DC Microgrids and the Virtues of Local Electricity

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Today, locally produced DC power (say, from photovoltaic panels) is typically converted to AC using inverters. Much of the time, though, the power supply in the end user's equipment just converts the AC fed to it back to DC.

With the decreasing cost of electricity generated by photovoltaics and wind turbines, DC microgrids may be the most efficacious way to provide electrical energy to those who have none. Just as cellphone use in the developing world exploded without the prior installation of landlines, DC microgrids could leapfrog over the traditional system of centralized AC generation. The market for microgrids in the developing world could be huge, and the benefits they would bring to what are now grossly underserved regions are monumental.

Clearly, DC microgrids hold extraordinary promise for a wide variety of situations. Why then are they still so few and far between?

Some of the blame, at least in developed countries, can be placed on antiquated building codes that make it difficult to set up the infrastructure needed for generating and distributing DC power locally, perhaps within a single building. And even if property owners can overcome this hurdle, they will still struggle to find advice on how to construct such a system.

One of the few resources now available is the EMerge Alliance, an organization of more than 100 member companies interested in fostering the development of DC microgrids for commercial buildings. Alliance members are working to speed the adoption of this approach to improving energy efficiency, in part by setting relevant standards.

The EMerge standard for occupied spaces specifies that power be distributed at 24 volts DC, with current limited to about 4 amperes on each circuit. This combination is considered intrinsically safe with respect to shock and fire hazards, allowing electricians to install relatively simple wiring (without grounding or metal junction boxes, for example) and still meet the United States' National Electrical Code.

The EMerge Alliance is also promoting a standard for data and telecom centers. It calls for DC to be created and distributed at 380 V, which saves energy by eliminating the AC-to-DC conversions in each individual piece of electronic equipment plugged into the building's power grid.

Setting technical standards for DC microgrids, while challenging in its own way, is not the only problem by far. Another barrier comes from the regulatory environment that people or companies face when they want to share the power they generate, even if they just want to send it to others in their immediate vicinity.

Distributing power from rooftop solar panels to several apartments in one building, for example, might be very easy from a technical standpoint, but someone interested in doing that must navigate through some rocky legal shoals. Would selling power to those apartment dwellers violate the monopoly granted to the local electric utility? What if you need to supplement the power you're providing by drawing some energy from the AC grid and converting it to DC? Would your purchase of electricity from the utility then be considered a wholesale transaction (which in the United States would be governed by federal law rather than by the rules of a state utility commission)?

Such questions are hard to answer, and it will surely take a long while yet for federal and state authorities to sort out the many legal sticking points that DC microgrids raise. The same is true for other countries, each of which will face struggles of their own developing public policies that can accommodate these unconventional grids. But it's important to do that if we want to move forward.

For more than a century, AC power grids have provided the foundation for industrialized societies. The adoption of AC allowed voltages to be shifted using simple transformers, allowing electricity to be carried over long distances even with the earliest systems. Edison's competing DC approach wouldn't have permitted that. And because electricity was initially used mostly to power induction motors and incandescent lights, AC served well.

Things are different now. For one, we have solid-state DC-to-DC power converters with efficiencies that are already about 95 percent. (When we begin to use the new wide-bandgap semiconductors in this equipment, efficiencies should rise even further.) So there is no longer any worry about how to shift DC voltage levels or carry voltage over long distances. Indeed, high-voltage DC transmission lines are often used to link separate AC grids, in part because they obviate the need for intergrid synchronization.

Another fundamental change that has come about since Tesla and Edison's day involves the kinds of things we plug into our outlets. Most of the loads now are essentially DC, so supplying them from a DC source would simplify their power circuitry and save energy overall.

These developments make you wonder why DC hasn't replaced AC entirely for power grids big and small. In addition to providing energy savings, such a move would mean that it would no longer be necessary for electronic-equipment manufacturers to accommodate the different AC voltage and frequency standards found around the world.

The prime reason AC continues to reign supreme is just that it would be enormously difficult to replace it entirely with DC equipment. So we continue to use it, even though the original justification for doing so no longer exists. This situation is all too common. We no longer have to worry about typewriter hammers sticking together, for example, yet we still use QWERTY keyboards, which are even older than our AC power grids.

But sometimes a shift to new technologies is inevitable, even when the transition promises to be expensive or otherwise disruptive. And for power grids, we have the luxury of being able to start small. So it's high time for the world to embrace DC microgrids, an old-yet-new model for providing people with electricity.

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"It really was a fierce battle between Thomas Edison, who advocated his system of DC technology, and Westinghouse and his partner Nikola Tesla who were advocating AC," Reed explained. "The disadvantage Edison really had with DC back then was he had no way of controlling the current on the DC cables. As he began to deliver DC to longer and longer distances, as he got to beyond a mile (1.6 km) or more, currents got so large that it wasn't safe. The cables had to become so large that it wasn't economical. So in his system he needed a power plant about every mile to feed this DC network."

This problem has now been solved. We can safely control the currents in DC delivery lines. Suddenly, converting AC to DC for long distance transportation opened up new possibilities.

voanews.com/a/can-ac-and-dc-power-systems-integrate/3292427.