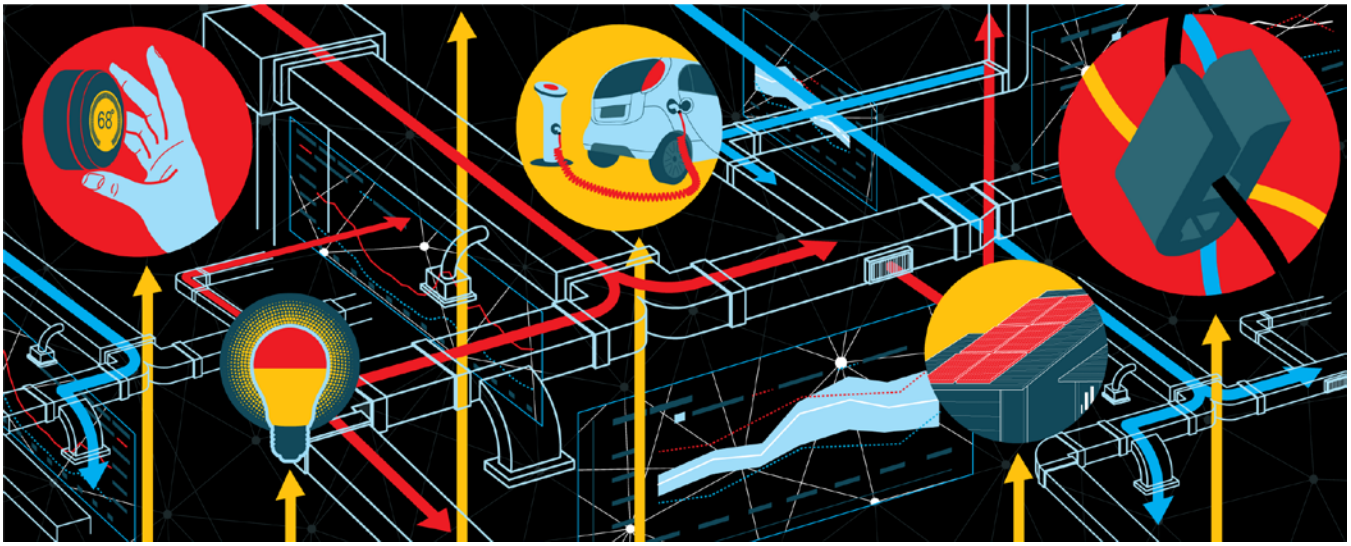
# *First Person*—Buildings with Brains, Billions in Savings



## The Story in Brief

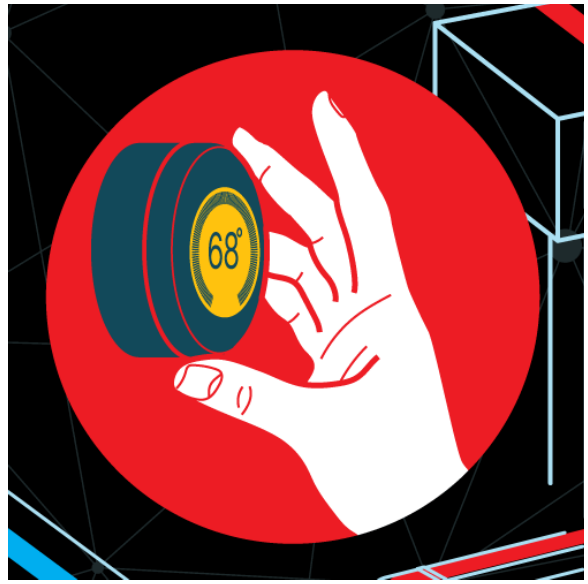
Building energy management company Verdigris has been supported by members of the EPRI-led Incubatenergy Network, which connects clean energy entrepreneurs worldwide with incubators, accelerators, investors, and electric utilities in search of novel technologies for the future grid. *EPRI Journal* spoke with Verdigris CEO Mark Chung about how building energy management systems work, the state of the technology, and the huge potential implications for electricity consumption, greenhouse gas emissions, and grid integration.

### EJ: What is a building energy management system?

**Chung:** A building energy management system helps to optimize energy use in a building. By optimize, I mean identify specifically where energy is being consumed, make adjustments, and achieve an efficiency target. Based on our experience working with clients, a conservative estimate is that commercial and industrial buildings waste 30% of their energy. For instance, even when a building is unoccupied, it may be actively cooling or have lights on. You can improve efficiency by tightening a building's cooling schedule or adjusting when lights are on and off.

Mark Chung

A building energy management system consists of two basic components. One is hardware, which includes sensors that measure electricity and produce data. The second component is software that collects the data and produces a visual display of the information to help the building manager better understand and optimize how and where energy is being used.




### EJ: Is the system automatically making changes in energy consumption, or is it giving information to the building manager who uses it to make changes?

**Chung:** It's a combination of both. The level of automation varies across different energy management technologies, buildings, and customer needs. Automation is possible when the energy management systems are integrated with building controls, which can manage the operation of HVAC systems, refrigeration, lighting, and other equipment.

