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## Why the Microgrid Could Be the Answer to Our Energy Crisis

By [Anya Kamenetz](#)

**Why small-scale, local power -- the microgrid -- could be the answer to our energy crisis. And why the big utilities are fighting it with all they've got.**



In Massachusetts, Jonah Decola teaches locals to build home power systems, like Sue Butler's 5.5-Kilowatt setup. Photograph by Bob O'Connor

In April 2007, a helicopter landed in a backyard in Johnson Valley, California, a desert hamlet of 440 residents on the outskirts of Joshua Tree National Park. "One of the neighbors went out and asked them what they were doing just a few hundred feet from his house," Jim Harvey, a local landowner, recalls. "They said, 'We're the Los Angeles Department of Water and Power, and congratulations! You're the lucky lottery winners of a brand new power line that's going to come right through the middle of your town.' "

That power line is called Green Path North -- an 85-mile-long high-voltage transmission wire from Los Angeles through public and private lands, connecting the city to potential geothermal and solar-thermal resources, with the whole shebang to be owned by the LADWP and paid for over the next decade by ratepayers. The cost: up to \$1 billion just for the transmission line, plus untold billions for the not-yet-planned power plants themselves. Some 2,000 acres of desert would be sacrificed for a project that would, if it ever gets built, carry about 800 megawatts of renewable electricity -- enough for 600,000 homes.

Green Path North is pretty typical of the renewables push in the United States: big, expensive, slow, and spectacularly uncertain. Twenty-eight states have pledged to shift their energy mix to at least 10% renewables, and at press time, Congress was considering a national target of 15% by 2020. But if many of us see this moment as a defining one, a key opportunity to reassess how we create and use energy across the country, the federal government seems content to leave the owners of the old energy world in charge of designing the new one. Big utilities are pushing hard to do what they do best -- getting the government to subsidize construction of multi-billion-dollar, far-flung, supersize solar and wind farms covering millions of acres, all connected via outsize transmission lines. Nevada senator Harry Reid has introduced legislation to speed the way for a national "electric superhighway." (Former Vice President Al Gore is another champion.) "We need to have an efficient way to take energy created in often remote areas and move it to where it is needed," Reid said this spring on the Senate floor. "A cleaner, greener national transmission system -- an electric superhighway -- must be a top national priority."

But the men appear to be victims of a bad metaphor. There's nothing especially efficient or high tech about heavy-duty aluminum-steel cables; "line loss" -- the power lost during transmission -- runs as high as 10% on our overloaded grid. The power lines take years to propose, approve, and complete; Green Path North alone has gone through seven potential routes since 2006. And the LADWP is taking a flyer that the remote, large geothermal and solar power plants it's supposed to connect with will even be built. In all, the federal Bureau of Land Management has to date received almost 400 applications for large solar and wind plants covering 2.3 million rural acres. Only a few of those have undergone environmental assessments -- and that's only the first step in a multiyear planning, permitting, and building process. Meanwhile, utilities are making plenty of money off their existing investments in fossil-fuel power. It often seems that according to utilities, renewables are the power resource of the next decade, and always will be.

Harvey says he has a better idea. The founder of the Alliance for Responsible Energy Policy, he's no NIMBY complainer. "We're just the opposite; we want it in our backyard," he says. "We want to put solar panels on our roofs and our neighbors' roofs." The nearby city of Palm Desert rolled out a program last August funding fixed-rate loans to private homeowners for rooftop solar, and within weeks, the money had been spent and panels were up on roofs. "The choice is clear," says Harvey. "If you want renewables, you want 'em clean and you want 'em fast, and the best way to do that is [rooftops]. But the utilities have been so adamant about thwarting these programs. They are the ones that are standing in our way."

The evidence is growing that privately owned, consumer-driven, small-scale, geographically distributed renewables could deliver a 100% green-energy future faster and cheaper than big power projects alone. Companies like GE and IBM are talking in terms of up to half of American homes generating their own electricity, renewably, within a decade. But distributed power -- call it the "microgrid" -- poses an existential threat to the business model the utilities have happily depended on for more than a century. No wonder so many of them are fighting the microgrid every step of the way.

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Theoretically, the microgrid is simple. Imagine you could go to Home Depot and pick out a wind or solar appliance that's as easy to install as a washer/dryer. It makes all the electricity your home needs and pays for itself in just a few years. Your home still connects to the existing wires and power plants, but it is a two-way connection: You're just as likely to be uploading power to the grid as downloading from it. Your power supply communicates with the rest of the system via a two-way digital smart meter, and you can view your energy use and generation in real time on your iPhone. Maybe you also have an electric car in the garage; the battery serves as backup storage for your house as well. And the best part: Assuming you produce more than you draw, instead of a monthly bill, you get a check.

