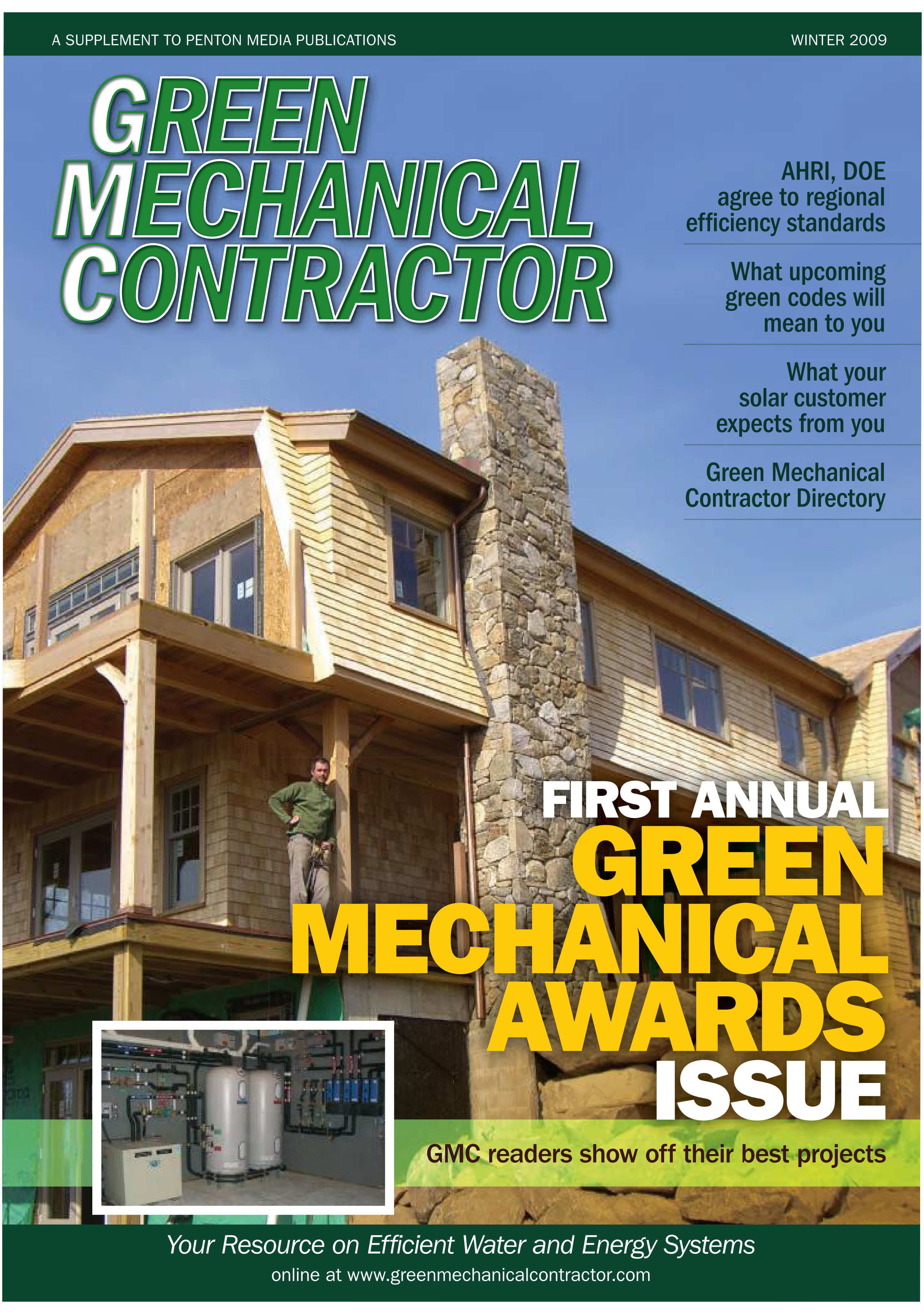

