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## Solving renewable energy challenges with the Internet of Things

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*Kelly Murphy, Business Development Specialist, Steffes Corporation*



Tilting at windmills is nothing new, but it's taken a different turn in discussions about renewable energy. While there is little argument about the need to reduce dependence on fossil fuel, the debate continues over how best to accomplish this. Wind and solar energy are two obvious choices, and countries such as Germany and the United States have been leading the way. Today, Germany produces approximately 30 percent of its electricity from renewable energy and has set a goal to reach 45 percent production by 2030. In the United States, Hawaii has an even bigger plan to achieve 100 percent renewable energy by 2045. However, the path to more sustainable energy hasn't been smooth. Built and expanded over decades, the world's power grids are designed to handle a consistent and predictable supply and demand. Too much generation can overwhelm the grid while insufficient generation leaves utility companies scrambling for backup solutions.

## Renewable energy challenges

Since the 1940s, Steffes Corporation has grown from a small North Dakota manufacturing company to a global designer of energy solutions with more than 300 employees. Specializing in electric thermal storage (ETS) technologies, the company has built a reputation for creating extremely energy-efficient heating products. Historically, most of the focus in the energy industry has been on reducing energy consumption when market prices or demand is high to reduce costs and balance utility load. Such solutions are designed to solve an energy deficit. However, what happens when energy sources spike suddenly and produce more than the grid can handle?

Rapid fluctuations in power load can cause a host of problems, potentially causing damage to the grid as well as affecting consumers downstream. Even if a fluctuation goes unnoticed in regular home use, a single millisecond of instability can damage computing systems or other sensitive equipment.

“Most people don’t know that the grid has to operate within a very small window to remain stable at about 60 hertz,” says Kelly Murphy, Business Development Specialist at Steffes. “So it’s fine-tuning all the time by throttling generators up or down. And as you add more unpredictable, variable energy generation to this system, you have volatility on one side from demand and on the other side from the addition of renewable energy. Until now, the impact of

renewable energy has been almost invisible to the system because we’re not working with it a lot yet. But certain areas, like Germany, Hawaii, and California, are using it more. And that’s where we’re discovering just how difficult it is to balance these three things: existing generation, new generation from renewables, and the unpredictable part of demand.”

To maintain consistent energy distribution, some utilities have had to bring fossil-fuel generators like coal power plants back online to compensate for slack production, or leave windmills sitting idle when the grid is full. To solve those challenges, Steffes wanted to create an affordable and efficient way to store and use excess energy.

## Grid stability on demand

Instead of looking for a solution within the grid itself, Steffes took a different approach. What if it could turn a device that typically consumes electricity into something that not only stores energy, but also can be interactively used to stabilize the grid and the entire energy distribution system? Better yet, what if that device could be found in ordinary households worldwide? Those questions led Steffes to electric water heaters, relatively inexpensive devices that account for between 20 percent and 40 percent of the residential demand or load on energy grids—and have electric resistors capable of quickly reacting and charging to deal with excess generation.

To create a regional, fast-response storage asset from a distributed network of water

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**Customer Name:** Steffes Corporation  
**Industry:** Manufacturing  
**Country or Region:** United States  
**Customer Website:** [steffes.com](http://steffes.com)  
**Partner Name:** Mesh Systems  
**Partner Website:** [mesh-systems.com](http://mesh-systems.com)

**Customer Profile:**  
Steffes Corporation is a leading provider of innovative energy management and heating solutions, and other manufacturing solutions for multiple industries. The company is a North Dakota manufacturing company and a global designer of energy solutions with more than 300 employees.

**Partner Profile:**  
Mesh Systems is an IoT software, services and solution provider that delivers turnkey systems that include hardware, software and networking frameworks for Smart products. Using the latest IoT services and components as the cornerstone, we help companies get new Smart products to market faster, with more scale and reliability, than ever imagined.



heaters, Steffes designed the Grid-Interactive Electric Thermal Storage (GETS) system with help from Microsoft partner, Mesh Systems, an early adopter of the Microsoft Azure platform, including the Azure IoT Suite and Azure Service Fabric.

“Steffes devices are orchestrated by an innovative concept called the “Power Tower” made possible the Azure IoT Suite,” explains TJ Butler, Chief Software Architect at Mesh Systems. “The Power Tower is a real-time mirror of every end-unit in the cloud and has sophisticated logic which helps blend, sync, and use greater volumes of renewable energy.”

By taking advantage of cloud technologies, Steffes can connect and control thousands of water heaters simultaneously to create a virtual storage asset for utilities. The devices store energy whenever it is produced—which might be at night for wind generation, or midday for solar—so that it is available on demand. “With Azure, we took this device that no one ever thinks about and turned it into a flexible tool for managing demand,” says Murphy. “As you get more renewable energy, you have to make load follow generation, rather than the traditional way of generation following load.”

Steffes manufactured water heaters with sensors that enable the company to monitor up to 150 data points for each unit. In addition to remotely monitoring data, the company can control each heater to instantly add or reduce load at any time. “We dampened the variability and volatility that accompany renewable energy generation resources while

simultaneously creating greater stability and resilience on the electrical grid and distribution system,” says Kelly. “That’s what happens when the simple water heaters meets the Internet of Things.”

## The worldwide future of renewable energy

The real-time control enables Steffes to provide grids with new frequency regulation services that are far more agile than conventional methods. “Remember, to stabilize the grid, utilities typically have to throttle these huge machines up and down,” says Murphy. “But now we can use a device that’s ubiquitous in people’s homes, and we aggregate and manage them in real time with second-by-second control. It’s much more efficient than trying to regulate frequency with giant upstream generators.”

Steffes has completed 24 separate trials running across seven time zones. Hawaii is already begun installing the Steffes GETS system in a new development called Kapolei Lofts that will include 499 rental homes in western Oahu.

The rest of the world is closely watching this cutting-edge, highly scalable solution. “We’ve learned that places as far away as Israel are studying what’s happening in Hawaii,” says Murphy. “Not only does Hawaii have high daily demand, but up to one-third of that demand is already supplied by unpredictable renewable energy, and they’re committed to going 100 percent. California has committed to 50 percent and Germany

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to 45 percent renewable energy. So if people want to understand the direction we're going, they should look at Hawaii, California, and Germany."

In addition to providing energy companies with precision control of its grids and distribution networks, Steffes expects to cut the upfront cost of water heaters

for consumers. But more importantly, it provides opportunities for more people to become stakeholders in renewable energy and improve their environment. "This is something that an individual, family, or community can do to put a mark on climate change," says Murphy. "They can do something at a very local level to speed the adoption of renewable energy."

By using IoT technologies to connect ordinary consumer devices like water heaters, Steffes is empowering home owners to help write the next chapter on sustainability.



## Software

- Microsoft Azure App Services
- Microsoft Azure Event Hubs
- Microsoft Azure SQL Database
- Microsoft Azure Storage
- Microsoft Orleans Framework
- Azure Cloud Services
- Azure API Management
- Azure Web Apps