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the NEWS

Energy Excellence in Martha's Vineyard

by Barb Checket-Hanks

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Nelson Mechanical Design (NMD) has a long-standing reputation for being a green contractor, and it goes beyond the steps many HVAC contractors are taking now, well intentioned though they may be. That's because NMD has been a trailblazer, pushed in part by the progressive customers on Martha's Vineyard.

We already introduced one of them in the article that ran in the May 5 *NEWS*: The Doug Rothmann home on the Vineyard is a net-zero energy, LEED for Homes building powered by a wind turbine. The horizontal, 6-ton, direct-exchange geothermal system serves radiant space-heating loads. A heat pump uses R-407. It's only one of several geothermal projects the company has designed and installed. The system's zoned control adds considerably to its functionality and convenience to the homeowner.

Geothermal certainly isn't new; the contractor explained that the geothermal concept has been commercially available since around the 1940s. Greater manufacturing and training improvements, however, have made their installation more feasible for more people, making this a great market for contractors like NMD. "We have spent many years researching and developing geothermal for our market," states the contractor's website. "We are accredited designers, installers, and dealers for two of the world's leading geothermal manufacturers."

This is one of several geothermal projects designed and installed by contractor Nelson Mechanical Design, Martha's Vineyard.

HIGH CUSTOMER AWARENESS

The high ecological awareness of customers in Martha's Vineyard has led the contractor to address a number of questions. For instance, the direct exchange geothermal systems installed by NMD, use copper refrigerant lines to couple to the earth and extract or dispose of heat. "Many of our customers are curious about the durability of the copper underground," the contractor said.

"The Copper Council of America has deemed that these lines should last virtually indefinitely in nonaggressive soil." In problem areas, anode protection systems ensure that the copper does not corrode.

NMD also designs and installs plumbing, heating, air conditioning, and solar systems, and performs mechanical design, engineering, software modeling, and analysis.

The contractor has even branched out into composting systems — specifically, Clivus composting toilets. "These systems are perfect for the environmentally conscious homeowner, or the water-consumption-conscious business owner," the contractor said. These systems offer reduced water consumption and discharge, and result in a nitrogen-rich "tea" that can be used to water gardens and lawns.

The residence of Brian K. Nelson and family, and the office of NMD Inc., house a unique mechanical room. This view shows DDC panels 1 and 2 on the left, air zone controls in the middle, and variable-speed circulator controls on the right.

The company's principals are David Sprague, a Master Plumber licensed in Massachusetts, an Accredited Installer (geothermal), a member of the International Ground Source Heat Pump Association (IGSHPA), and a Geothermal Pipe Fusion Welder; and Brian Nelson, a Master Plumber licensed in Massachusetts, who is working on his Certified GeoDesign license. Nelson has a Master's Degree in Mechanical Engineering, and a full member of the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE), the Association of Energy

Engineers (AEE), Geothermal Heat Pump Consortium (GHPC), IGSHPA, and Radiant Panel Association (RPA).

The West Tisbury residence, which was built around the frame of a reclaimed barn (originally built in 1852), is powered by wind turbines; a 5-kW wind turbine provides enough power annually to meet the entire energy load.

A horizontal, 6-ton direct-exchange geothermal field was selected to serve radiant space heating loads through a buffer tank. The heat pump uses R-407. An ERV is connected to a duct system designed for a future dedicated outdoor air system.

DHW preheat is accomplished using a flat plate heat exchanger powered by the heat pump with final hot water heating from an electric water heater. A separate outside reset on the buffer tank optimizes heat pump operation; the other two areas each have separate reset temperatures as the different rooms have differing loads.

The project demonstrates the value of careful design and building shell optimization, Nelson explained. By focusing on long-term energy use (as driven by the selection of a 5-kW wind turbine and its projected output) and the goal of annual net zero operation, the building shell was improved and the mechanical system reduced until energy goals were met.

Walls, ceilings, and floors were much thicker and better insulated than the norm — this worked well to reduce the sensible loads but increased the need for mechanical ventilation, Nelson explained. “We installed an ERV large enough for the nominal load of five people exercising — we understood that the occasional larger [yoga] classes would present an intermittent load that could be met over a longer period of time by a smaller ERV.”

