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Washington Monthly, May/June 2009

## Special Report: **Grid Unlocked**

**A smart, digital electric power system could bring vast energy-efficiency gains and a new wave of entrepreneurship—if Washington gets the regulations right.**

By [Mariah Blake](#)



**I**n the fall of 2002, Peter L. Corsell, a twenty-four-year-old former CIA analyst, decided to try his hand at the energy business. At the time, he knew nothing about the industry, apart from a few stories he had read in the *Wall Street Journal*. But he had a vague sense that renewable energy was going to be the next big thing. So he buried himself in research, reading books (he says he began with "the equivalent of *Electricity for Dummies*") and tracking down old acquaintances who he thought might know something—anything—about the business.



Ten months later, Corsell surfaced with an idea. Typically, putting up rooftop solar panels also means installing a tangle of wires, inverters, batteries, and other gadgets. Instead, Corsell envisioned a "plug and play" system that would combine these elements into a single unit that was quick and easy to install. With this in mind, he took out a second mortgage on his Northwest D.C. condo, and began pressing friends and family to invest in his venture. "Pretty much everyone who ever had the misfortune of knowing me, I hit up for money," Corsell recalls. Eventually, he cobbled together \$1.6 million, and launched the company under the bland moniker Equinox Energy Solutions.

Early on, the venture ran into some stumbling blocks: the initial prototype, which was the size of a large refrigerator and cost \$30,000 to build, had to be scrapped after tests revealed users were at risk of electrocution. (It has since come to be known as "Frankenbox.") But Corsell pushed on. In September 2004, a friend suggested he talk to Karl Lewis, a fortysomething veteran of the information technology business. The two

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men met at a grungy Dupont Circle sandwich shop, where they spent four hours hashing out technical plans on paper placemats. As they did, a vision began to take shape.

After the meeting, the men teamed up and began hiring engineers and software programmers; twenty of them worked elbow to elbow in a single, un-air-conditioned office. Part of the crew eventually spilled into Lewis's garage to hammer out a second prototype, which resembled a clunky black filing cabinet. Unlike the device Corsell originally envisioned, it had the brain of a computer, which meant it could juggle weather forecasts and electricity rates and decide automatically whether to store excess power from the solar panels in the batteries or sell it back to the grid.

The product finally hit the market in the spring of 2005. Only a few hundred were sold, but General Electric found the technology so promising that it offered to buy Equinox Energy for an undisclosed sum. Corsell declined, partly because it was beginning to dawn on him and Lewis that their creation had applications far beyond integrating solar panels. "We began asking ourselves, what would happen if we linked thousands of these things together," says Lewis, who is now the company's chief strategy officer. "What if, instead of firing up a new power plant every time energy demand surged, we could tap into an intelligent network, and hundreds of solar panels would automatically start feeding energy into the grid, or thousands of thermostats turned themselves down by a couple degrees?" With this in mind, he and Corsell rechristened the company GridPoint, and in the summer of 2006 began working on a trio of software applications to connect every piece of the electrical system, from the power plants and transmission lines to hot-water heaters and clothes dryers, into a vibrant energy ecosystem. They soon realized they were part of a burgeoning movement to build what is known as the smart grid.

These days GridPoint is thriving. Last September, as Wall Street was crumbling, the company managed to bring in \$120 million in capital, more than it had raised in the previous six years combined. Among its funders are Goldman Sachs and former presidential hopeful Bill Bradley. The atmosphere at the company's Arlington, Virginia, headquarters is weirdly reminiscent of Silicon Valley in the 1990s. When I visited the gold-brick compound on a recent afternoon, a twentysomething blond woman in low-slung trousers and flip-flops trundled through the reception area with a wagon full of microbrew. "It's Thirsty Thursday!" she exclaimed.

Meanwhile, GridPoint's work is on prominent display in Boulder, Colorado, where the power company Xcel Energy is building the nation's first fully integrated smart grid. Using GridPoint's "Energy Dashboard," an Internet portal similar to an online banking site, Boulder residents can get a minute-by-minute snapshot of their energy use or program their appliances to behave in ways that save them money and benefit the environment. Dishwashers can be set to run only when windmills are turning. Thermostats can be programmed to automatically adjust their settings based on factors like the time of day and the price of electricity. This system is expected to drive down energy use, cut greenhouse gas emissions, and save Boulder residents millions of dollars.