### EJ: There are many companies offering building energy management systems. Is there a unifying principle among all these technologies? In what ways do they differ?

**Chung**: The unifying principle for all these systems is a feedback loop in which data is used to understand performance and then make adjustments. It's like adjusting the speed of your car based on the speedometer reading. The main differences among these technologies lie in the data collected and the proprietary methods to analyze the data.

Most systems have a combination of hardware and software, but there's more industry focus on software-based solutions, as companies view software as the way to provide the most value.

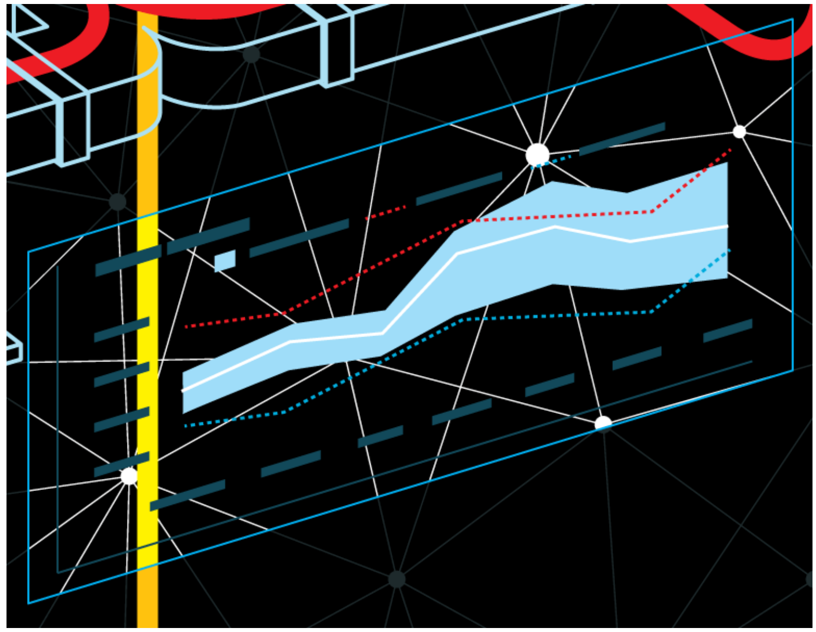
### EJ: How does Verdigris' building energy management technology work?

**Chung**: Our hardware comprises digital sensors and a data transmitter on a 4G wireless network. The sensors clamp onto electrical circuits at various building locations, and the data transmitter organizes and sends the sensor data to the cloud. No other hardware and no rewiring of circuits in the electrical panel are required.

Our software uses artificial intelligence to sort through, characterize, and manipulate the sensor data. The data reveals electrical waveforms, and our machine learning algorithms are able to recognize patterns and infer loads for each monitored circuit.

> "In five years, a smart building will be much more human-like. It will be self-aware in that it will know when people are in it, what to set its temperature at, when to reduce consumption from the grid based on price signals, and when to take energy from solar panels rather than from a battery. It will be able to share intelligence with nearby buildings so that they can work in concert to manage energy resources."

Large companies that do their own analysis can import Verdigris sensor data into their tool of choice. For customers with less sophisticated analytics capabilities, the Verdigris system can analyze the data and generate reports that can be used to benchmark performance, measure and verify energy savings, identify inefficiencies, and recommend actions. These reports are tailored to customer needs by industry and application. Some



reports are itemized bills that rank the most expensive equipment—what's consuming the most electricity and when that consumption is happening—while other reports identify machine failures or when equipment is acting irregularly. For example, you could have a motor or a pump that's rapidly turning on and off. This cycling, which can cause premature wear, usually isn't revealed through aggregate energy figures but will appear in a time-series graph.

We have another product that's not widely available yet that feeds insights back into the energy management system, which in turn automatically controls the operation of equipment, whether it be chiller cycle times or settings for exhaust fans and lighting. This system can be used to shave peak demand loads.

### EJ: Could you share a recent anecdote about how your company's technology resulted in huge energy savings for a customer?

Chung: The global manufacturing company Jabil has deployed Verdigris systems in 9 sites with approximately 8 million square feet. The systems have helped Jabil to determine causes of peak demand events and machinery load surges, enabling improvements in scheduling and operations. They helped to identify inefficiencies such as equipment cycling and inappropriate heating, cooling, and lighting changes. By providing a deeper understanding of load distribution, they also helped to size new equipment accurately.

### EJ: To what extent are building energy management systems already deployed in commercial and industrial buildings?

**Chung**: We're very early in the adoption of building energy management. Only about 20 to 25 percent of buildings are actively managing their energy use in some way. This figure includes customers that are simply evaluating their utility bills and making changes based on that. According to a 2012 survey by the U.S. Energy Information Administration, approximately 10% of commercial buildings use building automation or control systems. Typically, these are buildings larger than 100,000 square feet.

