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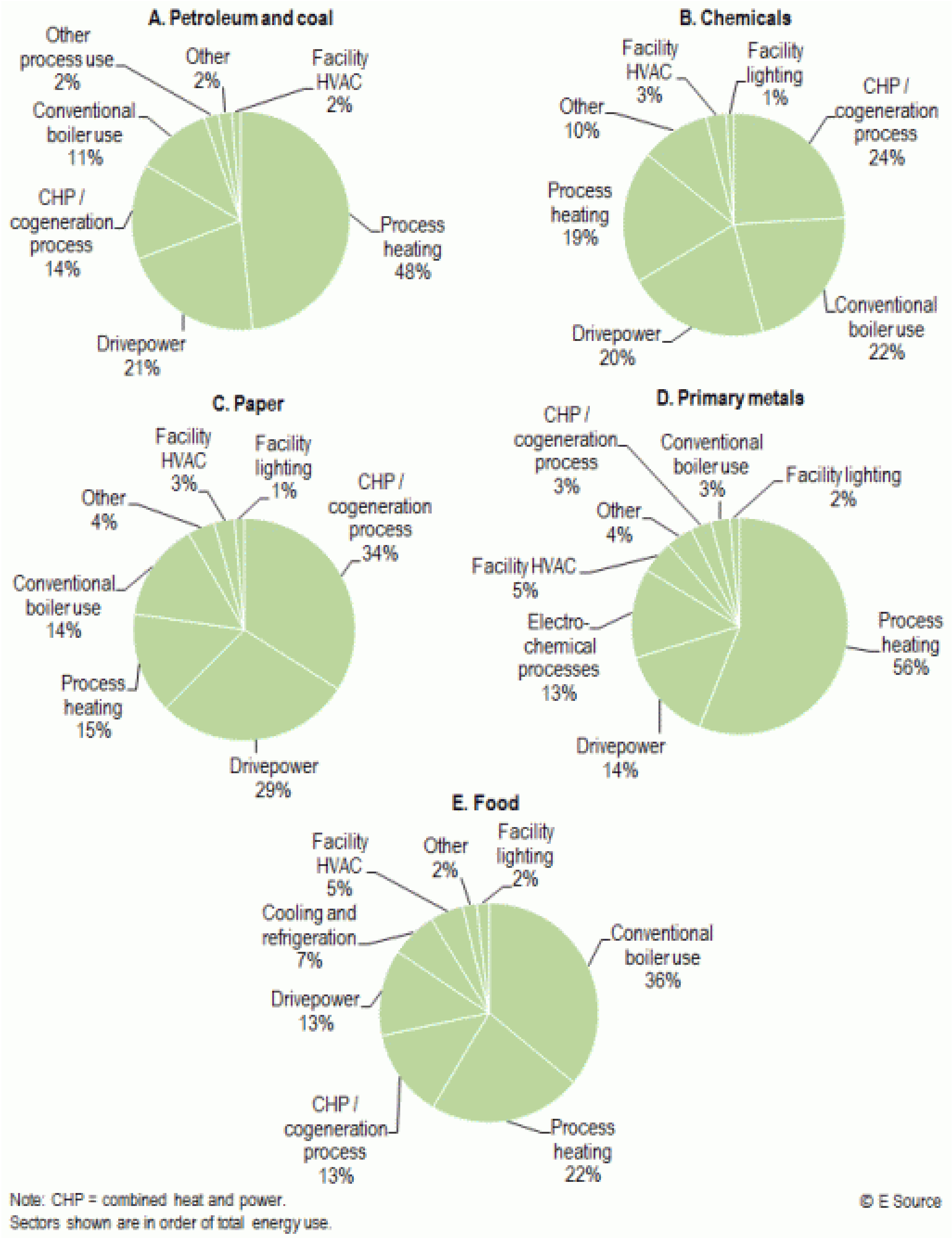
Managing Energy Costs in Manufacturing Facilities

The industrial sector accounts for approximately 31 percent of all energy consumption in the United States—consuming just over 21,000 trillion Btu annually—and much of this energy is used for manufacturing processes. On average, manufacturing facilities use 95.1 kilowatt-hours (kWh) of electricity and 536,500 Btu of natural gas per square foot annually, though actual consumption varies widely depending on the subsector. **Figure 1** shows a breakdown of energy use for the five manufacturing subsectors that consume the most overall energy. The petroleum and coal subsector is the largest consumer of energy, accounting for 25 percent of the entire manufacturing sector's energy use. The chemicals subsector is second, consuming about 20 percent of the sector's energy. The paper subsector accounts for about 10 percent of sector energy use, followed by primary metals and food, each of which represent about 5 percent of consumption.

