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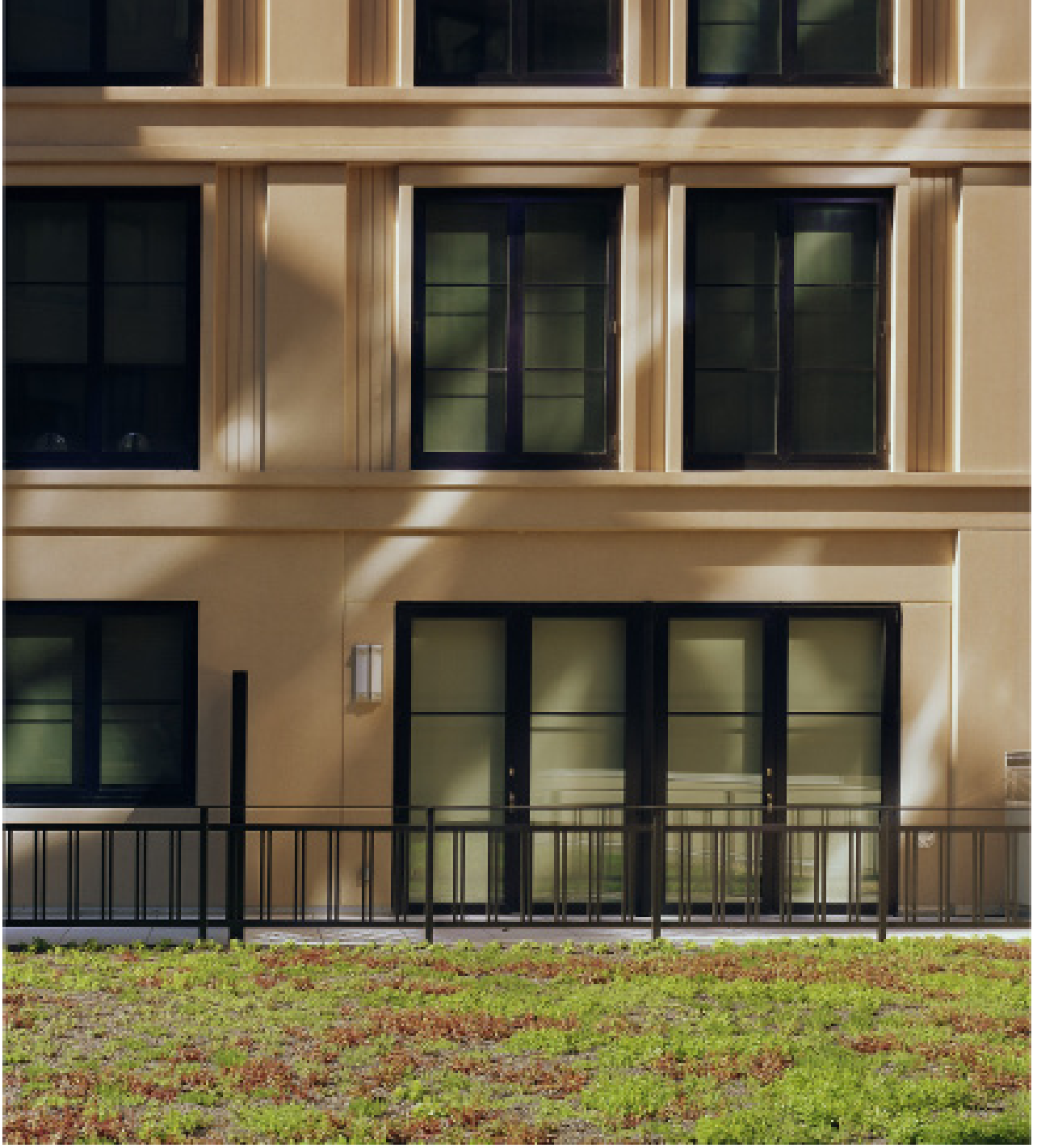

Swept Up In The Green Tsunami

Thermal Energy Transfer is Key To Commercial Building Efficiency

Without question, the green tsunami has hit our shores.

