JOE WOJCIK

Greg Reed, director of the Power and Energy Initiative and an associate professor in the Department of Electrical and Computer Engineering at Pitt, is investigating ways DC transmission lines could be integrated into AC-based infrastructure.

Work being done to get more current with electrical current

In AC world, DC may be 'technologically superior'

BY ANYA LITVAK

A Canonsburg electric components company is going against the current that's powered America for the past century.

Universal Electric Corp. is making a push to advance the use of direct current, which is getting increasing attention from renewable energy advocates and electrical engineers.

Here's why: Renewable sources such as solar panels generate electricity through direct current. Batteries, which offer a complement to intermittent renewable energy, store and dispense electricity via DC. And most computer parts run on DC.

Yet most of our infrastructure, from the transmission lines above to the outlets in our homes, are made for alternating current.

"We have an AC world with a technologically superior DC solution," said Tim Martinson, a director at Universal Electric who was hired at the company this month to advance this project.

"So, how do we move from an older technology to a more efficient and more reliable and simpler one? That's more of a commercial challenge than a technological challenge."

To address this challenge, Universal Electric is working to commercialize DC microgrids for data centers.

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>
> **Tim Martinson**, a director at Universal Electric Corp.

"With servers being placed every two to three years in industry because of technology upgrades, we see that that is the place to start to bring in that DC process," Martinson said.

Energy-sucking data centers and big server farms are seen as an ideal market for this technology, according to the EMerge Alliance, a nonprofit industry consortium aiming to commercialize DC microgrids for buildings.

Randy Malik, a distinguished inventor with IMB Power Technology, estimates that for a 10 megawatt datacenter, switching from AC to DC distribution improves efficiency by 8 percent and saves the company almost $1 million a year. Part of the savings is that DC distribution requires less equipment.

But where it might make sense for IMB, the concept may not trickle down to smaller data centers quite yet.

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Ken Hill, chief technology officer at Expedient, oversees the company's Pittsburgh data center housed in Allegheny Center.

Some of Expedient's clients have DC-powered equipment in the datacenter, which means Expedient converts the AC power it gets from Duquesne Light to DC specifically for those machines.

"It may be more efficient in the long run and I think it might be less heat out on the floor of the datacenter," if the utility sent some power through DC distribution lines, Hill said. But that's not a project for a small consumer like Expedient.

"If you're building a new center, that would be the time to think about it, not retrofitting," Hill said.

TRANSMISSION

While Universal is focused on the distribution level, University of Pittsburgh Professor Greg Reed is developing models and running simulations to demonstrate that integrating DC systems into the current grid will make it more energy efficient.

"It's not that we're going to replace the existing AC infrastructure," Reed said. But "there are going to be places where, as we look to expand networks, we can use more DC power."

Those places might be remote sun-drenched locations good for solar arrays or windy mountain ranges perfect for turbines but lacking a link to the electric grid.

"If we're going to get to these higher penetration levels of renewable energy and start to wean off some of the fossil types of resources, we're going to need to develop those over new and existing infrastructure," Reed said.

New infrastructure for DC lines also is "lighter" than for AC transmission, he said.

"An AC system requires three cables and towers," Reed said. "DC only needs two poles."

That's one of the reasons that a 70-mile transmission line planned to cross the Chesapeake Bay as part of an infrastructure build-out has been approved for high voltage direct current.

According to power grid operator PJM Interconnection Ltd, the DC insert will minimize the environmental impact on this area, even though it will cost more to build.

Typically, high voltage DC transmission becomes more economical than AC at a distance of about 300 miles, Reed said.

This fall, Reed's efforts were boosted by a $600,000 grant from the Pennsylvania Ben Franklin Partnership fund.

POWER ELECTRONICS

Companies such as Eaton Electric and ABB have become enthusiastic partners in the advancement of DC transmission and distribution, according to Reed.

Eaton is working on the power electronics needed that allow AC and DC sources in distribution to be part of one grid.

John Vernacchia, director of alternative energy solutions for Eaton, said the company's operations in Europe are more advanced in developing DC switching equipment, because places like Germany, a solar power leader, need it to distribute the renewable fuel.

The company is testing some of those components at a demonstration lab in Warrendale, where two solar arrays, totaling 30 kilowatts, are being installed on a roof and a covered parking structure.

"There's getting to be a greater number of DC loads out there," Vernacchia said.

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All about currents

Here's a primer on the difference between AC and DC, and how electric currents work:

- **DIRECT CURRENT:** Electrons traveling from point A to point B without changing direction. Power from solar panels is generated through DC. Most computer equipment runs on DC.
- **ALTERNATING CURRENT:** Electrons that change direction. The majority of U.S. transmission lines operate on AC.
- **FREQUENCY:** How many times per second the current alternates (measured in Hertz). In the U.S., the frequency of AC traveling through an electrical outlet is 60 Hz. In Europe, it's 50 Hz.
- **VOLTAGE:** The force with which electrons are pushed from point A to point B. Your electrical outlets are 120 V AC. European outlets are 220 V AC. High voltage transmission lines can be up to 765 KV.
- **INVERTERS:** Devices that change current from AC to DC or vice versa. These are present in your computers and are necessary to change the alternating current you pull from the wall into the direct current that powers your computer parts. The conversion process requires some energy to be used and produces heat.