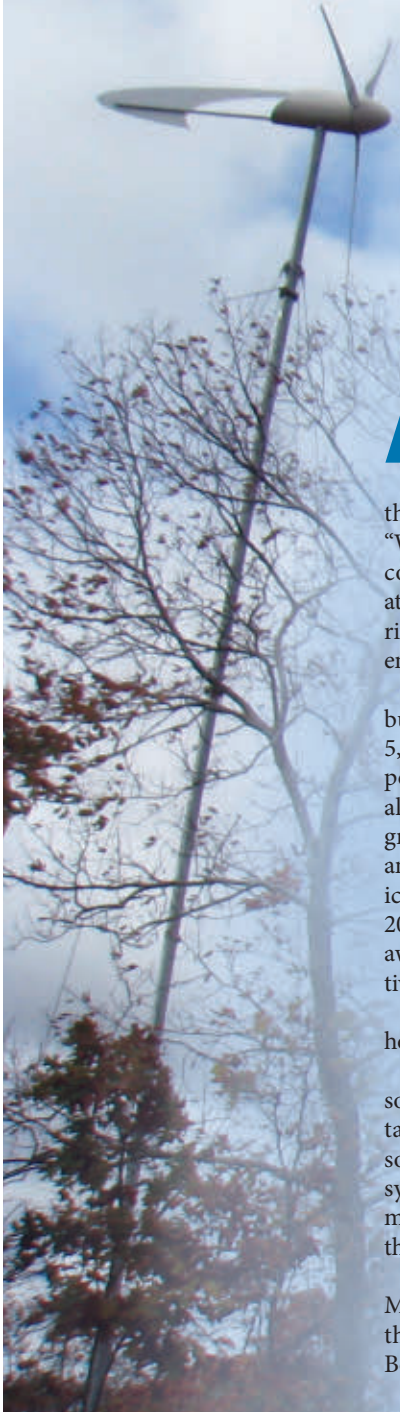
Cover Story By Lisa Murton Beets

The Power of Two

Wind turbine powers this home's geothermal system to yield net-zero energy use.



Alex Boyle speaks passionately about what he thinks should be a national imperative: to shift to renewable energy sources.

"We need to move beyond the barriers that are impeding our progress," he says. "We have to get serious about this. We can continue to burn fossil fuels, pollute the atmosphere and threaten our national security, or we can use the wind and geothermal energy right within our reach."

Alex and his wife Betty had a home built on Martha's Vineyard last year. The 5,000-sq.ft. timber frame net-zero house is powered by a 10kW wind turbine. Annually, the output of the wind turbine will be greater than the power used by the house and its geothermal system. Nelson Mechanical Design, Vineyard Haven, Mass., won a 2009 Green Mechanical Contractor (GMC) award for the project in the "Most Innovative" category.

The Boyles didn't set out to build a net-zero house, but that's how the project evolved.

"Nelson Mechanical Design installed a solar hot water system at our daughter's restaurant in Edgartown," Alex says. "I was so impressed with the performance of the system as well as the quality of the workmanship that I knew I wanted Nelson to do the mechanical work on our house."

Brian Nelson, co-owner of Nelson Mechanical Design, recommended a geothermal heat pump for the project. "The Boyles did not want to see outside condensing units, wanted an all-electric mechanical system and wanted high efficiency with low maintenance. A geothermal heat pump was the solution."

Nelson's extensive experience with the technology and his ability to inspire confidence helped the Boyles make their decision.

"Brian explained how geothermal works and gave us an elaborate presentation," Alex says. "My wife and I both were attracted to the concept of using stored energy in the ground. Based on Brian's presentation, the environmental aspects and the 7- to 10-year payback, we agreed to move forward."

Fortunately, the Boyles were in the early design stages when Nelson was brought in.

"For a GMC to fulfill their role as a green consultant, they need to be in the design process from the beginning," Nelson says. "The GMC can offer initial cost estimates for a wide range of HVAC approaches. Having this information in the beginning greatly increases the chance of success of the project and eliminates redesigning the project mid-stream."

Nelson says he's been brought into several projects mid-stream, to make them "greener."

"Invariably, money has been spent on the design of a conventional system that could have been spent on the design of a green system. This usually reduces the ultimate budget for a green mechanical system if total project cost is fixed," he comments. "And while the client is pleased to have a green design, they are usually upset that

they were not made aware of different 'green' mechanical options at the beginning of the project."

Once the Boyles were sold on the geothermal system, they began to explore the possibility of generating their own electricity to run it. Soon, Gary Harcourt, who had installed numerous other turbines on the Vineyard, was part of the design team.

"The payback of the wind turbine is effectively shortened by using the electricity on-site to heat and cool the home," Nelson says. "By replacing a fuel oil- or propane-powered system with a heat pump system using fixed price electricity from the wind turbine, the Boyles got the best of both worlds — insulation from fuel price inflation and reduced payback time."

NO EASY FEAT

From the beginning, Nelson knew the geothermal installation would be a challenge. The project site made a horizontal geothermal installation impossible.

"The solution was to install a six-ton vertical, direct exchange geothermal system inside the basement mechanical room using a compact drill rig," Nelson says. "Drilling conditions were extremely difficult; each of the six loops is only 100-ft. long."

As the team began drilling, they encountered 20 ft. of sand and 20-ft. boulders left over from the glacier that formed Martha's Vineyard, then more layers of sand, then more boulders.

"The pounding the drill rig endured was tremendous," Nelson says. "Fortunately, the direct exchange borehole diameter was only 4-in. instead of 6-in. or 8-in., as is common with closed-loop glycol systems."

Timber frame made the installation of ductwork difficult, so radiant space heating and three fan coils for heating, cooling and dehumidification were installed in various zones throughout the house.

"Plastic water heaters were chosen to greatly reduce long-term maintenance as the water quality was fairly aggressive," Nelson says. "The 2-in. foam insulation will also reduce standby loss, which allowed for more efficient loading of the geothermal heat pump."

SOPHISTICATED CONTROLS

When Nelson and his business partner, Dave Sprague, started Nelson Mechanical Design in 2005, they quickly realized that to position themselves as the Vineyard's "green mechanical contractor" they would have to learn how to design sophisticated direct digital control (DDC) systems.

"An integrated DDC system is really the only way to make it all work well," Nelson says. "Added benefits are the ability to trend energy use to back-up our initial projections, and the ability to get maintenance and alarm emails and text messages before the client realizes anything is amiss. We can offer our clients Web access from any computer, so they can manage their setpoints and energy use from afar. These control systems really help engage the client in watching their system in operation and help ensure they get the energy savings we projected."

The DDC system in the Boyle home works by evaluating the outside temperature, the dominant mode of operation (heating or cooling), the current chilled water and hot water buffer tank temperatures, and the current setpoint (based on heating and cooling reset temperature schemes) to determine how best to use the output of the heat pump.

"During the shoulder seasons where cooling and heating may be required, the DDC controls heat pump output to cool the chilled water buffer tank and heat the hot water buffer