Average energy use data

Figure 1: Manufacturing end-use energy consumption by subsector

Process heating, drivepower, cogeneration, and conventional boiler use generally consume the most energy in manufacturing facilities, regardless of subsector.



Top technology uses

- Drivepower
- Refrigeration
- Heating

Although the energy consumption of these manufacturing subsectors varies, there are four common categories identifying the top energy users for the manufacturing sector as a whole. Process heating, drivepower, cogeneration, and conventional boiler use collectively account for over 85 percent of the energy used in the top five subsectors. Facility HVAC and lighting are the next-largest categories of energy consumers, and, though both account for less than 4 percent of total energy consumption, these categories offer proven improvement opportunities for energy efficiency that won't interrupt plant processes.

To better manage your facility's energy costs, it helps to understand how you are charged for energy. Most utilities charge manufacturing facilities for their natural gas based on the amount of energy delivered, in therms. Electricity, on the other hand, can be charged based on two measures: consumption and demand. The consumption component of the bill is based on the amount of electricity (in kWh) that the building uses during a month. The demand component is based on the highest (or peak) usage in kilowatts (kW) occurring within the month, or, for some utilities, during the previous 12 months. Demand charges can range from a few dollars to upwards of $20 per kilowatt-month. Because energy costs can be a considerable percentage of your bill, care should be taken to reduce peak demand whenever possible. As you read the following recommendations for energy cost management, keep in mind how each one will affect both your consumption and your demand.

QUICK FIXES

this section

Most manufacturing facilities can benefit from low- or no-cost energy-reducing actions.

Turn things off

Turning things off seems simple, but remember that for every 1,000 kWh that you save by turning things off, you save $100 on your utility bill (assuming an average electricity cost of 10 cents per kWh).

Walk-through audits. For facilities that don't operate constantly, one method to identify energy-efficiency opportunities is a walk through the facility after hours. Much of the equipment that is left on overnight or over the weekend in an empty building is a good candidate for saving energy by switching it off. Consider recruiting volunteers from each shift as monitors.

Motors. Identify motors that are operating unnecessarily and shut them down. This could be as simple as ceiling fans running in unoccupied spaces or as complicated as cooling tower fans still running after target temperatures have been met.

Computers and office equipment. Use of information technology in manufacturing facilities is increasing. The typical desktop computer and monitor together can draw as much as 270 watts, and a notebook computer can draw 50 watts; if left on overnight and on weekends, a single computer and monitor could add over $100 to the annual energy bill. Most of the equipment sold today can go into a low-power sleep mode after a period of inactivity. Unfortunately, most users don't take advantage of this feature, but desktop computers shipped since 2008 should have these options enabled by default. If a facility has networked computers, an administrator may be able to control power settings at the server level with group policy objects (GPOs). The U.S. Environmental Protection Agency has created a free tool, EZ GPO , to assist network administrators in creating GPOs. In addition, if your system has multiple types of hardware and operating systems on the same network, it may be worthwhile to purchase a computer power management software solution.

Other plug loads. Items such as computer speakers, radios, and coffee pots can burn a significant amount of energy. Like computers, other office equipment such as printers and faxes will also have energy-saving settings. Smart strips sense when devices are in "off" mode and will cut all power to the devices plugged into them, eliminating phantom loads. Smart strips that control loads based on occupancy are also available. Supplying power strips to employees also gives them an easy way to switch off all their often-forgotten energy users at the end of the day.

Space heaters. Space heaters are energy hogs, drawing 1 kilowatt or more of power. As a first step, plug heaters into power strips controlled by occupancy sensors (other loads, such as task lights and monitors, can also be plugged into the power strips). Beyond that, recognize that the perceived need for individual space heating usually signals poor HVAC system control.

Lights. Turn lights off when they are not in use. For larger facilities that have lights covering vast floor areas, only turning lights on when they are needed can have a substantial impact on consumption. Occupancy sensors and timers can capture these savings, but they need to be combined with lighting systems that can be effectively controlled. A no-cost option is to simply train staff to turn off lights as part of closing procedures (you can also help by identifying the location of light switches on a posted notice).