A half-block from City Hall in Cambridge, Massachusetts, sits an unofficial prototype of this microgrid model. In 1983, when Sue Butler first bought her home, it was a condemned burned-out shell where police sent vagrants to crash. Today, the historic Italianate house built in 1858 has a comfortable artsy grace that matches the owner's; a cello and violin wait for a duet among a jungle of plants by the bay window. An elderly dog wheezes in the kitchen. On the roof, powering this cozy scene, sits a half-kilowatt microwind turbine and 5.5 kilowatts' worth of solar panels. The system was roughly half paid for by a \$25,000 grant from the Massachusetts Technology Collaborative, which administers a fund collected from a surcharge on every electric bill in the state. The solar installation can produce two to three times as much energy as Butler's home needs, meaning she can run her meter backward and sell a surplus back to the grid, a procedure called "net metering."

**Sue Butler's house** can generate juice for two others. Put one on every block and soon you have a renewable-power plant.

A neat addition to Butler's system is the standard commercial meter that she finagled from NSTAR, the local utility. Unlike flat-rate residential electric meters, commercial meters show the price of power varying with usage over the course of the day. Butler can bank power in the batteries in her basement -- they hold enough to run her house for a week -- and sell it back to the grid at times of peak use. "It's a low-tech smart grid," says Jonah DeCola, the soft-spoken self-taught engineer and union carpenter who put together her system as proof of concept. DeCola is building a career cobbling together systems like this and teaching community college kids, new immigrants, and ex-cons the trade as well. He calculates the payback on Butler's \$60,000 system at four-and-a-half years or less. "She's getting premium for her juice," he says.

Now think about this. Each Sue Butler can potentially power three homes. Put one of these on every block, and eventually you have a renewable-power plant right in the middle of an urban downtown. The developers of an office park or a mall can easily install 10 times as much solar power; and a town can do even more, like the town of Hull, on Boston Harbor, which currently has two community-owned wind turbines totaling more than 2 megawatts and is planning four more to power the entire town.

You may have heard a lot already about how companies such as Cisco, Google, GE, and IBM are investing billions in the so-called smart grid, the software and the digital appliances that will let consumers and power producers make intelligent, efficient decisions about their electric-power use. Well, the killer app comes when you, the consumer, can actually profit by using power intelligently. What we're talking about here is potentially a shift every bit as profound as the switch from mainframes to PCs, or from landlines to cellular -- a movement from behemoth centralized power plants to a network of privately owned, renewable, geographically distributed installations, managed using the same kind of packet-switching software that regulates the flow of information over the Internet.

The microgrid is all about consumer control -- aligning monetary incentives, with the help of information technology, to make renewables and efficiency pay off for the average homeowner, commercial developer, or even a town. The name of the game is to scale up renewables big enough, fast enough, to bring the cost down to parity with conventional resources.

Rooftop solar panels, for example, currently cost at least 25% more per watt installed than utility-scale solar, but that's without the cost of remote transmission (up to \$10 million a mile) and the 10% line loss. And you can get the power started in months, rather than years. What's more, instead of the utility model, in which ratepayers ultimately feed the profits of the utilities and their shareholders, with the microgrid, a return comes back to the folks who invest in saving and generating their own electricity, creating a positive feedback loop of consumer demand.

The scale of the microgrid can deliver unforeseen benefits, too. Amory Lovins, the green wise man of the Rocky Mountain Institute, is among the biggest and most influential fans of micropower; he's written a book, *Small Is Profitable*, laying out 207 reasons why. Among them: "Distributed generation" means a redundant, resilient, secure infrastructure -- that's why military bases and hospitals have their own power plants. Micropower can be more reliable, given that 98% of all blackouts originate in the grid. And it creates thousands of local jobs near population centers in design, installation, and maintenance. "Micropower, as of three years ago -- the latest global data -- was a third of the world's new electricity and one-sixth of the world's total," he tells *Fast Company* in his trademark pressure-wash style. "Micropower growth is very rapid, and it's [currently] almost wholly financed by private capital. Distributed renewables in 2007 got \$91 billion of new private investment... There are several quite distinct reasons for thinking that these stats I've just given you are the leading edge of a tsunami of change in the power sector." *Small Is Profitable* concludes that because the scale lowers capital risk, the economic benefits of a dollar invested in distributed renewables can be an order of magnitude (factor of 10) greater than the same dollar invested in conventional power plants.

