

RADIANT LIVING

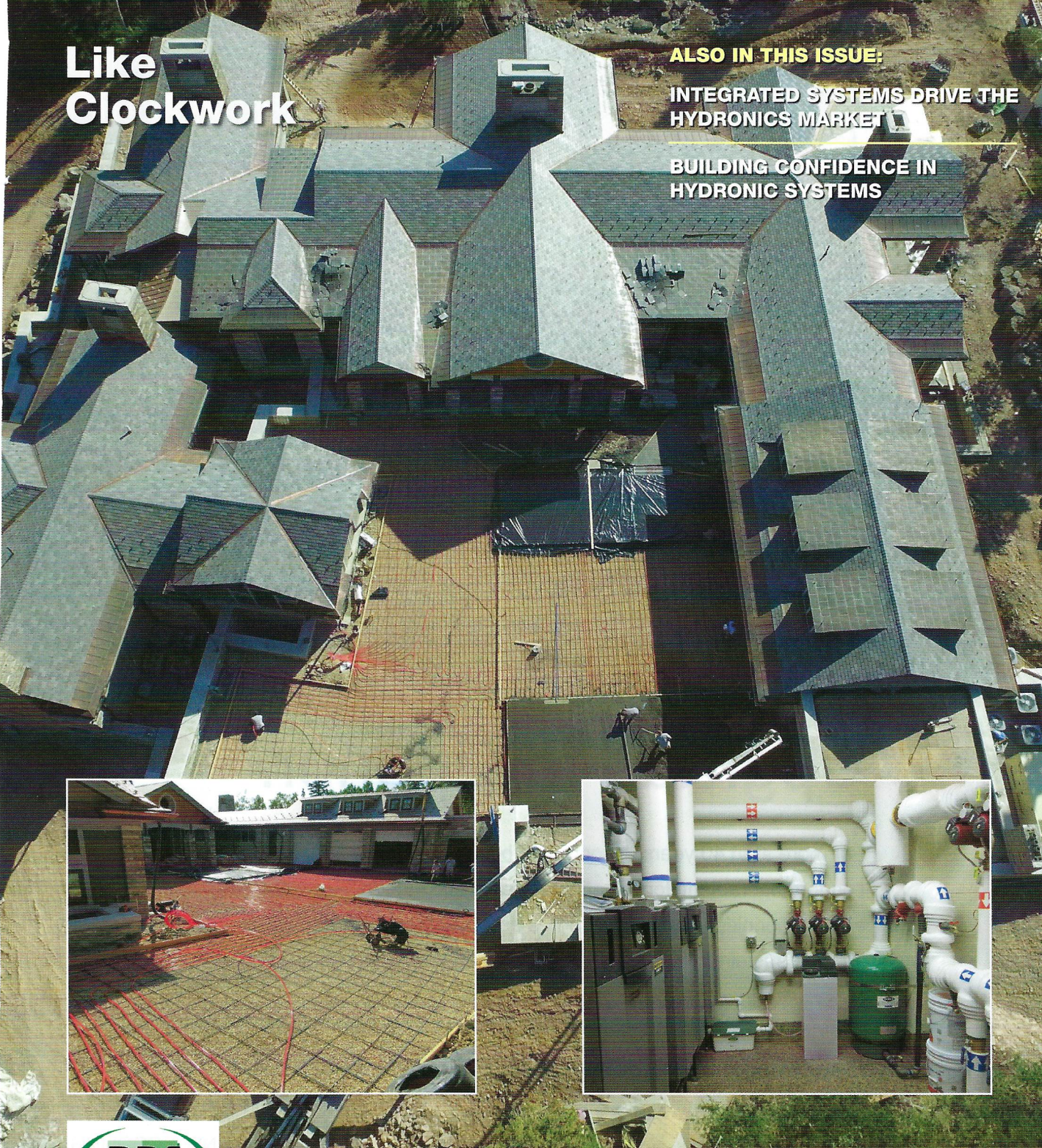
HEATING & COOLING SOLUTIONS THROUGH RADIANT TECHNOLOGY

**Like
Clockwork**

ALSO IN THIS ISSUE:

**INTEGRATED SYSTEMS DRIVE THE
HYDRONICS MARKET**

**BUILDING CONFIDENCE IN
HYDRONIC SYSTEMS**



THE OFFICIAL PUBLICATION OF THE RADIANT
PROFESSIONALS ALLIANCE

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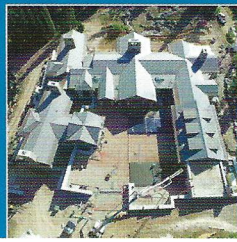
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Radiant Living is a supplement to CONTRACTOR and Contracting Business.com magazines published by Penton®. It features material from the Radiant Professionals Alliance, a nonprofit organization dedicated to communication and cooperation among those interested in the advancement of the radiant panel heating and cooling industry in North America. Its membership consists of manufacturers, distributors, contractors and other professionals. For more information, call the RPA at (877) 427-6601, or visit www.radiantpros.org.