GridPoint is just one of hundreds of new entrepreneurial ventures that are developing software and gadgets that marry electricity and digital intelligence. Along with giants like Google and IBM, these firms are forging the nuts and bolts of the smart grid, which will bring digital intelligence to one of the last vestiges of our analog economy: our electrical system. In doing so, they could revolutionize the way we use energy. Imagine a world where every dryer, dishwasher, hot-water heater, and car was part of a smart network that was working to make our energy system greener and more efficient.

The idea has captivated venture capitalists, who see the potential for sweeping innovation: smart grid companies are now attracting more venture funds than any other sector. It has also caught the attention of Washington. President Barack Obama has called building a smarter grid "one of the most important infrastructure projects" in America today, and noted that doing so is essential to realizing key energy goals—such as bringing more renewable energy online, paving the way for plug-in cars, and reviving the economy by creating millions of green-collar jobs. The stimulus package passed earlier this year makes a down payment on this vision, with \$4.5 billion for smart grid investments.

But such measures will do little good unless they're accompanied by deep changes to our patchwork regulatory system for electricity, which rewards inefficiency and stifles innovation. And as a result of a historical glitch, this system is the domain of states, meaning it is beyond the direct reach of Congress and the White House. How our leaders tackle this quandary will determine, to a large degree, whether the innovations that gave rise to start-ups like GridPoint are just a passing trend or the first rumblings of an Internet-style revolution that will forever transform the way we use energy.

**T**he regulatory system we have today was born of treachery and scandal. In the early 1900s, a handful of sprawling national conglomerates, known as public utility holding companies, began gobbling up local power companies. Using dubious accounting schemes and complex ownership arrangements, they drained their subsidiaries of profits, in part by charging them inflated rates for services like building power plants. As a result, people in most parts of the country were forced to pay outrageous sums for shoddy service—assuming they had service at all.

The power of the holding companies was legendary: Senator George Norris once said government could "no more contest with this giant octopus than a fly could interfere with the onward march of an elephant." But the ground began to shift after the stock market crash of 1929, when these firms (many of them built on piles of debt) began unraveling. The most spectacular debacle was Samuel Insull's \$3 billion empire, which collapsed in 1932, wiping out the life savings of many of its 600,000 shareholders. Several years later, Insull died of a heart attack in the Paris metro with only a few cents in his pocket.

Congress seized the opportunity and in 1935 passed the Public Utility Holding Company Act, which broke up the big power companies. Under

the new system, utilities were limited in their geographic reach, usually to a single state, and were given a monopoly over the region they served. They were also required to answer to state regulators, who were charged with setting rates based on two factors: how many power plants utilities built, and how much electricity they produced. This system was meant to keep prices low (customers could no longer be charged inflated rates for power plants or extras they didn't need). It also created an incentive for utilities to deliver power to every corner of their service area, which made sense at a time when 90 percent of the rural population didn't yet have electricity.

But by the 1960s electricity reached into even the remotest part of the country (thanks largely to another Depression-era program, rural electrification). Since then our biggest challenge has been finding ways to make our energy use more efficient and reduce our dependence on fossil fuels. But in most areas of the country, the regulatory rules continue to reward companies for building more power plants and churning out more electrons—a system that works against these goals. Also, the lack of competition between power companies means there's little incentive to innovate. And those that try are often stifled by regulators, who are wary of approving investments in novel technologies. The upshot? While the rest of our economy has raced ahead, becoming smarter and more interactive, our grid remains a clumsy, analog beast based mostly on 1950s technology. "For the last eighty years, we've been laboring under Depression-era rules," say Kurt Yeager, former president of the Electric Power Research Institute, an industry-funded think tank, and current executive director of the Galvin Electricity Initiative. "And those rules are toxic to innovation. As a result, our grid is frozen. It has turned into a museum piece."

The lack of innovation means grid operators have to rely on crude tools to manage the flow of electricity and diagnose and repair problems. When power goes out in most parts of America, the only remedy is to send a truck to hunt for the downed line. This creates a drag on the economy—outages alone cost a staggering \$100 billion a year—and leads to enormous inefficiency and waste.