No wonder big companies are starting to make bets on the potential of the microgrid. "It's dawning on major suppliers that there's been a Richter 8 under their feet," says Lovins. "Two of them -- large companies that manufacture heavy electrical equipment for power plants -- have called me in the last week to have a strategic meeting about micropower."

Then there's GE, a leading wind-power manufacturer, which in April announced a \$10 million co-investment in Southwest Windpower, the world's largest manufacturer of small turbines. Southwest's Skystream model, mounted on a 40-foot pole, supplies anywhere from 40% to 90% of an average home's electricity use. Retailing for \$12,000 to \$18,000, it's available to homeowners today with a four- to five-year payback after incentives, depending on local energy prices and how good the site is for wind. Managing director at GE, Kevin Skillern, sees huge growth in distributed generation: "The small-wind market is currently just \$100 million in total sales but has been growing 40% to 50% a year for a handful of years. The combination of stimulus programs and technology advances make this a highly economic purchase for nearly half of the U.S. population... From the perspective of both our venture-capital group and some of the senior people within GE Energy, distributed generation is going to happen in a big way."

David Shepler of IBM Research moved into a brand-new, four-bedroom home in New York's Hudson Valley in April; it combines highly efficient design with geothermal heating and cooling and 10 kilowatts of solar panels. The house is the first in a planned development called Green Acres and a showcase for Shepler's work as well. He calls energy the "challenge of our time." And IBM's vision, he says, is "achieving true distributed energy on a massive scale -- where it's not just me in New Paltz and a couple of eco-freaks here and there, but a third or a half of the roofs in cities or towns with solar panels." To make that possible, IBM is focusing on smart-grid software to manage the complexities of a system that might have 2,000 variable power inputs over 100 square miles, instead of two power plants. It's also developing cheaper photovoltaics (prices are already projected to fall by 20% to 30% this year), and Shepler has been working with the federal government to write recommendations for incentives and R&D investments. Allan Schurr, the VP of strategy and development at IBM's energy and utilities group, says simply, "Distributed energy is happening."

In fact, wherever a little public funding has gotten the ball rolling, consumer appetite for micropower has been essentially bottomless. To see just how fast the microgrid can emerge, there's no better place to look than Germany, where the market has been blown open thanks to what's known as a feed-in tariff. If net metering is simply the right to sell your power back to the grid at retail price, a feed-in tariff adds a little sweetener on top, paid for by a surcharge on all customers' bills. In effect, feed-in tariffs offer the same financing deal to citizens at large that utilities get on any power plant they build. The tariffs have been successfully adopted in 47 countries -- but Germany is by far the global leader. The policy was introduced there back in 1999, and the incentive increased in 2004, guaranteeing the small rooftop-solar producer four times the market rate for 20 years for any electricity he sells back to the grid. That year, installations of solar panels jumped from an average of less than 6 megawatts annually to 600 megawatts; the total 5.4 gigawatts of solar now operating in cloudy Deutschland make up a jaw-dropping third of the entire world's supply. That increased volume, meanwhile, has sent the price of solar panels plunging and created a world-leading industry with a quarter-million jobs. All this for just an extra euro on the average monthly bill, a charge that can be avoided by anyone who becomes a net-power producer.

In March, Gainesville, Florida, became the first U.S. locality to adopt a feed-in tariff, targeted to add 4 megawatts of solar a year for the next 10 years. The city reached its 2009 cap in just three weeks and its 2010 cap days later. Entrepreneurs are moving in to finance, install, and maintain solar panels on homes and malls across the city. The idea, here and elsewhere, is that eventually higher volume will bring down prices enough so that incentives can be phased out.

**If there's so much potential** in the microgrid, why hasn't it already hit gigawatt scale in the United States? One answer is that it pits local producers against the utilities themselves. If the distributed-generation scenario resembles cell phones, that casts the utilities in the role of Ma Bell -- as outdated, monopolistic incumbents. Ed Legge of the Edison Electric Institute, the lobbying organization for the utility industry (and leader of the national effort to oppose federal renewables targets), is surprisingly frank on this point: "We're probably not going to be in favor of anything that shrinks our business. All investor-owned utilities are built on the central-generation model that Thomas Edison came up with: You have a big power plant and you move it and then distribute it. Distributed generation is taking that out of the picture -- it's local."