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We must embrace alternatives

BY ROBERT P. MADER
EDITORIAL DIRECTOR

We're going to have to change our thinking in order to survive. I'm sure many in the radiant business look back fondly on the arrival of the European modulating condensing boilers that shook up the industry. Those were the salad days of the Radiant Professionals Alliance when an RPA convention drew several hundred people. I remember watching *This Old House* in those days, and you could spot the Viessmann boilers in the background behind Rich Trethewey. We were going to take over the world.

How that world has changed. We have an interview in this issue of *Radiant Living* with industry veteran Al Wallace, president of Energy Environmental Corp. (EEC), and up-and-coming industry veteran Maya Kadi, EEC systems engineering manager, for their views on the hydronics industry, in general, including code development, professional certification and industry knowledge.

"Over the past decade, the hydronics market has undergone a transformation from late mainstream with boiler heating to early adoption with heat pump-centric radiant heating and cooling equipment," Wallace says in this issue. "One-third of net zero commercial buildings will use ground-source heat pumps (GHP) or hydronic heating and cooling. In the future, integrated solutions will incorporate cloud-based controls."

I need to call out something Wallace said: one-third of net zero building will use ground-source heat pumps.

"Heat pump manufacturers are delivering product capabilities required for radiant heating and cooling, snowmelt, and domestic hot water," Wallace continues. "These water-to-water geothermal and air-to-water air-source heat pump (ASHP) enhancements are exciting. In temperate climates, ASHPs will continue to expand their operating limits for increased efficiency. For example, with high temperature delivery, WaterFurnace vapor injection units can be used for snowmelt applications. The company's variable speed GHPs enable the precise humidity

control required for radiant floor cooling. In Europe, dual-use heat pumps deliver radiant heating and domestic hot water."

There are many in this business who are, quite bluntly, freaked out by the rise of variable refrigerant flow (VRF) technology from Asia — and with good reason. VRF threatens the entire conventional order of things. Chillers, boilers, pipes and pumps, and cooling towers. We've spent a century or more conditioning spaces with water. We will continue to do that, but we must recognize that alternatives sometimes do the job better.

It's more than heat pumps. You must consider any heat source that's available, whether it's electric radiant or waste heat recovery or a desuperheater on a commercial refrigeration system.

"One innovation is using fluids from a closed-loop geothermal system to provide cooling to a structure at a coefficient of performance (COP) of 50," says Maya Kadi. "In another application, reversing the flow in driveway snowmelt piping in the summer acts as a virtual ground loop to double the COP of a GHP to heat a pool. These integrated hydronic systems are achieving efficiencies 10 times higher than forced air systems."

We have a feature in the September issue of *CONTRACTOR* magazine on the water-energy nexus, written by one of the smartest engineers I know, H.W. "Bill" Hoffman P.E., Austin, Texas. Bill notes that VRF technology is preferable in many applications because of the amount of water used by cooling towers.

Some of the efficiency ratings on this equipment are mind boggling, although I can think of one air-to-water heat pump that's so expensive that both you and your client have to be drinking the Kool-Aid to buy it.

We ignore it, however, at our peril. If we want to continue to be viable as an industry, we have to remember the old adage that we're in the business of making our customers comfortable, not just in the boiler business or hydronic heating business.

Q&A INTEGRATED SYSTEMS DRIVE THE HYDRONICS MARKET

Hydronics experts Al Wallace and Maya Kadi share their observations on the technology and initiatives fueling the growth of the hydronics market.