Outside-air intake controls. Many facilities have rooftop units for heating, ventilation, and sometimes cooling. Some are equipped with exhaust fans that bring in outside air for ventilation. Set these to run only when spaces are occupied.

Turning things down

Some equipment cannot be turned off entirely, but turning it down to minimum levels when possible can save energy.

HVAC temperature setbacks. If building temperatures are not controlled by an energy-management system, a programmable thermostat can increase energy savings and enhance comfort by automatically adjusting to preset levels. It can also lower temperatures on weekends and holidays.

Dimmable lighting controls. For larger facilities that might have lights on across the whole facility, lighting controls such as photosensors and dimmable ballasts can save energy by reducing lighting levels and helping to reduce maintenance costs. Photosensors adjust the light output based upon the amount of light they sense, and dimmable ballasts allow each fixture to adjust light levels as needed. It’s important, however, to combine these technologies with appropriate lamp types. For example, high-intensity discharge (HID) light sources have long start-up and restrike times and so can’t be shut off based on occupancy, but they can be dimmed to about 50 percent of initial power. Fluorescent lamps are a better choice for dimming due to their faster startup time, but frequent on-off switching can reduce their life span. Light-emitting diodes (LEDs) can be effectively controlled this way, but they come at a significant cost premium. For common areas, a recommended strategy is to use a combination of scheduled lighting and dimming, plus occupancy-sensor controls after hours.

Vending machine controls. Use occupancy sensors to power down vending machines when the area is unoccupied. Sensors can save nearly 50 percent of the $170 to $250 in annual electricity costs needed to operate a single vending machine.

Perform regular maintenance and cleaning

Keeping the facility and equipment in good working order is important, both to save energy and to protect equipment.

Process heating. There are a variety of ways to improve energy efficiency in process heating. Optimizing the ratio of air to fuel with flow metering or flue-gas analysis is one of the simplest ways to maximize burner efficiency. For indirect heating systems, inspect and clean heat-transfer surfaces regularly to avoid soot, scale, sludge, or slag buildup that can significantly reduce system efficiency. Reduce air infiltration into the heating process by repairing system leaks and keeping furnace doors closed whenever possible.

Motors. Mechanical problems are the main cause of premature failures of electric motors.

Routinely lubricating, checking for adequate and clean ventilation, and ensuring motors aren't suffering from a voltage imbalance will help them achieve their full-life potential while simultaneously minimizing their energy consumption.

Fans, bearings, and belts. Inspect fan blades, bearings, and belts at least once a year to prevent failure and maintain efficiency. During the inspection, fan blades should be cleaned, bearings should be checked for adequate lubrication, and belts should be adjusted and changed if needed.

Boilers. Develop a program for treating makeup water to prevent equipment damage and efficiency losses. Buildup inside the tank will decrease heat transfer to the water and necessitate more-frequent blowdown, which wastes both water and energy. In addition, the air-fuel ratio has the largest impact on combustion efficiency, so check it periodically to ensure that the combustion process is operating efficiently.

Air compressors. Check air compressor hoses and valves for leaks regularly, and make repairs if needed. A poorly maintained system can waste between 25 and 35 percent of its air due to leaks alone and can effectively double the cost of compressed air. Because leaks also result in lower pressure at the endpoint, operators can compensate by setting pressure levels higher than would otherwise be necessary, thereby increasing energy consumption. A leak detector can provide long-lasting benefits and can pay for itself in less than six months. Cleaning intake vents, air filters, and heat exchangers regularly will increase both equipment life and productivity. The Compressed Air Challenge, a collaboration of compressed-air users, offers a wealth of experience regarding compressed-air systems.

Building envelope and seals. One major source of energy loss is air leakage , such as through gaps around doors on the receiving and loading docks. Regularly check and repair gaps in door seals, and make sure employees keep the doors closed.

Lighting. Cleaning lightbulbs and fixtures can increase lighting output levels that have been reduced by dirt and dust. According to the U.S. Department of Energy (DOE), cleaning light fixtures can boost indoor light output by 10 percent. The plastic diffusers that cover most lamps need to be periodically replaced because, over time, they can turn yellow or brown, significantly reducing light output. Lenses can have the same problem. Replacing discolored diffusers or lenses will boost output by up to 20 percent. Calibrating occupancy sensors and photocells to restore correct operation can reduce energy use by up to 50 percent. For more information on lighting maintenance, see the Illuminating Engineering

Society's Recommended Practice for Planned Indoor Lighting Maintenance.