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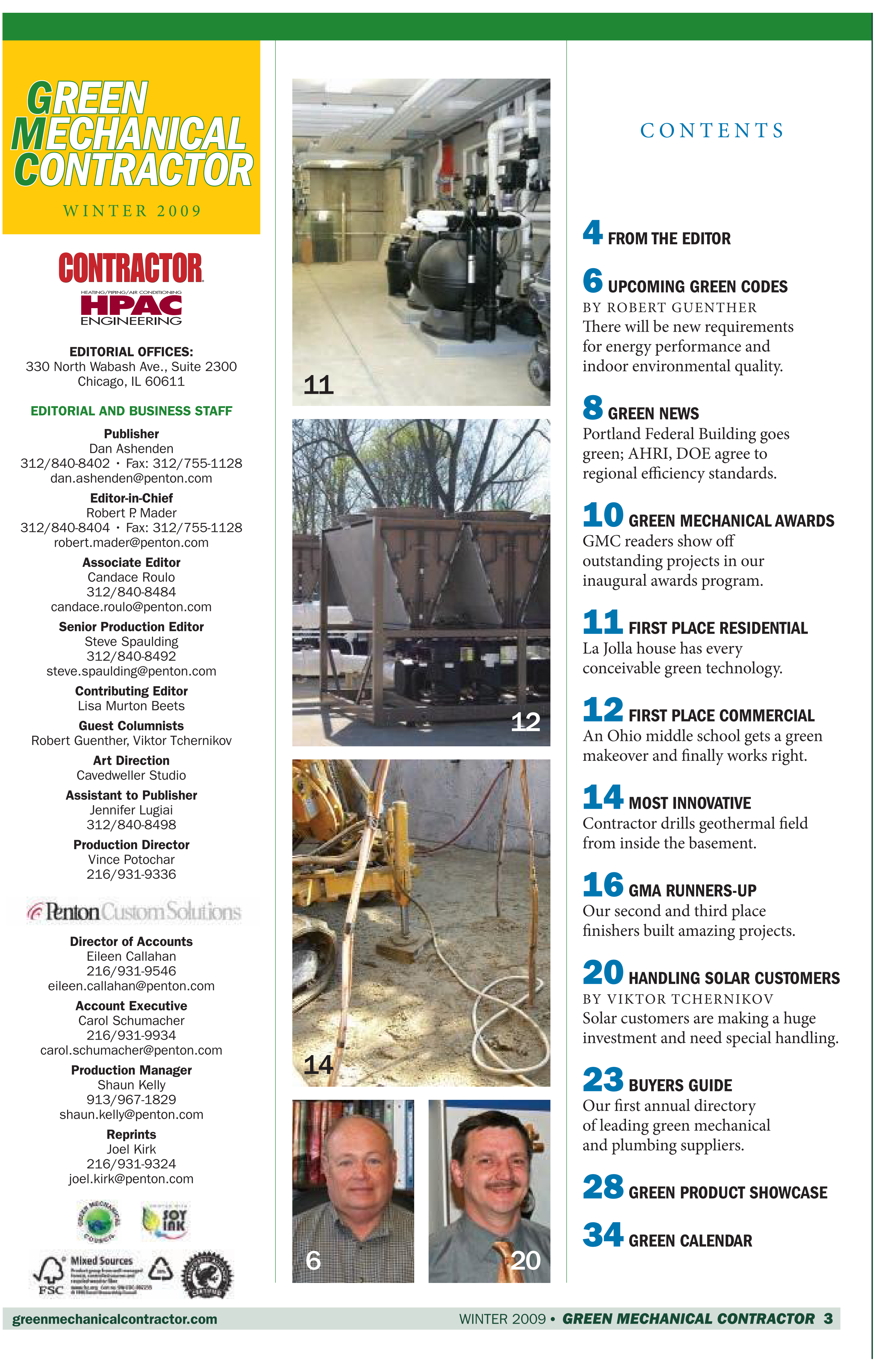