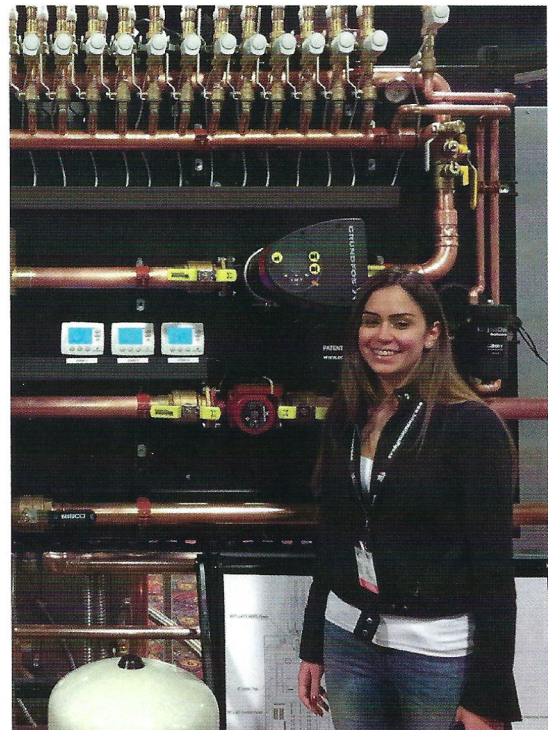
The Radiant Professionals Alliance (RPA) is an international trade association comprised of individuals and companies dedicated to increasing the use of radiant heating and cooling technologies through technical expertise for code development, professional certification and industry advocacy.

Radiant Living magazine reached out to industry veteran Al Wallace, president of Energy Environmental Corporation (EEC), and up-and-coming industry veteran Maya Kadi, EEC systems engineering manager, for their views on the hydronics industry in general, including code development, professional certification and industry knowledge. They candidly express their opinions in the Q&A article below.

***Radiant Living:* How would you characterize the market for hydronic heating and cooling systems?**

Wallace: The U.S. Department of Energy estimates that building heating and cooling account for 40% of the total energy use in the U.S., and 48% of the energy use in a typical home. Moving fluids versus blowing air creates a 47% energy savings, with increased comfort, making a compelling case for incorporating hydronic systems in commercial and residential buildings.

Kadi: The United States is unique in its use of forced air in low-mass buildings. European buildings use hydronic heating. In the Middle East, forced-air cooling saves energy in high-mass buildings. The most advanced systems for comfort and efficiency utilize radiant floor cooling in high mass structures. As the RPA and hydronic manufacturers demonstrate these benefits, the rate of adoption will accelerate.



Maya Kadi, Energy Environmental Corporation systems engineering manager and ASSE 19210 radiant instructor, pauses in front of radiant floor cooling injection panel she designed for a home in Aspen, Colorado.

***Radiant Living:* What is the future direction of this industry?**

Wallace: Over the past decade, the hydronics market has undergone a transformation from late mainstream with boiler heating to early adoption

with heat pump-centric radiant heating and cooling equipment. One-third of net zero commercial buildings will use ground source heat pumps (GHP) or hydronic heating and cooling. In the future, integrated solutions will incorporate cloud-based controls.

Heat pump manufacturers are delivering product capabilities required for radiant heating and cooling, snowmelt, and domestic hot water. These water-to-water geothermal and air-to-water air source heat pump (ASHP) enhancements are exciting. In temperate climates, ASHPs will continue to expand their operating limits for increased efficiency. For example, with high-temperature delivery, WaterFurnace vapor injection units can be used for snowmelt applications. The company's variable speed GHPs enable the precise humidity control required for radiant floor cooling. In Europe, dual-use heat pumps deliver radiant heating and domestic hot water.

Kadi: Future designers will be rewarded for simplifying complex methods and developing new architectures where systems can work together to improve performance. One innovation is using fluids from a closed-loop geothermal system to provide cooling to a structure at a

coefficient of performance (COP) of 50. In another application, reversing the flow in driveway snowmelt piping in the summer acts as a virtual ground loop to double the COP of a GHP to heat a pool. These integrated hydronic systems are achieving efficiencies 10 times higher than forced air systems.

Radiant Living: Why is the market for heat pumps integrated with hydronic systems so promising?

Wallace: Using our company as an example, the business case for integrated mechanical systems is compelling. Our customers are pleased, and our employees enjoy what they do. Residential customers love the comfort and appreciate working with one contractor for all their mechanical systems. Our commercial clients praise the low maintenance, reliability, and energy efficiency.

Though integration is more complex, using a proven process model reduces cost and risk. We have invested heavily in a technology demonstration home, employee training, and internal engineering services. The payback is showcase-quality solutions built in our shop and installed

on-site, reducing our cost of goods. While reducing the number of projects by 70%, we doubled annual sales over the past three years. Our average project size has tripled, and the diversification buffers economic fluctuations.

Kadi: Working with people is the most satisfying part of my job. For me, the most promising trait of the hydronics industry is the willingness of people to work together to deliver value to our collective clients. I feel indebted to the trainers at Uponor, WaterFurnace, the RPA, and the International Ground Source Heat Pump Association (IGSHPA) for the knowledge they have given me. Sometimes in our business, we forget that what we do makes a positive impact on people's lives and our environment.

Radiant Living: In your experience, what are the challenges in implementing integrated hydronic systems?