This attitude is understandable. After all, if utilities don't own it, they can't bill for it. And with close relationships between power companies and state regulators, they can and do throw up a variety of roadblocks to see that rooftop-solar programs and the like remain tiny. The nonprofit Network for New Energy Choices puts out an annual report called "Freeing the Grid," tracking the growth of microgrid-friendly policies. These are trending up -- 42 states now have rules allowing some form of net metering. But based on the fine print, 28 of those states earned Ds or Fs because their rules are too restrictive to allow the average person to participate. James Rose, who wrote the report, singles out Texas as an egregious example: In June 2007, Governor Rick Perry signed into law House Bill 3693, a big efficiency and conservation bill. Though the new law called for net metering to be deployed "as rapidly as possible," the report explained, utilities took a "hard line" against it at the regulatory level, and ultimately state regulations allow no such thing. "There was the feeling that some of the people who were interested in not having net metering had a lot of say in how net metering was defined," says Rose, choosing his words quite carefully.

The tactics utilities deploy to protect their profits can make a reasonable person's head spin. "In Arizona a couple of years ago, we got a renewables incentive passed," says Adam Browning, executive director of Vote Solar, a national advocacy group. "A local utility proposed that it collect money for all the electricity that you didn't buy from it. The argument was: We've got fixed costs associated with maintaining the transmission and distribution grid. So if you don't buy from us, *we want* to charge you for your 'fair share' anyway," which it reckoned as everything but the avoided fuel costs -- the oil that you don't burn by choosing renewables. So regular customers would pay 11 cents a kilowatt-hour, but customers with solar panels on their roofs -- not even using the utility -- would still have to pay 6.8 cents an hour. "We hired a lawyer contesting this, and eventually we won," says Browning. Today, Arizona has decent, though not finalized, net-metering rules.

It's a similar story in North Carolina. "Because of its rate structure, Duke Energy has acted as the greatest impediment in the state to the rapid adoption of energy efficiency and renewables," says Ivan Urlaub, the executive director of the North Carolina Sustainable Energy Association, who has worked closely with the state utility commission and with Duke to draft policy. "They've explained to us that net metering puts them at higher risk of losing revenue."

Jim Rogers, Duke Energy's CEO, told *Fast Company* he's a fan of putting solar panels on his customers' homes and businesses -- he just thinks Duke should own them. "I believe at the end of the day, we'll be able to do it cheaper and better than everybody else." But Urlaub says, "We know that's not true," pointing out that Duke recently submitted a public bid for a utility-owned 20-megawatt rooftop-solar program and came in higher than several independent, nonutility solar companies.

Nowhere is the conflict between the utilities' business-as-usual and a swift transition to clean energy more stark than in Los Angeles. The Los Angeles Department of Water and Power is the biggest city-owned utility in the country. You may remember it as the shadowy villain of 1974's Oscar-winner for Best Picture, *Chinatown*, which dramatized the true 1930s tale of how water was siphoned from California's farmlands into private hands. The hard-bitten private eye played by Jack Nicholson asks the Machiavellian executive played by John Huston what he could possibly need to buy with all his money, and Huston responds, "The future, Mr. Gittes! The future!"

The LADWP has been fighting the green future for at least 10 years. (It declined to comment for this article.) In 1999, when the first green-energy incentives were passed in the city, the LADWP quietly cut a deal with the city's top 30 users of electricity, offering them 5% discounts for 10 years in exchange for not building on-site generation or installing solar power. This includes L.A.'s public school system, the biggest energy customer in the city, which was then launching what would become a \$20 billion renovation -- building 100 new schools that by now could have had solar. At the same time, the utility assessed an extra fee to other customers, like the Los Angeles Community College District, which did choose to generate its own power.

Sunny L.A. currently employs just 1% solar energy, but pressure has been mounting to raise that figure; Mayor Antonio Villaraigosa's goal is 20% renewables by next year. So last fall, the LADWP introduced Measure B, a ballot proposal calling for 400 megawatts of rooftop solar on large commercial, industrial, and government-owned buildings. So far, so good. The catch was that all of it had to be installed, owned, and maintained by the LADWP on private property, at a cost of \$3.5 billion -- underwritten by ratepayers via an estimated 2% to 4% increase in utility bills. There was no benefit to the property owners themselves. And an independent consulting firm hired by the city questioned the LADWP's ability to handle the logistics of such a project at all.