Economizers. Many air-conditioning systems use a dampered vent called an economizer to draw in cool outside air when it is available to reduce the need for mechanically cooled air. The linkage on the damper, if not regularly checked, can seize up or break. An economizer that's stuck in the fully open position can add as much as 50 percent to a building's annual energy bill by allowing hot air in during the air-conditioning season and cold air in during the heating season. Have a licensed technician calibrate the controls; check, clean, and lubricate your economizer's linkage at least once a year; and make repairs if necessary.

Air filters. Change air filters every one to three months. More-frequent filter changes may be required for filters handling a heavy particulate load or large size of particulate. Air conditioners that are located next to highways or construction sites or that are using an economizer will also need more-frequent filter changes.

Leaks. A leak in an HVAC rooftop unit can cost $100 per unit per year in wasted energy. On a quarterly basis, cabinet panels and ducts on rooftop HVAC equipment should be checked for leaks. A check should also be made to ensure that the units are secure, with all screws in place. On an annual basis, inspect all access panels and gaskets—particularly on the supply-air side, where pressure is higher.

Condenser coils. Cleaning the condenser coil is one of the most cost-effective maintenance steps that can be done on HVAC rooftop units . A dirty coil that raises condensing temperatures by as little as 10° Fahrenheit (F; 5° Celsius [C]) can increase power consumption by 10 percent—resulting in about $120 in electricity costs for a 10-ton unit operating 1,000 hours per year. Condenser coils should be checked for debris on a quarterly basis and cleaned at least once a year.

LONGER-TERM SOLUTIONS

this section

Although the actions described in this section require more implementation efforts and costs, they can dramatically increase the efficiency of your facility.

Process heating

Process heating is the largest energy consumer within the manufacturing sector, averaging almost one-third of facility energy consumption. Monitoring the heating process from start to finish and maintaining the equipment can have a large positive impact on facility energy costs.

Waste heat recovery. In most fuel-fired heating equipment, the largest heat loss occurs when spent combustion gases are exhausted, because these gases still contain a significant amount of thermal energy. This waste heat can be recovered and used in a variety of processes, including preheating combustion air before it enters the system, preheating load material before it enters the heating process, steam generation for secondary processes, and hot water or space heating.

Furnace pressure controllers. When hot combustion gases are exhausted into ambient air that is a significantly lower temperature, negative pressure builds within the furnace. This allows cooler ambient air to infiltrate the furnace through the flue or through other leaks and openings within the system. This additional air will then be heated and exhausted, wasting process heat energy and lowering system efficiency. Furnace pressure controllers adjust within the furnace to maintain a positive pressure, reducing cool-air infiltration into the heating system.

Lower flammable limit (LFL) monitoring equipment. Process heating applications that have removal processes for flammable solvents should consider LFL monitoring equipment. When flammable solvents are used in production processes, high oven temperatures evaporate them, emitting flammable vapors. The National Fire Protection Association (NFPA) standard 86 sets LFL guidelines for concentrations of low-vapor solvents and requires proper ventilation ratios to reduce solvent-vapor concentration to appropriate levels. Although solvent vaporization rates are not uniform, NFPA ventilation guidelines are calculated on the theoretical peak ventilation needs for safety. LFL monitoring equipment tracks the solvent-extraction rate in real time and adjusts the ventilation rate according to system needs, maintaining a safe ventilation ratio while saving the energy to run the equipment at higher levels.

Motors

Motors are responsible for almost 70 percent of electricity consumption in the manufacturing sector. Proper maintenance, sizing, and overall system care can help eliminate waste losses.

Properly size motors. Though motors often operate under varying load conditions, they are generally selected based on the highest anticipated load. This leads to the purchase of more-costly motors than necessary and adds the risk of underloading them. Consider selecting a motor based on the load duration curve (LDC) of its specific application rather than its highest anticipated load. The LDC shows the relationship between motor capacity and utilization, indicating the average load demand for the motor. Using the LDC to select appropriately sized motors results in smaller, less-expensive motors that will operate more efficiently over their lifetimes but that are rated slightly below the highest anticipated load. This method risks overloading and overheating the motor, but most manufacturers design motors with a service factor above the stated rate that allows motors to temporarily overload without harm.