Wallace: EEC specializes in integrated hydronic systems involving radiant floor heating and cooling, GHPs, snowmelt, pool heating, and solar thermal. Our company and capabilities have evolved with substantial challenges. The context for my response is as company president and as an expert witness in the courtroom.

Ten years ago, we built a research and development home in Colorado, where mistakes did not create liability. From this project, we developed a process model, controls, and a patent application leveraging work with the National Renewable Energy Laboratory in Golden, Colorado. The resulting systems created profit only when balanced with accountability through rigorous design and delivery. Industry professionals who fail to comply with these precepts risk substantial liability, particularly as related to radiant floor cooling. Sadly, many firms have been the object of lawsuits.

For example, a national engineering firm provided the design for a fixed price bid by a mechanical contractor for a 1,000-unit commercial radiant floor cooling project. The engineers underestimated both the



This 1.5 million BTU/hr hybrid vapor injection heat pump and boiler system for an Aspen home delivers superior comfort using hydronic heating or cooling, DHW, snowmelt, and pool heating at four times the efficiency of a conventional system. (IGSHPA Conference)

cooling loads and the cooling capacity of the radiant floor, and made the incorrect assumption that cooling loads were constant throughout the building. After commissioning, the cooling was inadequate, requiring the mechanical contractor to retrofit overhead fan coils at a cost of several million dollars.

Hydronic contractors tend to outsource load calculations and radiant design to manufacturers or distributors. These calculations may not comply with the Air Conditioning Contractors of America (ACCA) Manual J calculations required by building codes, and these entities do not guarantee radiant cooling system performance or provide a control sequence of operation (CSO).

The International Association of Plumbing and Mechanical Officials (IAPMO) coordinates the development and adaptation of plumbing, mechanical, swimming pool, and solar energy codes. The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) focuses on building systems, energy efficiency, indoor air quality, refrigeration, and sustainability.

The congruence of radiant cooling with geothermal requires a knowledge of building science and codes from both organizations. For example, a radiant-cooled slab cannot remove latent heat (moisture in the air), so a forced air system is always required for supplemental cooling and dehumidification. Building codes do not address a method to calculate integrated cooling loads or provide a CSO to make the system work properly.

In one project with which I'm familiar, a mechanical contractor assumed that the in-floor cooling system installed by a hydronic contractor eliminated the need for ductwork in a large custom home in Colorado. He installed a few supply registers to provide supplemental cooling. The home was uncomfortable due to solar heat gain and the lack of ventilation air flow. While the general contractor initially blamed the radiant contractor for the lack of cooling, the mechanical contractor had failed to



Energy Environmental Corporation's net zero technology demonstration home in Centennial, Colorado, has used advanced controls with radiant heating and cooling with geothermal heat pumps for 10 years. This project permits beta testing systems and controls with minimal risk to the company.

comply with building code requirements to perform ACCA Manual D duct design calculations for supplemental cooling, and meet ASHRAE 62.2 requirements for ventilation in all rooms.

Unfortunately, some contractors are unaware that general liability insurance excludes the contractors' "work product," so the remediation required in the previous examples would not be covered. I recommend hydronic contractors procure professional liability insurance (errors and omissions), which provides indemnity for faulty design, and product liability insurance, which provides insurance coverage if custom controls are used.

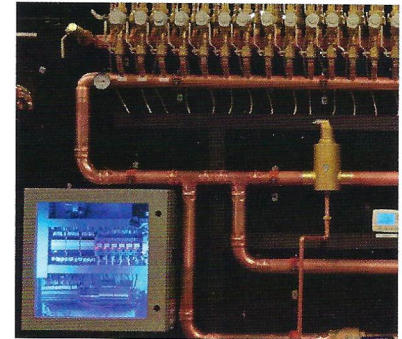
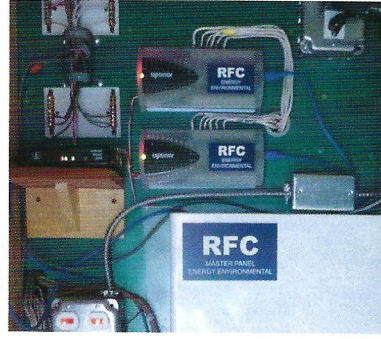
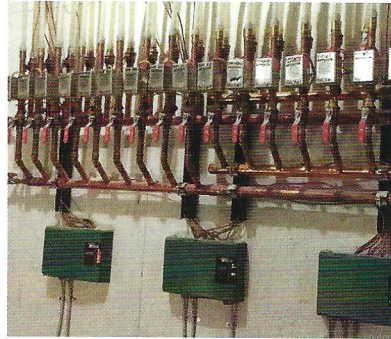
Kadi: Training is lagging the rate of adoption for integrated hydronic systems, creating a challenge finding skilled workers. Radiant design courses from manufacturers and trade organizations are light on cooling details and do not address CSO.