Enter Ron Kaye. Kaye arrived in L.A. as part of the entourage of an Indian guru in 1980, and for 23 years was the editor of the *Los Angeles Daily News*, the second-biggest paper in the city. Last year, after he was put out to pasture by the paper's new owners, he reinvented himself as a blogger and full-time rabble-rouser. He appears on an amateur video on his Web site, sitting by his pool, flanked by pink bougainvillea, rattling off tales of city council malfeasance like a civic-minded Walter Matthau. The way Measure B was rushed onto the ballot raised red flags for Kaye, and he put together an ad hoc coalition to oppose it. Measure B supporters sued him and his coalition, but the case was thrown out of court; Kaye's side finally defeated the measure by less than 1%, spending \$75,000 to the LADWP's \$1.6 million.

Despite the vote, the LADWP remains publicly determined to retain control of any renewables built in the city. "Every day of this has been a learning experience," says Kaye. "This whole thing explains why L.A. has the most coal-burning power plants in the country, why it's reliant on fossil fuels and lagging behind other utilities in getting renewables." The problem, he says, is "LADWP's need to monopolize resources."

**Electric monopolies** were supposed to have been busted a decade ago, but thanks to the Enron debacle, deregulation is a half-finished experiment. Almost no one wants to get rid of the utilities entirely, but it may be time for them to go the way of their rough contemporaries, the railroads. In the late 19th century, railroad companies were the biggest, baddest, most dynamic and capital-intensive industries in the country; their owners and financiers -- the Astors, Vanderbilts, and Cunards -- amassed piles of Monopoly money as they laid track from coast to coast. Today, the rail network is still crucial for freight and commuters alike, but it's only one component of a far more diverse, faster, more flexible transportation system.

Yet citizens, policy makers, even environmentalists seem to have become mired in the energy status quo. "We want to make sure utilities don't see it as a threat to their revenues when customers are generating their own electricity," Ashok Gupta, energy analyst with the Natural Resources Defense Council, told me. But why not? If we can leverage public money to empower customers to both cut energy use and make their own green power, why should anyone but shareholders care if utilities are relegated to a background role? Industries evolve, they shrink, sometimes they die. Just go check the current earnings for Amtrak.

The evolving role of utilities is easier to envision in Massachusetts than elsewhere. Here, since deregulation, utilities by law have been out of the generation business -- buying power from subcontractors, making them theoretically agnostic about whether that juice comes from big plants or small local sources. The unassuming lobby of the Department of Energy and Environmental Affairs (the state is the first to combine the two departments) boasts a bulletin board crammed with press clips hailing the Green Communities Act, signed by Governor Deval Patrick last summer, as one of the most forward-looking policies in the country. As the name of the law suggests, encouraging local renewable-energy installations owned by towns, businesses, and residents, from offshore wind to rooftop solar, is one major strategy.

Ian Bowles, the state's secretary of energy and the environment, masterminded the Green Communities Act. He speaks frankly and sarcastically, with a bit of a squint that says not much gets by him. He worked on the Kyoto Protocol under Clinton, and he sees the electric industry as overripe for transformation. "There are so many unexplored opportunities here," he says. "It's like we're still with that goldenrod 1970s rotary phone." He calls the utilities "historically fat, dumb, and happy, cruising along, building their stuff, getting their rates recovered, and delivering a good return for their shareholders." But he suggests there may be a huge new niche opening up in the market: "What's been missing is that, unlike Verizon in the cellular business, there's no big heavy-balance-sheet company doing a marketing push out there -- on TV, with a toll-free number: Take your home and cut your energy use in half! Brought to you by Home Depot."

It will take a major act of political courage to create a microgrid market big enough to draw in a Wal-Mart or a Home Depot, or even to grow a startup like Jonah DeCola's Clean and Smart or the dozens of others ramping up across the country. Even in Massachusetts, individual installations are limited to 2 megawatts (10 megawatts for cities or towns), and to just 1% of peak capacity in each local area, which Bowles admits was a political compromise. But with the right policies in place, there's a lot of money to be made in this market -- perhaps even by an innovative utility that has reinvented itself as a comprehensive renewables-and-efficiency services company.

In the end, the visionaries of the microgrid are confident that with the help of evolving technologies and dropping prices, the unstoppable force of the American consumer will steamroll the last immovable industry out of the way. That would do more than help save the planet -- it would deliver an unprecedented amount of flexibility, control, and transparency to the industry that more than any other defines modernity.

"It's inevitable that consumers will continue to want to exercise more involvement in energy decisions," says Allan Schurr at IBM. "Our research shows that only 30% of consumers are satisfied with the passive ratepayer role. I think consumers will articulate their needs to utility providers directly and indirectly through the political process and utility commissions. I don't think utilities can make unilateral choices here. The force is very strong."

The power, after all, belongs to the people.