Improve power quality. Motor performance is greatly affected by the quality of input power and voltage imbalance. Improving the former and minimizing the latter will increase performance efficiency. Because industrial facilities can receive additional charges for poor power factor, adding capacitors to improve power factor is an easy way to reduce your energy bills. In addition, voltage imbalances can further disrupt motor performance. In a three-phase system, the voltage of all phases should be equal; balancing these single-phase loads equally among all phases will reduce performance losses from voltage imbalances, and isolating any disruptive loads and feeding them from a separate line will help improve power quality.

Use high-efficiency motors. Improve motor efficiency by rebuilding existing motors or by upgrading to new, higher-efficiency models. Rebuilding old motors can improve efficiency by a few percentage points. Motor shops will install new bearings, rewind the core, and "dip and bake" the motor (to keep the core electrically insulated). As of 2010, federal standards mandate premium-efficiency levels for virtually all new motors. Thus, although buying a new, high-efficiency motor may cost more than repairing an existing one, new motors can more than make up for the cost in energy savings, higher service factor, longer bearing and insulation life, lower vibration levels, and diagnostic maintenance systems. Some new motors draw a larger start-up current, so verify that your system has the appropriate capacity before you buy, and remember that the cost of electricity to operate a motor for its lifetime far exceeds its purchase price. In general, replacing a standard motor with an energy-efficient motor is usually only cost-effective once the standard motor has failed—doing so before motor failure may not provide the cost savings needed to justify the measure.

Install VSDs. When loads change, variable-speed drives (VSDs) can alter the speed of a motor accordingly, often significantly reducing electrical consumption. VSDs can be installed in most existing systems because they are designed to operate standard induction motors.

Compressed air

Although compressed air is often viewed as an essentially free resource, these systems account for nearly 10 percent of overall electricity consumption and are often poorly designed or maintained.

Match your supply to your load. Generate compressed air at the pressure required, and no higher—halving pressure can result in energy savings of more than 50 percent. Additionally, sequence your machines to ensure that, when the demand is at less than full capacity, one or more compressors are shut off entirely (instead of having several operating inefficiently at part load).

Switch off compressors. Turn compressors off when production is down. Also, consider making piping changes to enable the shutoff of supply to production areas when there's no need for compressed air.

Review operations. Look for applications where a more appropriate alternative technology could replace compressed-air use. For example, atomizing or aspirating processes with compressed air could be modified to use more-efficient low-pressure blowers or fans.

Boilers

Boilers account for the largest nonprocess consumption of natural gas within the manufacturing sector. Optimizing operational setpoints and regular maintenance will ensure that boiler systems are performing efficiently.

Add boiler controls. Take advantage of a boiler control system's onboard efficiency strategies, such as outside-air reset and outside-air high-temperature shutoff. If none exist, consider retrofitting boiler controls onto the system to optimize performance and eliminate unnecessary cycling. A particularly effective new control system measures real-time heat load using a flow meter and temperature sensors in conjunction with an advanced software algorithm to enable the boiler to deliver only enough heat to match the load. By reducing short-cycling losses, this control strategy can reduce boiler energy consumption by as much as 45 percent. At the moment, the only company selling this type of control system is Thermodynamic Process Control Inc.

Install a waste-heat recovery system. On average, stack loss from boilers is around 15 percent. Blowdown also produces waste heat that is lost through drainage. Consider installing waste-heat recovery systems for both of these processes. The heat released within the boiler room, from the boiler and stack, can also be captured to preheat the intake air or makeup water for the boiler.

Use steam traps. Steam traps are automatic valves that release condensed steam from the boiler while preventing the loss of live steam. According to the Boiler Efficiency Institute , a one-eighth-inch steam trap with a valve that is stuck open on a 150 pounds per square inch gauge (psig) steam line will lose 75.8 pounds per hour of steam. Unnoticed, a leak of this nature could result in thousands of dollars worth of wasted energy. An ultrasonic leak detector can effectively detect faulty traps—it isolates sound frequencies, compares the frequencies to those of a properly functioning steam trap, and shows the results to users via a digital display.

Operate boilers at peak efficiency. For facilities with more than one boiler, optimizing load management across boilers can help save energy by operating them at peak efficiency. The most efficient units should be utilized first as demand increases, and the least efficient should drop off first as demand decreases. Scheduling loads across boilers to minimize short-cycling can also improve system performance.