The "wave" I'm referring to, of course, isn't a rogue monster from the deep, yet it is in response to seismic shift in the building industry happening on a global scale. And though we Americans now embrace the need for change, conceptually, we've only just begun to shape it substantively.

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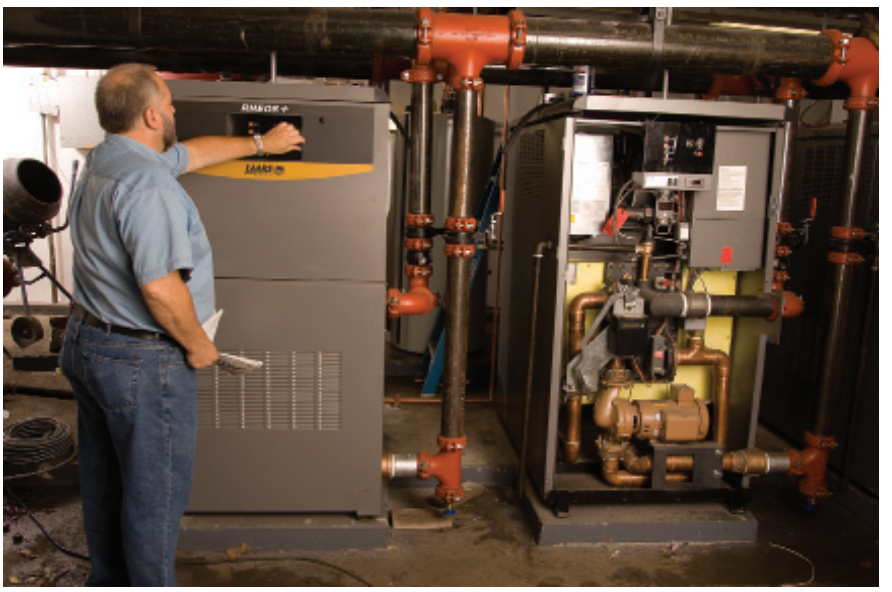
Though in the opinion of many Asians and Europeans - with a twinge of annoyance at our weary pace - we've resisted the need to develop and support green technology far too long. Renewable energy development has just begun to supplant our voracious thirst for fossil fuel.

If there's a silver lining to our current economic woes - fueled by the, well, lack of cheap fuel - it's the wake-up call we received, encouraging, at last, serious introspection about how we handle the need to move toward greater energy efficiency on a broad scale.

Solar thermal, wind, biomass and biogas, hydrogen, photovoltaic and geothermal technology; all are now among the renewable energy sources being developed at a greater pace than anticipated just a few years ago. Related to geothermal is one of the fastest growing trends in the commercial building industry: the use of water source heat pumps, or water-loop heating and cooling systems.

"Water-loop technology has been around for decades, though now - pushed by rising energy costs and the 'call to arms' by the USGBC and the advantages of LEED certification - interest in the technology is gaining rapidly," said John Bailey, vice president of sales and marketing for Oklahoma City-based ClimateMaster, Inc., the world's largest supplier of water source heat pump systems. "We refer to the water-loop process as 'thermal energy transfer.'"

A ClimateMaster water-to-water heat pump is commissioned by mechanical contracting firm, Horwitz NSI.



A contractor checks the boilers during the installation of a thermal energy transfer system.

The newest generation of water source heat pump heating and cooling technology for large buildings has pushed operational efficiencies into the 500 to 600 percent range. That is: for every unit of energy used to operate equipment, the system delivers 5 to 6 units of energy in return.

That's *smart* use of energy. Add new and sophisticated controls to the picture, system integration with building automation systems, and supplemental energy sources like photovoltaics and hydrogen cells . . . and you begin to see the potential for how quickly the commercial building market is evolving.

