

5.2.7 HVAC Technologies to Consider

New (or generally unfamiliar) HVAC technologies can help facility managers lower energy costs, reduce environmental impacts, and enhance indoor environmental quality. Information is provided here on a number of these technologies. Some of the new technologies covered in this section of the first edition of *Greening Federal Facilities* (1997) are now in fairly widespread use and merit their own sections of the guide (ground-source heat pumps, absorption cooling, and desiccant dehumidification). Other technologies have been added to this section. Although new technologies may be available only from a single manufacturer, and although the energy performance data are sometimes limited, these systems are worth considering.

Opportunities

Not every Federal facility will be able to try out relatively new or unfamiliar technologies, but as these systems become better known and trusted, potential applications will grow. Ventilation-preheat solar collectors are demonstrated to be highly cost-effective in hundreds of cold-climate applications. A number of the technologies described here can help control indoor humidity. In arid climates, evaporative cooling and an innovative rooftop evaporative system can be effective. Where electrical power demand costs are high, natural-gas engine-driven cooling may be appropriate.

Technical Information

VENTILATION-PREHEAT SOLAR COLLECTORS (TRANSPIRED AIR COLLECTORS)

This very simple solar collector passively preheats ventilation make-up air via a large, unglazed solar collector. These collectors are most effective on south-facing building facades, though significant deviation off true south (plus-or-minus about 60°) results in only minor loss of performance. The Canadian company Conservall Engineering, Inc., has pioneered this system under the tradename Solarwall. The sheet-metal collector has perforations that allow air to pass through into corrugated air channels under the outer building skin. The ventilation system air intakes are configured so that make-up air is drawn through the collector before it enters the building.

In new construction, installation costs are typically in the range of \$6 to \$7 per square foot (\$65–\$75/m²), though if the sheet metal facade replaces a more expensive facing, such as brick, there may actually be a *net reduction in cost* for this ventilation preheat system. With retrofit applications, costs are usually somewhat higher than with new construction.



Fort Carson uses a ventilation-preheat solar collector wall to warm outside fresh air before it enters an aircraft hanger. Intake air is preheated by 30–50°F (17–28°C). Such systems can reduce annual heating cost by \$1–\$3 per square foot (\$11–\$32/m²) of collector wall, depending on fuel type, significantly reducing demand on boiler systems.

NATURAL GAS ENGINE-DRIVEN COOLING

An engine-driven cooling system is similar to a conventional electric cooling system, except that the compressor is driven by a natural gas engine rather than an electric motor. Configurations include chillers, packaged direct-expansion units, and heat pumps, usually in sizes from 200 tons to 4,000 tons. Engine-driven systems are variable-speed, have higher part-load efficiencies, generate high-temperature waste heat (that can be used), and can often reduce operating costs. Consider engine-driven natural gas cooling when electrical demand charges are high or natural gas is particularly inexpensive.

COOLING EQUIPMENT WITH ENHANCED DEHUMIDIFICATION

Reducing indoor humidity is a prime factor in discouraging microbiological growth in the indoor environment. *Section 5.2.5* addresses desiccant dehumidification. Heat pipes can also be used to efficiently remove moisture with direct-expansion or DX cooling. Heat pipes enable DX coils to remove more moisture by pre-cooling return air. Heat absorbed by the refrigerant in the heat pipe can then be returned to the overcooled, dehumidified air coming out of the DX coils. The system is passive, eliminating the expense of active re-heat systems. Somewhat more fan energy is required to maintain duct static pressure, as is the case when any new element is added to the ventilation system, but no additional pumps or compressors are required. Increased fan energy must be considered when calculating system energy savings. Energy savings up to 30% have been reported. At least one manufacturer builds a variable-dehumidification system for DX equipment that precools liquid refrigerant rather than the air stream.

EVAPORATIVE COOLING TECHNOLOGIES

Evaporative coolers (also known as swamp coolers) have been used for many years in hot, arid parts of the



Each innovative “air tree” above provides ventilation for six offices at the National Renewable Energy Laboratory’s (NREL’s) Solar Energy Research Facility in Golden, Colorado. Air is cooled and humidified by direct evaporation, or “swamp cooling.”

