



Zero-Energy Schools Ace Their Scores for Savings and Sustainability Using ClimaCool[®] Chillers in Geoexchange System

Since its first zero-energy school, Odyssey Elementary, opened in 2014, the Davis School District north of Salt Lake City, Utah, has reaped amazing cost savings. As a result, the District has repeated the technology, smart architecture and solar PV panels in that school design for long-term operating cost savings. Two more zero-energy elementary schools in the district are now open – Kays Creek and Canyon Creek. In addition, Farmington High School, which is the largest facility that the district has ever built, is under construction for a Fall 2018 open and will also feature a net-zero ready design.

The two-story, 85,000 square foot Odyssey Elementary School won several design awards and has been certified as LEED[®] Gold and Energy Star[®]. More importantly, the school district achieved impressive operating cost savings. The Odyssey Elementary School saw \$0.37/sq. ft. utility costs compared to the average utilities cost of \$1.00/sq. ft. for a similarly sized building. When the Davis School District saw those savings, it committed to a long-term plan for building schools that could achieve comparable cost savings in the face of utility rates that

might double in cost in ten years.

The key elements of the Odyssey Elementary system – geoexchange heating and cooling, indirect evaporative cooling, thermal displacement ventilation (TDV), photovoltaic arrays, daylight harvesting – were repeated at the next two elementary schools and the high school.

At a Glance

Issue: Design a sustainable K-12 school mechanical system that could provide long-term operating cost savings and enhance the learning environment.



Solution: Using an integrated system design employing geoexchange heating and cooling, indirect evaporative cooling, thermal displacement ventilation photovoltaic arrays, and daylight harvesting.

Outcome: Utility costs at the first zero-energy school were 63% less than a similarly sized building.

Only minor tweaks were necessary at the later schools due to the difference in the building sites, according to Wade Bennion, P.E. + LEED AP and principal of Van Boerum and Frank Associates, the mechanical engineers on the design team. “The Canyon Creek school has a horizontal rather than a vertical ground source field and the Kays Creek school has half the number of bore holes.”

Modular Water-to-Water Heat Pumps for the Geoexchange System

The three elementary schools are each equipped with three 30-ton ClimaCool modular water-to-water heat pumps used for heating. Those modular heat pumps performed so well in the geoexchange system at the Odyssey School that the only tweak to the units in subsequent schools was the compressor staging. While the units in the first school had compressors that staged on and off, the units in the second and third schools had inverter compressors for multiple stages of operation. “The inverter technology helps zero in on the hot water supply temperature of 130° F and avoid nuisance trips,” Bennion said.

The ClimaCool modular heat pumps provide operating reliability that was a key requirement for the school district’s building team. “The redundancy built into the modular heat pump system allows continued heating operation using two of the three chillers if one should stop,” said Terry Shields, president of Midgley-Huber Inc., the ClimaCool representative in Salt Lake City. “Avoiding interruption in learning for students and teaching staff was a priority of the District team.”

Both the Davis School District and Van Boerum and Frank Associates had long-term relationships with Midgley-Huber so they were confident in selecting the recommended ClimaCool units. The flexibility of the



ClimaCool modular water-to-water heat pump installed in the Canyon Creek Elementary School.

modular design of the chiller system was also seen as an advantage for future expansion needs, according to Shields.

The 400,000-square foot size of the Farmington High School meant that the mechanical system had to be scaled up. That school will have five 70-ton ClimaCool simultaneous heat and cooling modular heat pumps. In addition to heating, these units will also be used for backup mechanical cooling to provide 55° F supply air in the high school’s auditorium. “The size and height of the auditorium meant that thermal displacement

“The applied heat pump system has proven so reliable that it is now the HVAC system of choice of the maintenance team.”

Wade Bennion, P.E. + LEED AP, principal of Van Boerum and Frank Associates



At 400,000 sq. ft. in size, the Farmington High School is the largest construction project undertaken by the Davis School District.(rendering: Davis School District, Facebook)



The mechanical room of the Odyssey Elementary school contains some of the equipment comprising the innovative system with indirect evaporative cooling, daylight harvesting, solar panels and a geothermal heating and cooling. The ClimaCool geothermal heat pump is visible in the center.

ventilation wasn't economical in that space," Bennion said. "Other spaces in the high school, however, will use indirect evaporative cooling and thermal displacement ventilation, which are quite economical to use in the Utah climate."

Maintenance Team's System of Choice

Energy efficiency isn't the only advantage that the District has discovered from the ClimaCool modular heat pump system. "When the District was planning the zero-energy schools, the maintenance team of the District was part of that planning," Bennion said. "Going from unitary-type water source heat pumps with a mechanical chiller, as previously used in a few of the District's schools, to an applied heat pump system was a concern. The applied system has proven so reliable and easy to maintain, however, that it is now the maintenance team's HVAC system of choice as well."

Bennion added, "Early in the process of designing the Odyssey School system we were considering water-to-air heat pumps, however, the design team was charged by the District to have operating costs as low as possible. That meant we needed to evaluate

"When designing a geothermal system, consider choosing an applied system with a water-to-water heat pump with the gas boiler backup for redundancy and efficiency."

Wade Bennion, P.E. + LEED AP, principal of Van Boerum and Frank Associates

alternate technology." The District had previously used thermal displacement ventilation with a more conventional system that included a mechanical chiller in one of its junior high schools.

For the zero-energy schools, the design team went to the next level of innovation by combining TDV with indirect evaporative cooling to provide more effective ventilation for the learning environment. That system combination not only surpassed ASHRAE Standard 62 ventilation performance guidelines, but also increased energy cost savings, helping to meet the District's goal of minimizing operating costs.

The ClimaCool modular heat pump units also contribute to those operating costs savings. "At the Odyssey School, the heat pump heating-only units achieved a COP of 3.12," said Terry Shields.

Advice for Geoexchange System Designers

Over his career, Bennion has developed both a passion and an expertise for applying innovative technology to mechanical system design for schools. When asked what advice he would give to other engineers designing geoexchange systems for schools, he said to choose a central modular system with a water-to-water heat pump with electrical backup for heating and cooling. He also recommended the use of energy modeling programs that include the latest technologies. "We used special modeling software that included a TDV system to accurately model the school's operating schedules. That software also helped determine how much photovoltaic capacity would be needed to achieve a zero-energy system."

Bennion pointed out that the team received a pleasant surprise when the system at Odyssey School actually out-performed even the prediction made by the energy modeling software. "Overall the Davis School District and the entire design team are pleased with the performance of the zero-energy schools. We look forward to designing the next generation of high performance, sustainable schools for the families in the District."

Project Team

Owner: Davis School District, Utah

Architect: VCBO Architecture

Mechanical Engineers: Van Boerum & Frank Associates, Inc.

Electrical Engineers: Envision Engineering

Structural Engineering: Bsumek Mu & Associates

Contractor: Hughes General Contractor

Chiller System Equipment: Midgley-Huber, Inc.



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