“The small site footprint precluded the use of a closed-loop horizontal glycol geothermal system so we opted for the direct exchange approach. This reduced our field size by half, which reduced excavation costs as well,” Nelson said. “Use of a buffer tank with the 6-ton heat pump ensured that more of the operating time of the heat pump would be closer to full load, especially when a smaller radiant zone was the only active zone.

“We set up an outside reset scheme for the buffer tank to make sure heat pump energy use was held to a minimum,” he said. “The buffer tank setpoint typically rides about 5˚F hotter than the outside reset setpoint of the other two radiant zones.” Domestic hot water is preheated using the geothermal heat pump through a flat plate heat exchanger with final heat provided by a plastic electric water heater. This residence was Martha’s Vineyard’s first LEED for Homes project.

SPECIALIZED ZONES

The entire system is controlled, monitored, and accessed from an ENV direct digital control, a

Web-based system that allows the client to monitor and operate the system from the Internet, sends status alarms, and trends energy use for system optimization.

The client wasn't sure if radiant floor warming or space heating would be more comfortable in conjunction with forced-air zones, Nelson said. "Through the use of the ENV control system, we were able to offer both control schemes," said Nelson.

The basement of the Nelson residence is used as the testing grounds for new heating and cooling technologies and control systems. Here, chilled and hot water buffer tanks are on the left, circulators for

"We installed slab sensors in the three zones for use with a floor-warming control scheme, and will use the room temp info collected from the forced-air system communicating thermostats in a radiant space heating scheme. This will allow the homeowner to easily convert between a floor-warming radiant approach and a space-heating radiant approach with a few mouse clicks."

The contractor then set up three radiant floor zones with two different mix temperatures for the two different floor types in the zones. "As the ENV system directly controls the water temperature via the motorized mixing valves, it will be relatively simple to add radiant cooling in the future by simply reversing the heat pump operation and storing chilled water in the radiant buffer tank (and installing the appropriate relative humidity transmitters in living spaces for the dew point calculation)," explained Nelson.

For humidity control, the ENV is connected to a relative humidity transmitter in the basement zone to provide a relative humidity set point for the basement heat pump. The control system also will be able to stage radiant heat with dehumidifying operation during the winter — and because of the home's proximity to the ocean, fog and high levels of humidity often occur during the heating season.

"An important part of the control system is the ability to trend energy use and determine how close our initial system sizing was to the actual heat loss/gain of the building," Nelson said. "The ENV system will allow us to isolate actual energy use and where it occurs in the mechanical system. This information will assist us not only in the commissioning process, but also in setting a benchmark to maintain long-term system efficiency" — something that is gaining more and more importance.

NELSON'S TEST RESIDENCE

The contractor likes to test new systems out rather personally. In fact, the residence of Brian K. Nelson and family, and the office of NMD Inc., house a very unique mechanical room. For years, the basement of the Nelson residence has been used as the heating, cooling, and domestic hot water plant for the home, as well as being testing grounds for new heating and cooling technologies and control systems.

Currently, an 8-ton horizontal geothermal DX ground-to-water system provides all of the heating, cooling, and domestic hot water preheat for the Nelson family. Two 4-ton heat pumps take turns raising the temperature of the heating tank, or lowering the temperature of the cooling tank, to provide warm air heat or air conditioning, as needed. This hot or chilled water is sent to two air handlers and run through oversized hydronic coils.

This system preheats the domestic hot water in conjunction with an AET solar hot water panel system. A Noritz tankless hot water system (a backup) boosts the domestic hot water when needed.

A DDC system controls every aspect of the home's heating, cooling, and solar hot water systems. A flat-screen display shows how many tons of carbon dioxide and money the system is saving, as well as how the system is operating at that moment. Both DDC and traditional gauges and meters display ground, water, and air temperatures throughout the system, as well as water and air pressures. "This allows us to measure the performance of the system and compare real-world data with our software projections," said Nelson.

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