

# HVAC

In Florida, according to the U.S. Department of Energy, nearly 45 percent of a building's energy consumption goes toward fulfilling cooling, ventilating, and heating requirements. Identifying and implementing efficiency measures that target HVAC equipment and systems can help reduce energy consumption while maintaining or improving occupant comfort. This HVAC Tech Brief outlines the pros and cons of various energy-efficiency measures and is designed to serve as a comprehensive, quick-reference guide for everyday use. For more in-depth information, visit [www.gulfpower.com/business/save/programs/heating-and-cooling](http://www.gulfpower.com/business/save/programs/heating-and-cooling) to access additional details on specific topics.

## Split and Packaged Systems

Approximately half of all U.S. commercial floor space is cooled by self-contained, packaged air-conditioning or heat pump units, most of which sit on rooftops. Also called unitary air conditioners and heat pumps or simply "DX or packaged units," these mass-produced machines include cooling or heat-pump equipment, air-handling fans, and sometimes gas or electric heating equipment. Though much less common, some commercial buildings are conditioned by split systems, in which an indoor unit contains the evaporator and supply fan and an outdoor unit contains the condenser and compressor.

Some ownership tips for DX units include:

- » **Select the right size.** Under- or oversized equipment can compromise capacity, efficiency, and humidity levels, resulting in unnecessarily high first costs for equipment and ductwork as well as uncomfortable work spaces.
- » **Consider high-efficiency models.** Select units that have earned the Energy Star label or that are promoted by utility programs to assure higher levels of equipment efficiency.
- » **Pay attention to design, commissioning, and maintenance.** It's important to make sure that the overall system is designed to be efficient, that it's commissioned to operate as planned, and that it's properly maintained. For example, a low-static-pressure duct system will reduce control problems, noise, and the required fan power.

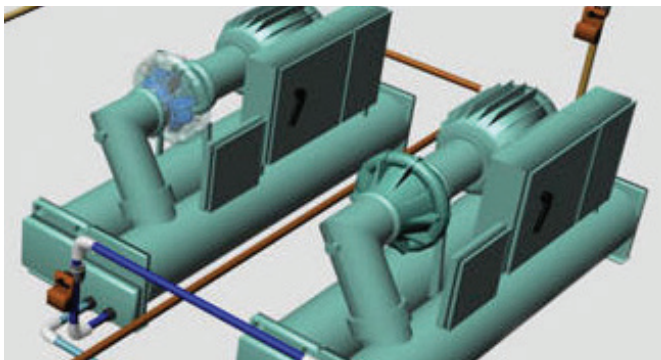
## Chillers

Electric chillers provide chilled water that is circulated throughout commercial and industrial buildings for air conditioning. Typically, a central chiller plant consists of one or more chillers and auxiliary systems such as chilled-water pumps, condenser-water pumps, and cooling towers. The chillers produce cold water, which is pumped to one or more air handlers or fan coil units throughout the building, where the water absorbs heat from warm indoor air. The cool air is then distributed around the building through a network of ducts. Water-cooled chillers, which



use a cooling tower to remove heat, are typically more efficient than aircooled chillers, which blow air across the condenser coil.

- » **Over 300 tons.** Centrifugal compressors dominate the market for this size range. They spin the refrigerant vapor from the center of an impeller wheel outward so that centrifugal forces compress it. They have the highest efficiency of any compressor type, particularly at full load, and they are amenable to operation with a variable-speed drive (VSD), thus enabling even higher efficiencies.
- » **Under 300 tons.** Screw compressors are used primarily in this size range. They compress the refrigerant by squeezing it between two rotating helical rotors that mesh. They are up to 40 percent smaller and lighter than centrifugal machines, so they're popular as replacements. Also available in this size range is a new type of centrifugal compressor that uses magnetic fields to levitate the compressor shaft in midair, eliminating mechanical friction and the need for traditional oil-lubricated bearings. This compressor also makes variable-speed operation possible—not a readily available option in this size range in the past.



It's important to select a chiller (and its associated efficiency) carefully. Choosing a chiller that's most efficient at full or part load, according to standard ratings, might be counterproductive because the ratings don't measure the efficiency of the overall cooling system. An analysis of the entire chiller plant, preferably using simulations, will tell whether a more efficient chiller is a better option than upgrading the auxiliary equipment or improving operating strategies.

## Demand-Controlled Ventilation

Demand-controlled ventilation (DCV) adjusts ventilation rates based on actual occupancy at any given time instead of at a fixed rate for full occupancy. DCV sensors monitor carbon dioxide (CO<sub>2</sub>) levels to determine how many people are inside, which in turn signals the HVAC system to adjust the amount of outside air brought into the building to comply with ventilation standards.

- » **What to look for.** Facilities that are good candidates for DCV include:
  - Those with long operating hours, widely varying and largely unpredictable occupancy, and at least moderate annual heating or cooling loads.
  - Grocery stores, supermarkets, big-box stores, theaters, lecture halls and other performance spaces, places of worship, sports arenas, schools and colleges, office buildings with variable occupancy, restaurants and bars of all types, and department stores.
- » **Estimate cost-effectiveness.** DCV savings are dependent on the difference between design and actual occupancy rates.
  - A good initial action would be to simply estimate occupancy on an hourly basis for a typical week in each season and compare that data with the building's design occupancy, which will be specified by local building codes. Even better, if you can get hourly data from cash registers, you can approximate occupancy by associating a given number of shoppers, theater-goers, or diners with each register transaction.
  - For a better estimate, use a low-cost portable CO<sub>2</sub> sensor to measure the effective ventilation rate for a given facility. Portable sensors coupled to dataloggers are available from several manufacturers at prices ranging from \$550 to \$700. If CO<sub>2</sub> concentrations are below 800 parts per million (ppm) much of the time, the facility is

probably a good candidate for DCV. While not an energy savings technique, if CO<sub>2</sub> concentrations rise above 1,500 ppm on a regular basis, then DCV could help to improve air quality.