Lighting

Broadly speaking, lighting savings can be found in two areas: installing the most appropriate lighting technology and controlling it effectively.

Upgrade to more-efficient lighting. HID light sources, such as metal halide and high-pressure sodium lamps, have long dominated the market for lighting indoor spaces with high ceilings , but today other technologies have proven more efficient under many common situations. Fluorescent fixtures using high-performance T8 lamps and ballasts can replace older fluorescent or HID fixtures at heights of less than 20 feet (6 meters). For locations requiring greater clearance, and for many high-bay areas, high-performance T8 systems or high-output T5 systems are effective. In cases where temperature extremes may be experienced or where color quality is especially important, ceramic metal halide lamps are a good choice. Induction lighting, which boasts very long lamp life, can be a good choice where access for maintenance is difficult or would disrupt manufacturing processes. Light-emitting diodes (LEDs) are getting to the point where they can offer significant efficiency, controllability, and performance benefits, but LEDs generally come at a much higher initial cost. LED performance is also sensitive to ambient temperature—high temperatures can reduce efficiency and lamp life. The best application of LEDs is in cold-storage areas. LED product quality is also very uneven, so products must be chosen with care.

Retrofit wireless controls. A fairly new lighting control strategy, wireless controls offer users significant control capabilities and savings opportunities. These systems generally involve the installation of sensors that measure factors like occupancy and ambient light levels. Users can control the lighting settings (either at the fixture level or by groups of fixtures) through sophisticated software portals on a computer. This approach can save energy by only having light fixtures turned on when they're actually needed, and by changing light levels based on actual user needs and ambient lighting conditions. These systems may also be configured to react to demand-response events (either automated or manual) by dimming lights as much as possible based on previously established settings and on real-time occupancy and ambient light levels. The use of wireless mesh networks also allows these systems to be installed much more quickly than wired systems, thereby reducing downtime and upfront costs.

Use smart lighting design in parking lots. Parking lots are often overlit—an average of 1 foot-candle of light or less is usually sufficient. The most common lamps used for outdoor lighting are HID sources—metal halide and high-pressure sodium. In recent years, fluorescent lamps, compact fluorescent lamps (CFLs), and induction lamps have also become viable sources for outdoor lighting, offering good color quality and better control options than HID sources. LEDs are also rapidly becoming a good choice because they can reduce light pollution while offering efficiency and long life. LEDs are expensive, but costs are decreasing and performance continues to improve. Dimming and occupancy-sensing controls can also lead to energy savings in parking lots.

Install LED signage. According to current U.S. federal standards, all exit signs manufactured after January 1, 2006, must draw no more than 5 watts per illuminated face of the sign. LEDs used in exit signs and other applications can cut energy costs and also reduce maintenance costs compared to incandescent, CFL, neon, and other options. To see what your building could save by replacing aging exit signs with contemporary models, use the exit signs savings calculator from the U.S. Environmental Protection Agency's (EPA's) Energy Star program.

HVAC

Improving HVAC systems through these measures will help facilities reduce wasted energy while increasing occupant comfort.

Air infiltration. Air infiltration through open loading docks and doors can be a major source of energy loss for manufacturing facilities. The loss can be minimized by making sure that the doors are closed and sealed whenever possible, but that can be easier said than done. People working on loading docks can find it tedious to open and close doors several times a shift, so they save time by leaving the doors open. One solution is to install specially designed doors that open and close quickly (but safely) and encourage employees to use them whenever possible. There are also doors that automatically close if left open. In doorways with so much traffic that even rapidly opening doors would be too slow, adding strip curtains has proven to be an inexpensive way to reduce energy losses.

Radiant heaters. One challenge with efficiently heating a manufacturing facility is the wide range of functions and spaces in the facility. If a large facility has a small section used as an office, people working there will expect a reasonable indoor room temperature year-round. The same applies to individuals working on a loading dock on a cold winter day.

Maintaining a comfortable temperature throughout the entire space can be costly and inefficient. In these situations, gas or electric radiant heaters (also known as beam radiant heaters) can be mounted above the areas that require heat, keeping workers comfortable even with the building air as low as 40° to 50°F (4° to 10°C). These devices provide thermal comfort to people directly in front of them, but they are not designed to bring the overall air temperature up.