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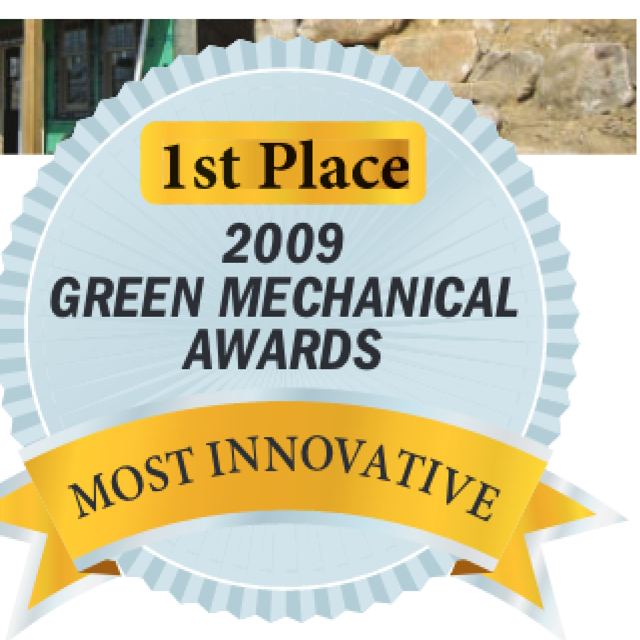

