consider energy requirements when selecting and operating motors, pumps, compressors, heaters, coolers, and the like. Where else should engineers look for opportunities to improve a facility's energy efficiency?

Everywhere! Improving energy efficiency should be approached from many different directions. A strong, corporate-wide energy-management program, involving facility, operations, environmental, health and safety, and especially management personnel, is essential. Improvements to cross-cutting technologies, such as the use of energy-efficient motors and the optimization of compressed air systems, as well as fine-tuning production processes, such as clinker-making cement kilns, can lead to significant reductions in energy use. Process measures are often overlooked in many energy-efficiency programs but can lead to significant savings.

ENERGY STAR (www.energystar.gov) is a joint program of the U.S. Environmental Protection Agency and the U.S. Dept. of Energy that (among other things) helps businesses improve their energy management practices. It has produced several guides for improving energy efficiency in specific industry sectors, such as cement manufacturing, petroleum refining, and pharmaceutical manufacturing. This article is excerpted from "Energy Efficiency Improvement and Cost Saving Opportunities for the Pharmaceutical Industry: An ENERGY STAR Guide for Energy and Plant Managers," which is available for download at <http://industrial-energy.lbl.gov/node/63>. The entire document covers a variety of topics in detail and includes numerous case studies as well as references for additional information and for the data in this article. Much of the information provided is relevant to non-pharmaceutical facilities as well. Due to space limitations, this article focuses on heating, ventilation and air conditioning (HVAC) systems.

The components of HVAC systems include dampers, supply and exhaust fans, filters, humidifiers, dehumidifiers, heating and cooling coils, ducts and various sensors. The greatest opportunities for energy efficiency exist at the design stage for HVAC systems in new industrial facilities. It is generally cheaper to install energy-efficient HVAC equipment during building construction than it is to upgrade an existing building with an energy-efficient HVAC system later, especially if those upgrades lead to production downtime.

Recommissioning. Before replacing HVAC system components to improve energy efficiency, the possibility of recommissioning should be explored. Recommissioning is



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essentially the same as commissioning, but applied to a building's existing HVAC, controls and electrical systems. It involves a detailed assessment of existing equipment performance and maintenance procedures compared to intended or design performance and procedures, in order to identify and fix problem areas that might be hampering building energy efficiency. Recommissioning can be a cost-effective retrofit in itself, sometimes generating more savings than the cost of the retrofit measure. For example, recommissioning may avoid the need to install new or additional equipment, leading to savings in capital investments.

The ENERGY STAR Building Upgrade Manual (www.energystar.gov/ia/business/BUM.pdf) recommends a step-wise approach to recommissioning, in which a series of building "tune-up" strategies are pursued. First, lighting and supplemental loads should be assessed, then the building envelope, then controls, then testing, adjusting and balancing, then heat exchange equipment, and finally heating and cooling systems. Most of these steps relate to HVAC system components or factors that will directly affect HVAC system energy consumption (such as building envelope and lighting).

Energy monitoring and control systems. An energy monitoring and control system supports the efficient operation of HVAC equipment by continuously managing and optimizing HVAC system energy consumption while also providing valuable diagnostic data for tracking energy consumption and identifying potential HVAC system problems. The average payback period for HVAC control systems is a little over a year.

Non-production temperature set-back. Turning building temperatures down in winter or up in summer and reducing ventilation in certain areas during periods of non-use, such as weekends or non-production times, can lead to significant savings in HVAC energy consumption.

Duct leakage repair. Duct leakage can waste significant amounts of energy in HVAC systems. Measures for reducing duct leakage include installing duct insulation and performing regular duct inspection and maintenance, including routine leak detection and repair. Repairing duct leaks in industrial and commercial spaces can reduce HVAC energy consumption by up to 30% or more.

Discharge-air temperature management. In facilities with make-up air handling systems, energy can be wasted when cooled make-up air must be reheated. By setting higher discharge air temperatures when demand for cooling decreases, unnecessary reheating of the make-up air supply can be reduced.

Variable-air-volume (VAV) systems. VAV systems adjust the rate of air flow into a room or space based on the area's current requirements, and therefore work to optimize the air flow within the HVAC ductwork. By optimizing air flow, the loads on building air handling units can be reduced, leading to reduced electricity consumption.