Large ceiling fans. Improving air circulation with large fans can be an effective way to save a substantial amount of energy. If the space is cooled, ceiling fans save energy by improving air circulation, which can allow the facility to raise the temperature by as much as 4.5°F (2.5°C) while still maintaining occupant comfort. If the facility is heated, warmer air will naturally stagnate near the ceiling where it won't do much good, but changing the direction of ceiling fans will vertically circulate the heated air. Several case studies have shown that a few large ceiling fans provide better air circulation and greater energy efficiency than multiple smaller, high-velocity fans.

Reflective roof coatings. If the roof of your building needs recoating or painting, consider white or some other highly reflective color to minimize the amount of heat the building absorbs. This change can often reduce peak cooling demand by 15 to 20 percent. For a list of suitable reflective roof coating products, check out the Energy Star Roof Products page .

Cogeneration

If your facility does not already have a cogeneration system—also called combined heat and power (CHP) systems—consider installing one. These systems simultaneously supply heat and electricity from a single fuel source. By design, they are very efficient and produce power at double the efficiency of delivered power from a central plant. Cogeneration systems are commonly found in plants with large heating needs, such as oil refineries and paper mills.

Building systems and O&M programs

Making improvements to building systems and operations and maintenance (O&M) programs are vital to the success of any energy-saving strategy.

Track your energy use. Use the Energy Star Portfolio Manager to track your energy consumption. Once you've entered basic data such as building floor area and utility bill data, this tool calculates an index of energy consumption per square foot that will enable you to compare individual buildings, either across your portfolio, against their past performance, or to other similar facilities. Armed with such comparisons, you can identify and prioritize the plants with the biggest energy-consumption problems or track your progress for those plants in which you’ve implemented energy-efficiency measures.

Upgrade your O&M program. One simple way to improve the energy efficiency of facilities with little or no capital investment is to ensure that the building shell—and the expensive systems within it—are properly operated and maintained. Implementing a rigorous O&M program requires the buy-in of senior management and O&M staff alike. Ensuring that O&M activities are thoroughly documented and that staff are well-trained and -equipped also helps. FEMP’s *Operations & Maintenance Best Practices*, Release 3.0, has an entire chapter (PDF) dedicated to major equipment common to industrial facilities.

Retrocommission your facility. Retrocommissioning (RCx) is a process performed on facilities already in operation that identifies facility performance objectives, tests and verifies that those objectives are being met, and provides documentation of the process. Though most RCx programs focus on HVAC and lighting improvements, RCx objectives for an industrial facility will also focus on other process systems within the building. Commonly evaluated areas that typically offer energy improvement opportunities include compressed-air, steam, chilled-water, process-ventilation, pump, and fan systems. One industrial RCx program participant saved $26,000 in annual energy costs through measures including a rooftop unit (RTU) night setback adjustment, computer-room air conditioner (CRAC) unit setback, compressor adjustments, and an RTU economizer. Facility upgrades performed through retrocommissioning provide an initial efficiency boost, but an effective O&M program is essential for maintaining those improvements. Recommissioning every few years will also keep a facility operating efficiently.

Install an enterprise energy management (EEM) system. It is impossible to optimize what you don't measure, so you might consider an EEM system to track your facility's use of electricity, water, compressed air, gas, and steam. An EEM system is a combination of data-acquisition hardware and software that allows for a broad-based understanding of how energy is used in a facility. The information an EEM system collects allows energy managers to track costs, identify anomalies, and automate demand-response reactions. These insights on performance can be used to compare one facility against another or to look at how performance varies over time. An EEM system would be useful for determining the actual payback periods of any efficiency measures implemented.

Consider electric forklifts. Diesel- or propane-fueled forklifts require extra ventilation in the facility, which adds to the HVAC load in conditioned spaces and increases overall energy use. Electric forklifts have higher initial costs (capital plus installation) but lower energy and total operating costs, so the total lifecycle costs are comparable. One often-unexpected cost when deploying electric forklifts is increased demand charges, but these can be avoided by using a timer to only charge the forklift batteries during off-peak hours. In addition, some electric forklifts use regenerative braking technologies to increase the useful life of each battery charge. An emerging option is the use of fuel cell–powered lift trucks, which are just entering the market.

Upgrade materials-handling control systems. Some facilities have sophisticated systems in place for conveying and sorting manufactured items and work in process; these systems can offer additional savings opportunities. If conveyors constantly move at top speed regardless of how loaded they are, there is potential for savings. Custom equipment to control the distribution system can be designed to meet the functional requirements but slow down or switch off when possible to save energy.

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