Water-source heat pumps move heat very efficiently. The best models will extract 5 kWh of heat from the water loop for every 1 kWh of electricity used to power the compressor and fan, delivering all 6 kWh as heat into the air. This 6 to 1 ratio is called the COP (Coefficient

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Horwitz/NSI engineers Jeff Rusinko and Josh Counihan (above), and Robbie Skantz (service tech, below) reviewing specs and lubricating bearings on a large pump motor.

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of Performance), and can be equated to a 600% efficiency level.

By comparison, the very best fossil fuel furnaces and boilers produce heat at less than 100% efficiency. Heat is then removed from the air (cooling mode) at similar efficiencies, providing EER (Energy Efficiency Ratio) levels over 20 Btu/Watt [5.86 Watt/Watt].

With the potential for off-the-charts efficiency performance, building owners are now at attention. When the design engineer can calculate a three- to four-year payback for new equipment (or perhaps even shorter than that in some instances), there's real incentive to install new technology - many of the systems ideal not only for new construction, but also for retrofit application.

At this year's AHR Expo in New York City, Bailey said he wanted to show me something outside. He led the way. When the door opened, a blast of cold air reminded us of the very real need for indoor comfort control. From the Javitts Center, we had a decent view of the city's impressive skyline.

With the sweep of his hand, he directed me to the landscape. "Take a look. Thirty to 40 percent of the high-rise buildings you see have some form of water-loop technology," he said. "But few people realize it. The industry's changing, and the market for this new technology is growing quickly. The technology continues to improve steadily and yet a large number of building owners still haven't heard the news."

Water-source heat pump, or thermal energy transfer (TET) systems provide highly efficient zone-controlled heating and cooling throughout a building by circulating water in a closed piping loop to move and exchange thermal energy. With such technology a building has, within it, many separate heat pumps, connected by closed-system water loops that transfer thermal energy with great efficiency.

Compared to traditional two-pipe, central chiller-based building systems, the installation of water-sourced equipment often saves 10 to 15 percent in the initial cost or up to 20 to 30 percent of the installed cost when compared to a four-pipe system. A high efficiency chiller is typically 10 to 15 percent less efficient than a water source heat pump (TET) system, operationally, while a standard chiller performs 30 to 50 percent less efficiently. Maintenance costs are often 10 percent higher with chiller-based sys-

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A contractor inspects an installation during a system commissioning.

A completed installation of Laars boilers. Another of the system's "business end" is heat generation for when supplemental heat is required. These Laars boilers add heat to a thermal energy transfer system when needed.

varies from 1 to 4 Watts per square foot (11 to 13 Watts per square meter)

• People - We emit thermal energy ranging from 300 to 500 Btus per hour [88 to 147 Watts] depending upon our activity

• Equipment - The energy consumed by equipment such as computers, printers, copiers, pumps and motors is emitted as heat

• Solar gain - Perimeter zones with large glazed areas may require daytime cooling even during cold weather.

The cast-off thermal energy within the building envelope recovered in the water loop of a water-

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tems. Heat pump life expectancy is about 20 years; a chiller will typically serve for 20 to 25 years. And, with a thermal energy transfer system, maintenance needs are also typically low.

Individual heat pumps add or remove heat from the air within each zone as required to meet its unique heating or cooling load. During zone heating, they extract needed heat (thermal energy) from the common water loop. During zone cooling, heat is rejected into the water loop where it can then be shared with all other heat pumps throughout the building. It's in this way that rejected heat - which is wasted to the outdoors in most HVAC systems - is fully utilized before any new energy source is used to heat or cool the building.

Bailey explained that all buildings contain year-round sources of thermal energy, or internal heat gains, that are recovered and recycled by thermal energy transfer systems, such as:

• Lighting - The electrical energy used for lighting in most structures

Replacing a filter for a "vertical stack" water-sourced heat pump unit is easy for technicians. All key parts are accessible within the living or public space.