Photo: Warren Gretz

country. These systems are typically roof-mounted. Cooling is provided as hot, dry outside air is blown through an evaporative media that is kept moist. *Indirect* evaporative coolers can work in climates where moist air is not wanted in the building, though efficiency is lower.

On larger buildings in hot, dry climates, the benefits of evaporative cooling can be achieved through roof-spray technology. A modified spray-irrigation system can be used on the roof to drop daytime roof-surface temperatures from 135–160°F to 85–90°F (57–71°C to 29–32°C). With a typical (poorly insulated) roof system, this can reduce interior temperatures significantly.

A newer, more innovative use of evaporative cooling is *night-sky radiant cooling*. This approach works in climates with large diurnal temperature swings and generally clear nights (such as in the Southwest). Water is sprayed onto a low-slope roof surface at night, and the water is cooled through a combination of evaporation and radiation. This process typically cools the water to 5–10°F (2.7–5.5°C) below the night air temperature. The water drains to a tank in the basement or circulates through tubing embedded in a concrete floor slab. Daytime cooling is accomplished either by circulating cooled water from the tank or through passive means from the concrete slab. Developed by the Davis Energy Group and Integrated Comfort, Inc., this NightSky™ system was used at the U.S. Customs border patrol station in Nogales, Arizona, and monitored by Pacific Northwest National Laboratory (PNNL) in 1997. The average cooling efficiency was found to be nearly 15 times greater than that of conventional compressor-based air-conditioning systems.

REFRIGERANT SUBCOOLING

Refrigerant subcooling systems save energy in air conditioners, heat pumps, or reciprocating, screw and scroll chillers by altering the vapor-compression refrigerant cycle. Three types of refrigerant subcooling technologies are being manufactured, and each adds a heat exchanger on the liquid line after the condenser: (1) suction-line heat exchangers, which use the suction-line as a heat sink; (2) mechanical subcoolers that use a small, efficient, secondary vapor-compression system for subcooling; and (3) external heat-sink subcoolers that used a mini-cooling tower or ground-source water loop as a heat sink. Subcoolers increase energy efficiency, cooling capacity, and expansion valve performance (i.e., decrease flash gas).

Heat sink subcooling can be used (1) where units are being replaced; (2) where building expansion is planned; or (3) where current capacity is inadequate. The best applications are in climates that are hot year-round—1,200 or more base-65°F (18°C) cooling-degree days—and with DX systems. With external heat sink subcooling, condensing units and compressors should be downsized, making the technology more appropriate when existing equipment is being replaced, when construction or expansion is planned, or when current cooling capacity is inadequate. PNNL’s evaluation of subcooling in Federal facilities is contained in a *Federal Technology Alert* available from FEMP.

References

Space Conditioning: The Next Frontier, U.S. Environmental Protection Agency, Washington, DC, 1993.

Space Heating Technology Atlas (1996) and *Commercial Space Cooling and Air Handling Technology Atlas* (1997), E Source, Inc., Boulder, CO; (303) 440-8500; www.esource.com.

Natural Gas Cooling Equipment Guide, American Gas Cooling Center, Washington, DC, 1995.

Contacts

For information about all types of gas cooling equipment, contact the American Gas Cooling Center, 400 N. Capitol Street, NW, Washington, DC 20001; (202) 824-7141; www.agcc.org.

Federal Technology Alerts and other publications about new HVAC technologies are available from the FEMP Help Desk at (800) DOE-EREC (363-3732), or see the FEMP Web site at www.eren.doe.gov/femp.

Conserval Engineering, Inc., 200 Wildcat Road, Downsview, Ontario M3J 2N5, Canada; (416) 661-7057; www.solarwall.com.

Davis Energy Group, 123 C Street, Davis, CA 95616; (530) 757-4844; www.davisenergy.com.