Adjustable-speed drives (ASDs). ASDs can be installed on VAV air handlers and recirculation fans to precisely match the flow and pressure requirements of air handling systems. Energy consumption can be lowered considerably, since the fans are not constantly running at full speed. ASDs can also be used on chiller pumps and water system pumps to minimize power consumption based on system demand.

Heat recovery. Heat recovery systems reduce the energy required to heat or cool facility intake air by harnessing the thermal energy of the facility's exhaust air. Common heat recovery systems include heat recovery wheels, heat pipes, and run-around loops. For areas requiring 100% make-up air, heat recovery systems can reduce a facility's heating or cooling costs by about 3% for each degree (Fahrenheit) that the intake air is raised or lowered, with a typical payback period of three years or less.

Efficient fans. Exhaust fans are standard in any HVAC system. Mixed-flow impeller exhaust fans are an efficient alternative to traditional centrifugal exhaust fans. Mixed-flow impeller fans are typically 25% more efficient than centrifugal fans, and can be cheaper to install and maintain. The expected payback period for this measure is about two years.

Changing the size or shape of the sheaves of a centrifugal fan can help to optimize fan efficiency and airflow, thereby reducing energy consumption.

Chiller efficiency improvement. The efficiency of chillers can be improved by lowering the temperature of the condenser water, thereby increasing the chilled water temperature differential. This can reduce pumping energy requirements. Another possible efficiency measure is the installation of separate high-temperature chillers for process cooling. Sizing chillers to better balance chiller load with demand is also an important energy efficiency strategy. If available, secondary cooling water from municipal sources can be leveraged to reduce chiller energy consumption.

Solar air heating. Solar air heating systems use conventional steel siding painted black to absorb solar radiation for insulation. Fresh air enters the bottom of the panels, where it is heated as it passes over the warm absorber. Fans distribute the air. In addition to energy savings, such a system can provide clean, fresh air for employees, even out hot and cold spots in the plant, and reduce emissions. However, this measure is only relevant for buildings in cold climates, and the potential benefits should be analyzed based on the local conditions of each site.

Building reflection. A reflective coating, available in different forms and colors, on the roof of buildings in sunny, hot climates can reduce air conditioning requirements. In colder climates, heat lost due to cool roofs (*e.g.*, in winter) also needs to be taken into account, and often negates savings. In addition to location and weather, factors such as roof insulation, air conditioning efficiency, and building age influence energy savings.

Roof gardens. Roof gardens on a flat roof improve the insulation of a building by providing both heat (in the winter) and air conditioning (in the summer). In the winter, green roofs can freeze, so they carry a slight heating penalty, but they still yield net energy savings. In addition, a roof garden can increase the lifetime of the roof, provide and reduce runoff, and reduce air pollution and dust. In addition to saving energy and lasting longer than traditional roofs, a roof garden absorbs rain, slowing run-off to local storm drains.

Trees can also help reduce HVAC energy use under certain conditions. In hot climates, deciduous trees, which provide shade in the summer and none in the winter, should be planted on the west and southwest sides of the building (based on the path of the summer sun). Trees planted on the north side of the building in cold climates can reduce heating in winter by shielding the building from the wind. Vines can provide both shade and wind shielding.

Building insulation. Adding insulation to a facility will nearly always result in the reduction of utility bills. Much of the existing building stock in the U.S. is not adequately insulated. Older buildings are likely to use more energy than newer ones, leading to very high heating and air conditioning bills. Even for a new building, adding insulation may save enough through reduced utility bills to pay for itself within a few years.

Low-emittance (Low-E) windows. Low-E windows improve building insulation by lowering the amount of heat transmitted into the building. There are two types of Low-E glass — high solar transmitting (for regions with higher winter utility bills) and low solar transmitting (for regions with higher summer utility bills).

Fume hoods. The energy required to heat and cool make-up air for laboratory fume hoods can account for a significant fraction of laboratory HVAC energy consumption. Fume hoods are often operated at high air-exchange rates in an effort to guarantee the safety of employees. Significant energy savings can often be realized by using low-flow fume hoods, variable-flow exhaust systems, and/or bi-stable vortex hoods.

To assess the feasibility of the energy efficiency measures presented here and in the ENERGY STAR guide, each plant should investigate the applicability and economics of the suggestions to its own unique production practices. 