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source heat pump system can be used for most purposes that require heat, such as:

• Space heating - Water-source heat pumps in zones that require heating will extract thermal energy from the water loop.

• Water heating - Water-to-water heat pumps can be equipped to extract thermal energy from the water loop to heat domestic hot water, swimming pools and spas, or to serve hydronic loads such as radiant heat or snow-melt systems.

• Ventilation - Dedicated "outside air" heat pumps extract thermal energy from the water loop to heat outside air used for ventilation.

Water-source heat pumps use a simple vapor compression refrigerant circuit to efficiently provide zone heating or cooling. During the cooling mode, heat is extracted from the air and rejected into the water loop. During heating mode, the process is reversed, with heat being extracted from the water loop and rejected into the air. Thus, thermal energy is transferred, or "pumped" between the air and the water loop, in either direction, on demand.

(Pictured above and below) One of the "business ends" of a thermal energy transfer system is the water tower, typically located on a rooftop to shed heat through evaporation if needed.

Why water?

In a word: efficiency. Water is the most efficient way to move thermal energy.

A two-inch water pipe can carry the same amount of cooling as a 24-inch air duct, requiring up to 90% less transport energy in the process and taking up far less space. The mass of the water loop also provides thermal storage, allowing a substantial amount of heat to be carried from occupied periods into morning warm-up. The advantage of thermal storage is not a capability found with traditional HVAC systems.

Water-source heat pump heat exchangers are both compact and efficient. This is because of the high mass and thermal conductivity of water. Water-source heat pumps - unlike traditional HVAC systems that are inefficiently tied to outdoor dry bulb temperatures - operate at lower condensing temperatures because they are linked to the outdoor wet bulb temperature when using a cooling tower, or deep earth temperature when using a ground heat exchanger. This leads to higher efficiencies and longer service life.

Water-loop heat pump systems combine water-source heat pumps on a common piping loop with a heat rejector and boiler, which are used to maintain the circulating water temperature within a controlled range, typically from 60ºF to 95ºF. The most common heat rejectors are open cooling towers with isolating heat exchangers, closed-circuit evaporative coolers, or dry

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coolers.

Each zone heat pump uses the water loop to provide heating or cooling at any time, during or after hours, regardless of the operating mode of the other heat pumps. This is accomplished without the duplicate operation of heating or cooling systems, or the double waste inherent in reheat modes.

Water-to-water heat pump systems also operate very efficiently under part-load conditions, such as when a small portion of the building remains occupied after hours. Only the required zone heat pumps are used, unlike systems that must keep a large central plant in operation at an inefficient scaled-back capacity in order to serve a small portion of the load.

One of many ClimateMaster water-sourced heat pumps in a LEED condo in Washington, DC. Some were located in mechanical closets, other vertical-stack heat pump units were located within the living space.

One of the key facets of a thermal energy transfer system is hydronic system pumping system efficiency. Here a pump station, part of a Taco Load Match system, receives a routine service call.

A typical building has a perimeter with outside exposure that is directly affected by variable outdoor weather conditions and a core without outside exposure that is virtually unaffected by the weather. In order to understand the energy sharing benefits of a water-source heat pump system, the interaction of the loads in the core and perimeter zones must be studied throughout the year during occupied periods, with internal gains, and unoccupied periods with temperature setback/setup and little or no internal gains.

To illustrate this, the following are the main energy consuming operating modes of an office building in a temperate climate.

• Summer, occupied: Typically, all zones require cooling and are rejecting heat into the water loop. The heat rejector maintains the maximum water loop temperature according to a predetermined setpoint (fixed or outdoor reset). The boiler is off.

