

Dedicated Outdoor Air Systems Save Energy, Lots of Energy

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When Madison Investment Advisors (MIA) wanted to expand their facility, they wanted the addition to be a model of energy-efficiency and hired Doug Kozel of KEE Architecture to lead the effort. Doug hired The Renschler Company to design the heating, ventilating, and air-conditioning (HVAC) system and requested that the system incorporate ground loop heat pumps. The addition has been occupied for over a year and recently received a Focus on Energy Award of Excellence from the Wisconsin Green Building Alliance (WGBA).

Project Description

The MIA addition is a 10,775 square-foot office expansion located at 550 Science Drive in Madison, Wisconsin 53711. It is connected by an enclosed bridge to an existing facility designed earlier by the same architect. Two above-grade floors provide office space and a two-story atrium. A below grade level is used for mechanical systems and storage. The addition is occupied by 33 employees who typically work 50 hours each week. KEE Architecture included generous amounts of glass so occupants could enjoy natural daylight as well as the surrounding views with mature trees and greenery. A picture of the finished facility was provided by KEE Architecture and appears below:



Figure 1: Southeastern Exposure (Courtesy of KEE Architecture)

Interactive Design

Working with the Renschler Company, KEE Architecture specified high-performance, triple-glaze glass assemblies for much of the building. Although these glass assemblies added to the first cost, the Renschler Company modeled the peak heating and cooling requirements to

determine that the added cost of upgrading to high-performance glazing was more than offset by the cost reductions that came from smaller heat pumps and a smaller vertical ground loop. Furthermore, by designing a building with overhangs on the southern exposure and a brise soleil on the connecting bridge, both pictured previously, KEE Architecture allowed for day-lighting and views while reducing unwanted glare and heat gain.

HVAC Design

The Renschler Company had provided HVAC designs for dedicated outdoor air systems in several buildings constructed by the Renschler Company in the Madison area including the Wisconsin Electrical Employees Benefit Fund (WEEBF) Building, the RenewAire Renovation, and a Home Savings Bank Branch. All three of these buildings have been dual-certified through the United States Green Building Council (USGBC) Leadership in Energy and Environmental Design (LEED®) program and the Green Building Initiative (GBI) Green Globes® program. Two of these buildings scored in the upper 88th percentile of Energy Star® based on actual utility bills. Although these buildings combined dedicated outdoor air with furnaces and split cooling (AC) units, that same concept is easily applied to heat pumps as shown in Figure 2.

During occupied hours, an air-to-air heat exchanger (in this case a RenewAire energy recovery ventilator) runs at full volume exhausting bathrooms and janitor's closets and using the embodied energy in the exhaust air to pre-condition outdoor air before that air is introduced into the return air system as ventilation air. This exhaust air leaves the building after most of its embodied energy has been removed. During unoccupied hours, the unit is off. In addition to reducing energy use, the constant volume fan in the air-to-air unit insures occupants are receiving ventilation air volumes that exceed code requirements and national standards whenever the building is occupied.

Seven high-efficiency Trane water source heat pumps serve the addition. Each unit is controlled by a dedicated wall-mounted setback thermostat in a zone. During occupied hours the fan in the unit runs at full volume. The heating and cooling equipment in the heat pump run to maintain the air temperature between 70 to 75°F year-round. During unoccupied hours the fan in the unit cycles on and off to maintain the air temperature between 65 and 80°F year-round.

When the outdoor air temperature is between 50 and 60°F free cooling with outdoor air is achieved with a simple economizer. Damper D-1 (See Figure 2) opens to outdoor air and closes to return air while damper D-2 opens to allow return air to leave the building as relief air. When the outdoor air is below 50°F or above 60°F, damper D-1 closes to outdoor air and opens to return air while damper D-2 closes.

Three separate vertical ground loops provided by G. O. Loop join together in a common indoor loop that serves the heat pumps. An in-line loop pump, mounted to each heat pump, switches on when the heat pump compressor is on and remains off otherwise. The result is a loop flow that exactly matches the heat pump demand without using variable volume pumping which typically requires having a loop pump running at all times, even when no compressor is calling for fluid.