- » **Evaluate cost savings.** Two free DCV evaluation tools are available: Honeywell's Demand Controlled Ventilation Savings Estimator, and the AirTest CO<sub>2</sub> and Ventilation Calculator.

## Thermal Energy Storage

Thermal storage systems offer building owners the potential for substantial operating cost savings by using off-peak electricity to produce chilled water or ice for use in cooling during peak hours. The storage systems are most likely to be cost-effective in situations where:

- » A facility's maximum cooling load is much greater than the average load.
  - » The utility rate structure has high demand charges, ratchet charges, a high differential between on- and offpeak energy rates, or seasonal rates.
  - » An existing cooling system is being expanded.
  - » An existing tank is available.
  - » Limited electric power is available at the site.
  - » Backup cooling capacity is desirable.
  - » Cold air distribution would be advantageous.
  - » **Storage medium.** The options include chilled water, ice, and eutectic salts. Overall, ice systems offer the densest storage capacity but the most complex charge and discharge equipment. Water systems offer the lowest storage density but are the least complex. Eutectic salts (a combination of inorganic salts, water, and other elements that freeze at a desired temperature) fall somewhere in between.
  - » **Operating strategies.** Several strategies are available for charging and discharging storage to meet cooling demand during peak hours. These are:
    - Full storage. A full-storage strategy, also called load shifting, shifts the entire on-peak cooling load to off-peak hours. The system is typically designed to operate at full capacity during all nonpeak hours to charge storage on the hottest anticipated days. This strategy is most attractive where on-peak demand charges are high or the on-peak period is short.
    - Partial storage. In the partial-storage approach, the chiller runs to meet part of the peak period cooling load, and the remainder is met by drawing from storage. The chiller is sized at a smaller capacity than the design load. Partial storage systems may be run as load-leveling or demand-limiting operations.
- In a load-leveling system, the chiller is designed to run at its full capacity for 24 hours on the hottest days. The strategy is most effective where the peak cooling load is much higher than the average load.

In a demand-limiting system, the chiller runs at reduced capacity during on-peak hours and is often controlled to limit the facility's peak demand charge. Demand savings and equipment costs are higher than they would be for a load-leveling system and lower than for a full-storage system.

## Energy Recovery Ventilation

Energy recovery ventilators exchange moisture and heat between the incoming outside air and exhaust air streams. This reduces the conditioning requirements for the incoming air, saving energy. These systems are more cost-effective in humid climates with very hot or cold temperatures and in buildings that use a large amount of outdoor air. Though they can be retrofit, they are more cost-effective in new installations, as they can allow for the downsizing of heating and cooling equipment. There are two main types:

- » **Membrane plate-type heat exchanger.** Incoming and exhaust air streams pass along membrane plates in separate channels that allow both heat and moisture to transfer through them.
- » **Enthalpy wheel.** A wheel containing desiccants rotates through the incoming and exhaust airstreams. Moisture and heat absorbed from one airstream is removed as the wheel rotates into the opposing airstream.

## Variable-Frequency Drives

Variable-frequency drives (VFDs) allow induction-motordriven loads such as fans and pumps to operate in speed ranges as wide as 25 to 100 percent of nameplate speed. By controlling motor speed so that it finely corresponds to varying load requirements, VFD installations can increase energy efficiency (in some cases energy savings can exceed 50 percent), improve power factor and process precision, and afford other performance benefits such as soft starting and overspeed capability. They also can eliminate the need for expensive and energy-wasting throttling mechanisms such as control valves and outlet dampers. The best application for VFDs are loads in which torque increases with speed, including centrifugal pumps, fans, blowers, and most kinds of compressors. However, some constant-torque loads can be good as well, such as reciprocating compressors, positive-displacement pumps, conveyers, center winders, and drilling/milling machines.

Consider the following factors when evaluating potential VFD applications:

- » **Operation at less than rated output.** In general, all loads with throttled output should be evaluated for VFD retrofit. To qualify as an economical VFD application, the output from a motor/load system must have significant operation at less than rated output. Most loads throttled continuously at 70 percent or less of rated output are good candidates for adjustable speed.
- » **High duty cycles.** In general, the longer a motor operates, the more attractive it becomes as a VFD retrofit candidate.

A motor/load system operating for 6,000 hours per year with throttled output will be three times more attractive for VFD retrofit than the same motor operating 2,000 hours per year.

- » **Motor choice.** For an increasing number of applications, alternative variable-speed technologies such as electrically commutated motors (ECMs) may offer benefits over an induction motor/VFD system. This is especially true for applications that require high speeds or a large range of speeds, high torque at low speed, or four-quadrant (such as motor, brake, and generator) performance.



## Electronically Commutated Motors

ECMs are brushless permanent magnet motors that run on direct current. They are 80 percent efficient—significantly higher than the permanent split capacitor (PSC) motors that are commonly found in HVAC equipment, which are only about 60 percent efficient. ECMs can also be controlled to run at variable speeds, which can deliver even higher energy savings when low fan speeds can be utilized.

ECMs are increasingly being incorporated into new, high-efficiency HVAC and refrigeration equipment. For example, manufacturers commonly use ECMs as one way to increase the seasonal energy-efficiency ratio ratings for new air conditioners. Also, in 2009, manufacturers began producing ECMs that could be used to field-replace the inefficient PSC motors found in existing HVAC equipment. However, variable-speed operation is not possible in retrofit applications because of the complexity and expense of configuring the motor in the field, so ECMs are set to run at an approximately constant speed.