• Winter warm-up: During recovery from night setback, most zones will require heating and will be extract-

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ing heat from the water loop. The boiler maintains the minimum water loop temperature according to a predetermined set-point. The heat rejector is off. The warm-up period is typically one hour or less per day.

• Winter, occupied: Because of internal heat gain, most core zones require cooling. Most perimeter zones will require heating. Because heat is being simultaneously rejected into and extracted from the water loop, both the boiler and the heat rejector will remain in the "off" mode much of the time. And this is the essence of *thermal energy transfer:* the inherent sharing of energy within the water loop minimizes boiler and heat rejector operation and provides maximum system efficiency.

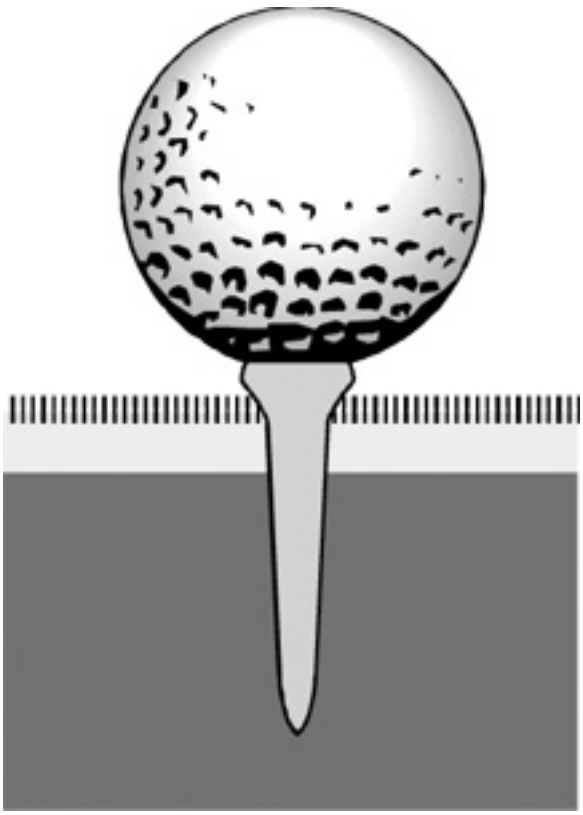
The many advantages of water-to-water systems include:

• *Year-'round individual control.* Each zone heat pump provides individual temperature control. This allows each occupant to control heating or cooling regardless of season, during or after hours, regardless of what other zones are doing. Zones served by single heat pumps can be as small as 200 square feet or as large as many thousands of square feet.

• *Energy savings*. Water-source heat pumps provide zone heating and cooling at the highest rated levels of efficiency. The water loop inherently recovers much of the energy needed for heating the building, minimizing boiler use. Water-loop heat pump systems operate efficiently under partial occupancy and at part-load conditions. They also eliminate the double energy waste of zone reheat (cooling with subsequent reheating), which is common in many HVAC systems.

• *Tenant metering.* The majority of the system operating cost occurs at the zone heat pumps, which can be metered at the tenant level. Thus, each tenant pays for only what they use.

• *Quiet operation.* Though large central chillers and high-speed, high-static fans may produce noise and vibration, modern water-source heat pumps operate with great stealth, even though they're often located within occupied spaces. Sound levels produced by the latest models are greatly reduced by the use of new compressor technology, variable speed fan motors and sound-isolating designs. Quiet operation has become a fundamental requirement for many tenants.



Do You Know What This Means?

It's time to start making plans to attend the Chief Engineers Annual Golf Outing.

As the most popular event of the year, the golf outing always sells out fast. Please contact any Board member for information or to make your reservation or contact Golf Chairman Jim Cacciottolo at 312-307-4333.

Date: September 17, 2010

Place: St. Andrews Country Club

Tee-Off: 9:00 am PROMPTLY

ATTENTION VENDORS: This is a perfect opportunity to grab the chiefs as they make their rounds! Sponsor a hole and get your word out to a captive audience. Call the CEAC office for details.