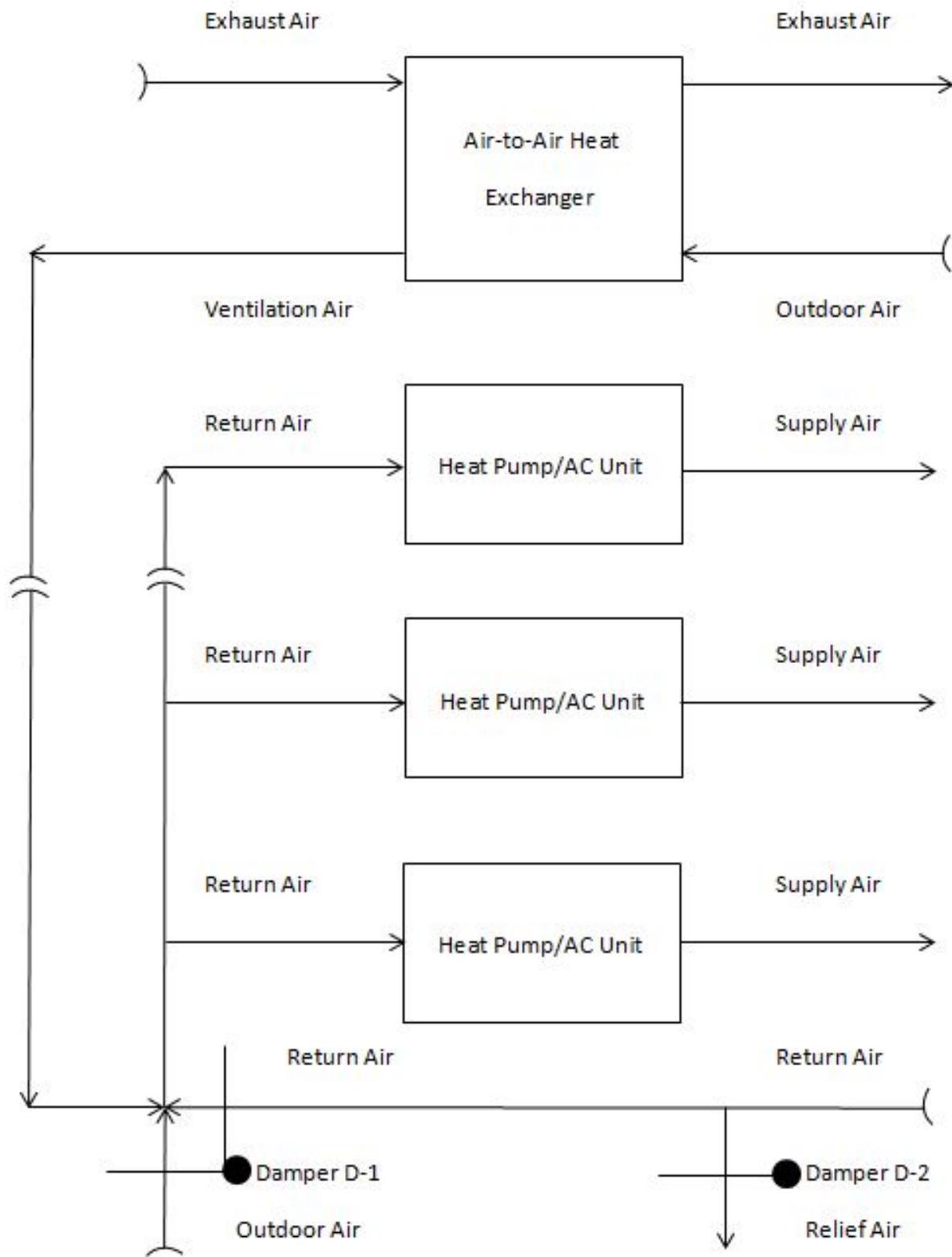


Figure 2: Dedicated Outdoor Air System (Courtesy of the Renschler Company)

Energy Efficiency

In addition to generous views of the outdoors and having an open day-lit work environment, MIA enjoys low utility bills in their addition. Energy Star® results for the first 12-months of energy bills appear below:

OMB No.2060-0347



STATEMENT OF ENERGY DESIGN INTENT

November 2, 2012

FACILITY INFORMATION & CHARACTERISTICS

Facility Name: Madison Investment Advisors Addition		Location: 550 Science Drive, Madison, WI 53711 United States	Design Energy (kBtu)¹ Electricity - Grid Purchase 378,732
Space Type: Office	Total Floor Area: 10,775 sq. ft.	Total Gross Floor Area: 10,775 Sq. Ft.	