> "Improving the energy efficiency of commercial and industrial buildings by 10 percent could save $40 billion annually and result in a reduction in greenhouse gas emissions roughly equivalent to eliminating 1 out of every 5 registered highway vehicles."

### EJ: What are the implications for broad deployment of building energy management systems with respect to electricity consumption?

**Chung**: The implications are enormous. Energy use in commercial and industrial buildings in the United States costs an estimated $400 billion annually, and approximately 30% of energy in buildings is used inefficiently or unnecessarily. Improving the energy efficiency of commercial and industrial buildings by 10 percent could save $40 billion annually and result in a reduction in greenhouse gas emissions roughly equivalent to eliminating 1 out of every 5 registered highway vehicles. [Source: ENERGY STAR]

### EJ: How can communication between buildings and grid operators be enhanced?

**Chung**: Communication between existing building energy management systems and utilities is virtually nonexistent today. There are steps that both utilities and energy management companies can take to address this. Utilities should avoid investing in proprietary advanced metering infrastructure, which results in devices that are not interoperable. Companies like Cisco and Juniper have already built widespread, secure communications networks. The Green Button initiative to make utility data more interchangeable is a step in the right direction but is too slow. The larger energy management companies could set up consortia for open industry standards, which can help accelerate adoption of these technologies among building managers and grid operators.

### EPRI Research on Efficient End-User Technologies

EPRI's End-Use Energy Efficiency and Demand Response program tests and demonstrates emerging energy-efficient, demand-responsive customer technologies—including building energy management systems—to accelerate adoption into utility programs for the benefit of the public. Researchers are characterizing their grid impacts and providing information to advance the progress of codes and standards. To advance grid connectivity, EPRI is demonstrating a new interface that enables customer appliances to connect to any communication network and receive and execute commands using a common language.

### EJ: What building energy management innovations do you see emerging in the next five years? What will a smart building be like?

**Chung**: In recent years, the biggest energy management innovations have been in data analytics. I think the next phase of innovation is going to be in artificial intelligence. Machine learning and control loops are going to drive significant reduction in building energy consumption. In five years, a smart building will be much more human-like. It will be self-aware in that it will know when people are in it, what to set its temperature at, when to reduce consumption from the grid based on price signals, and when to take energy from solar panels rather than from a battery. It will be able to share intelligence with nearby buildings so that they can work in concert to manage energy resources. A building will be able to compare its performance with that of other buildings and determine what it can do better. A city of 'intelligent buildings' could share best practices and learn from each other to help optimize the grid.

### EJ: As buildings get more effective at sensing and controlling energy use, what potential benefits could they provide to grid operations?

**Chung**: Utilities typically provide a lot more grid capacity than is used because of demand and the lack of grid-scale energy storage. Smart buildings can serve as controllable grid resources that could dramatically reduce peak loads and the amount of grid infrastructure needed.

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### EJ: What is the potential for integrating building energy management systems with battery storage?

**Chung**: The biggest driver of integrating energy management systems with battery storage is the need for demand management and resource planning. Verdigris' system generates 15-minute, 2-hour, and 4-hour demand forecasts. If a building stores enough energy in batteries to handle peak demand, the energy management system can shape the building's load profile to save energy costs and help pay for the integrated battery/Verdigris system.

### EJ: How about building integration with electric vehicle charging?

**Chung**: Fortunately, most electric vehicle infrastructure is enabled with Internet Protocol communications, so there's potential for interoperability with building energy management systems. That integration hasn't happened yet, but is likely to be adopted soon. Energy management systems can take advantage of the variable charging load to do more intelligent things. For example, a bank of electric vehicles can serve as battery storage for the building, with the energy management system optimizing when vehicles charge and discharge. You could potentially charge a car for free and borrow that charge back at the right times.

### EJ: How do electric utilities need to consider potentially significant changes in building energy consumption as they update their grid models and conduct long-term grid planning?

**Chung**: I don't think this is going to happen at utilities in a bubble. If building energy data were made accessible in an open, modern framework while protecting the privacy of individual businesses, the energy management community can work on the problem with utilities.

### EJ: What R&D in the electric power sector is needed to more fully integrate buildings into grid operations?

**Chung**: We need more research on controlling building equipment. Besides HVAC equipment, how can we control other equipment like refrigerators and motors and create more interoperability among them? All the energy-consuming devices in a building need to speak a common language.

### By the Numbers: The Potential of Building Energy Management in the United States

- Number of commercial and industrial buildings: nearly 6 million
- Annual energy costs for commercial and industrial buildings: $400 billion
- Energy wasted in commercial and industrial buildings: 30%
- Savings as a result of improving building energy efficiency by 10%: $40 billion
- Percentage of greenhouse gas emissions generated by commercial and industrial buildings: 45%
- Greenhouse gas emissions reductions from improving building energy efficiency by 10%: roughly equivalent to eliminating 20% of registered highway vehicles
- Energy savings identified by Verdigris customers: up to 50%

Sources: U.S. Environmental Protection Agency, U.S. Energy Information Administration, Verdigris