This past year, I was certified as an ASSE 19210 Hydronics Installer Instructor, and attended advanced

hydronics training with Uponor. Last year, I was technician-certified by WaterFurnace, and recently attended the Certified GeoExchange Designer (CGD) course with IGSHPA. While these courses represent the highest level of instruction for their respective technologies, they did not provide me with the knowledge required to design a GHP-based radiant floor cooling system. We now focus on hiring brilliant individuals and training them in-house. I look forward to working with the RPA to include these lessons in future curricula.

Radiant Living: What are some of the most common mistakes made on hydronic systems?

Kadi: The most common mistakes are uncomplicated. When I inspect an underperforming hydronic system, the problems relate to improper design or installation. Contractors often use rules of thumb instead of doing the math. Experienced hydronic contractors will recognize as obvious the mistakes I highlight here:



For larger homes, hydronic controls are evolving from heating-only systems with multiple six-zone valve controllers, to Windows® or BACnet DDC, to licensing turnkey heating and cooling and heat pump controls integrated on one panel, such as Simply Radiant® shown in cooling mode.

Manifolds are undersized for flow rates. PEX tubing spacing is too wide. Air separators and expansion tanks are missing, undersized, or in the wrong sequence related to the circulator. Circulators are undersized/oversized. Pipe size and distances are non-compliant for flow rate or fixtures. Purge and fill ports are missing. Piping is not labeled. Glycol systems use automatic potable water refill. There are improper or missing backflow or pressure reducers. Fast-acting zone valve actuators are installed. Heat exchangers are not counter-flow. Reverse-return is missing. PEX B crimp rings and connectors are used with PEX A tubing. Circulators with check valves are installed at high points in the system. Contractors install cold water supply for radiant cooling without dew point control. Improper CSO. Undersized heating and cooling tanks. Using a boiler in-line with a heat pump. We eliminate most of these issues by installing modular panels based on proven designs to achieve required functionality.

Wallace: What she said.

Radiant Living: What can contractors and installers learn from these examples?

Kadi: Read John Siegenthaler's book, *Modern Hydronic Heating for Residential and Light Commercial Buildings*. After I attended the Train the Trainer for ASSE 19210 Certification Course hosted by the RPA, I read his book. While I had professional training in mechanical engineering,

this book presents best practices and continues to be a valuable reference for hydronic heating systems design. With the exception of radiant cooling systems, most of the failures noted earlier would be avoided if the contractor had followed the guidance within this book.

Wallace: Comply with the code. As a member of the IAPMO 2015 Uniform Solar Energy and Hydronics Code (USEHC) technical committee, I was impressed with the committee members' knowledge of best practices for geothermal, hydronics, and solar systems. This is the first code set to develop standards specific to hydronic and geothermal systems. Even if not adopted in local jurisdictions, contractors should follow these rules when designing and building systems.

Radiant Living: Any other advice for contractors out there?

Kadi: The best designs emanate from collaboration among designers, installers, manufacturers, and technical experts. What seems intuitive with heating may be a major failure in cooling. Good design requires rigor. Technicians cannot be expected to build quality systems without detailed shop drawings. Modular components and controls simplify design. If you can buy it, don't build it.

Wallace: EEC has developed design methods and patented a process architecture and controls for integrated systems (patent www.energy-homes.org). We offer our products

and services to help designers and contractors succeed in delivering this technology. We have moved toward assemblies that simplify installation and maintenance, reduce risk, and improve profitability. Examples of the components found in our systems include: WaterFurnace® heat pumps; Grundfos® Magna3 circulators; Uponor® PEX and fittings; Spirovent® air separators; Webstone® components; Honeywell® dew point relays; Lochinvar® boilers; and Danfoss® actuators and valves.

Al Wallace is president of Energy Environmental Corporation (EEC). He is an ASHRAE member, RPA member, Certified Geo-Exchange Designer, Certified Energy Manager, and IGSHPA-certified trainer. He earned a B.S. in aeronautical engineering from the USAF Academy, an MBA, and master's degrees in architecture and landscape architecture from the University of Colorado.

Maya Kadi is Systems Engineering Manager for EEC. She is an ASME member and ASSE 19210 instructor. Maya is a Canadian citizen fluent in English, French and Arabic. She has degrees in mechanical engineering from Notre Dame University Lebanon and baccalaureates general sciences, Soeurs des Saints Coeurs- Byblos, Lebanon.