RESULTS FOR ESTIMATED ENERGY USE	DESIGN	MEDIAN BUILDING	ESTIMATED SAVINGS
EPA Energy Performance Rating (1-100) ¹	87	50	37
Percent Energy Reduction (%) ²	40	0	N/A
Site Energy Use Intensity (kBtu/sf/yr)	35	59	24
Source Energy Use Intensity (kBtu/sf/yr)	117	197	80
Total Annual Site Energy Use (kBtu/yr)	378,732	635,950	257,218
Total Annual Source Energy Use (kBtu/yr)	1,264,965	2,124,074	859,110
Total Annual Energy Costs (\$)	\$ 12,943	\$ 21,733	\$ 8,790
Pollution Emissions (metric tons/yr) ³			
CO ₂ -eq	86	144	58

Figure 3: Actual Energy Use (Courtesy of Energy Star)

The addition scored in the upper 87th percentile which means energy use was lower than 87% of similar office buildings in this location.

Indoor Air Quality

The dedicated outdoor air system provides ventilation air at a constant volume of 1,025 cubic feet per minute (cfm) whenever the building is occupied, as reported by the balancing contractor. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Standard 62 – Ventilation for Acceptable Indoor Air Quality requires 812 cfm of ventilation air based on the floor space (10,775 square feet) and peak number of occupants (33). Therefore, the occupants are getting 26% more ventilation than what is required by ASHRAE Standard 62 and several more times the ventilation air required by code.

Innovation

The integration of a simple economizer with the dedicated outdoor air system is one reason why this facility has performed exceptionally when it comes to energy efficiency despite the large amounts of glass and open space. This innovative setup is easy to control with only wall-

mounted thermostats, easy to install, and easy to commission which makes it ideal for smaller facilities with modest budgets.

Operating and Maintenance

All heat pumps, circulation pumps, and glycol piping/equipment are located in a basement mechanical room where they can be maintained without entering occupied spaces. Since the heat pump compressors are heating and cooling with ground-temperature fluid and are not subject to wide outdoor air temperature variations, wear on the heat pump compressors should be reduced. Furthermore, each heat pump has a dedicated circulating pump that runs only when the heat pump compressor is on which reduces pump run time and should reduce maintenance while extending pump life.

Cost Effectiveness

According to the Energy Star® Target Finder results, when compared to an average office building of the same size, the MIA addition reduces energy costs by \$8,790 each year.

Environmental Impact

According to the Energy Star® Target Finder results, when compared to an average office building of the same size, the MIA addition reduces greenhouse gas emissions by 58 tons each year. That comes out to be 1.8 tons per employee each year while achieving an exceptional work environment and outstanding indoor air quality.

Conclusion

The successful outcome of this addition came from the top down. MIA, a firm that specializes in helping people to invest their money successfully, recognized the benefit of having an addition with low utility bills and also showed that their connection to the surrounding environment was more than just a matter of aesthetics, they wanted to make a real difference. KEE Architecture immediately set out to design a facility that would link occupants to the outdoors with good daylight, open spaces and extraordinary views, but they always kept energy efficiency in their design by using good shading techniques, specifying high-performance glazing, and recognizing the benefits of ground loop heat pump systems. The Renschler Company already had an established track record combining dedicated outdoor air systems with high-efficiency heating and cooling systems to achieve exceptional energy performance without compromising indoor air quality. By putting all of these elements together in an integrated design, MIA achieved a building that meets all of their objectives for comfort, health, and energy efficiency.

For additional information on this HVAC system, contact Eric Truelove at 608-332-8444 or etruelove@att.blackberry.net.