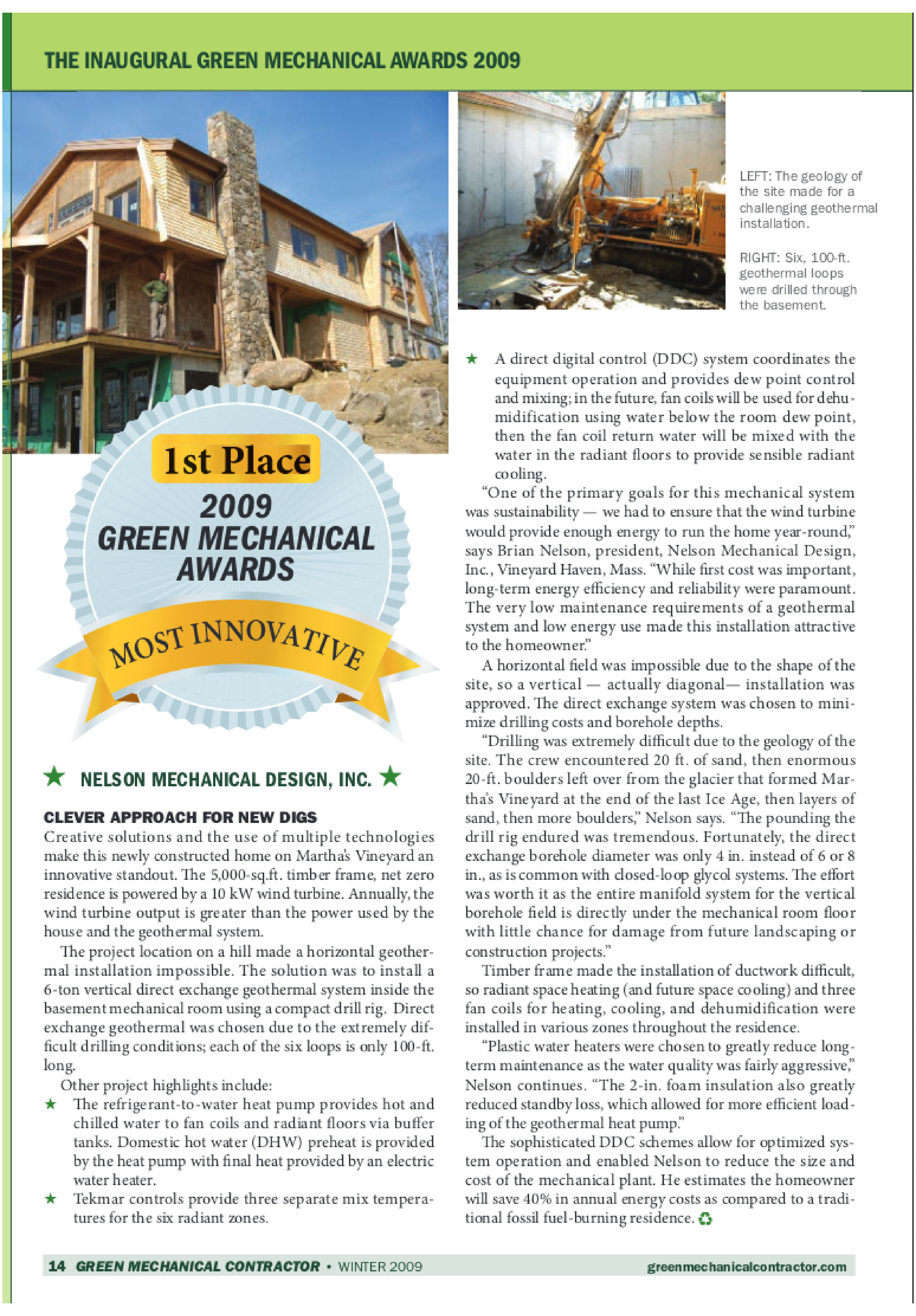

LEFT: The geology of the site made for a challenging geothermal installation.

RIGHT: Six, 100-ft. geothermal loops were drilled through the basement.

★ NELSON MECHANICAL DESIGN, INC. ★

CLEVER APPROACH FOR NEW DIGS

Creative solutions and the use of multiple technologies make this newly constructed home on Martha's Vineyard an innovative standout. The 5,000-sq.ft. timber frame, net zero residence is powered by a 10 kW wind turbine. Annually, the wind turbine output is greater than the power used by the house and the geothermal system.

The project location on a hill made a horizontal geothermal installation impossible. The solution was to install a 6-ton vertical direct exchange geothermal system inside the basement mechanical room using a compact drill rig. Direct exchange geothermal was chosen due to the extremely difficult drilling conditions; each of the six loops is only 100-ft. long.

Other project highlights include:

- The refrigerant-to-water heat pump provides hot and chilled water to fan coils and radiant floors via buffer tanks. Domestic hot water (DHW) preheat is provided by the heat pump with final heat provided by an electric water heater.
- Tekmar controls provide three separate mix temperatures for the six radiant zones.
- A direct digital control (DDC) system coordinates the equipment operation and provides dew point control and mixing; in the future, fan coils will be used for dehumidification using water below the room dew point, then the fan coil return water will be mixed with the water in the radiant floors to provide sensible radiant cooling.

"One of the primary goals for this mechanical system was sustainability — we had to ensure that the wind turbine would provide enough energy to run the home year-round," says Brian Nelson, president, Nelson Mechanical Design, Inc., Vineyard Haven, Mass. "While first cost was important, long-term energy efficiency and reliability were paramount. The very low maintenance requirements of a geothermal system and low energy use made this installation attractive to the homeowner."

A horizontal field was impossible due to the shape of the site, so a vertical — actually diagonal— installation was approved. The direct exchange system was chosen to minimize drilling costs and borehole depths.

"Drilling was extremely difficult due to the geology of the site. The crew encountered 20 ft. of sand, then enormous 20-ft. boulders left over from the glacier that formed Martha's Vineyard at the end of the last Ice Age, then layers of sand, then more boulders," Nelson says. "The pounding the drill rig endured was tremendous. Fortunately, the direct exchange borehole diameter was only 4 in. instead of 6 or 8 in., as is common with closed-loop glycol systems. The effort was worth it as the entire manifold system for the vertical borehole field is directly under the mechanical room floor with little chance for damage from future landscaping or construction projects."

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

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

The sophisticated DDC schemes allow for optimized system operation and enabled Nelson to reduce the size and cost of the mechanical plant. He estimates the homeowner will save 40% in annual energy costs as compared to a traditional fossil fuel-burning residence. ♻