As we struggle to kick our carbon addiction, the shortcomings of our system only become more glaring. Within the next few years, plug-in hybrid electric cars are expected to hit the market en masse. These will need far less gas than the current generation of hybrids, such as the Toyota Prius, which charge their batteries by harvesting the energy from braking and acceleration rather than by tapping into the grid. As a result, this new breed of vehicles could drastically cut our dependence on oil. But they will also drive up demand for electricity, which could strain our patchwork grid—a system that is already running on the ragged edge of failure. Oak Ridge National Laboratory recently studied what would happen if a quarter of all U.S. cars were plug-in hybrids. Assuming they all plugged in during the early evening, when most people get home from work and demand for electricity is highest, we would have to build as many as 160 new power plants, mostly coal-fired behemoths. On the other hand, if the grid were smart, cars could be programmed to power up when demand is lowest—say, in the middle of the night—and to coordinate their charging times. In

that case, it's possible that not a single new power plant would have to be built.

The combination of a smart grid and plug-in cars also solves another problem. One of the largest stumbling blocks to bringing large amounts of green energy online is the lack of storage on the grid. Because electricity moves at almost the speed of light and has to be used the moment it is produced, grid operators are constantly juggling supply and demand. Without the ability to store power and manage the flow of electricity on a micro and a macro level—something that becomes far easier when digital intelligence is added to the grid—intermittent power sources like solar and wind power can throw off the fragile balance of the system, causing surges and blackouts.

But once we have a critical mass of plug-in cars, their batteries can be tapped as a vast, distributed storage network. This, combined with a smart and nimble grid, could make it possible to bring huge quantities of renewable energy online. It could also drastically reduce the need for what is known as "spinning reserve"—keeping extra power plants idling in case a generator goes down. Often this means coal plants are belching carbon into the air even when they're not producing power.

Add smart appliances to the mix, and the possibilities multiply. In 2006, Pacific Northwest National Laboratory teamed up with the Bonneville Power Administration and outfitted 112 homes on Washington's Olympic Peninsula with smart meters, which gave customers a minute-by-minute breakdown of how much electricity every appliance was using. Customers were also given smart thermostats, smart dryers, and smart water heaters, and were signed up for real-time pricing. This means energy prices varied minute by minute, like the prices paid by power companies rather than the flat rates paid by most retail customers.

Using a simple software interface, homeowners programmed their appliances to strike the right balance between comfort and economy. Jerry Brous, a sixty-nine-year-old retired steel worker who participated in the study, says the system was "easy as pie" to use. "I live in a retirement community, and some of the older folks weren't sure at first that they could do it," he adds. "But I'd walk them through it, and they'd be off and running." The rest was left up to the devices themselves, though consumers were free to override the controls. The thermostats, for instance, took incoming price information, matched it against the homeowner's preference, and adjusted the temperature accordingly. Most of the time, these subtle differences went unnoticed by homeowners. But they shaved an average of 10 percent off electricity bills, which made the program popular: when it came time to tear out the equipment, many participants protested. What's more, the program reduced power usage during periods of peak demand by 15 percent.

This is key, since energy efficiency is the shortest route to cutting our emission of heat-trapping gases. If the entire country reduced its energy use by 10 percent, we would produce 660 million tons less carbon dioxide per year, according to the American Council for an Energy-Efficient Economy. That's the equivalent of taking nearly half of American cars off the road. Shifting energy use away from periods of peak demand also

creates major benefits. Roughly 45 percent of our power plants are what are known in industry circles as "excess capacity," meaning they are fired up only a few days, weeks, or months a year when demand surges. The rest of the time, they sit idle. Flatten out the peaks, and far fewer plants will be needed in the future. In fact, if we could lower peak demand by a mere 5 percent, we would have to build 625 fewer power plants over the next twenty years, according to a study by the Brattle Group, a research and consulting firm. What's more, since it is usually costly gas-fired plants and dirty diesel generators that are used to meet peak demand, lowering the peaks would also cut carbon emissions and drive down power prices.

Of course, the Olympic Peninsula Project was just a modest prototype. Customers in Boulder, where 50,000 homes are being outfitted with smart technologies, will have a far broader menu of options. Instead of just three devices, they will have access to numerous smart appliances and gadgets (in part by using smart plugs). They will also be able to link other technologies—like solar panels and plug-in hybrids—into their intelligent home networks. This means, among other things, that they can program their cars to charge up when the price of energy dips, and sell some of the power back to the grid when the rate climbs. As part of the program, energy prices will also vary based on demand and energy source, so electricity from wind power costs less than that from coal-fired plants. Thus, customers will be rewarded for running their energy-hungry appliances when the grid is flush with clean electricity.

This program is expected to drive down energy demand by as much as 30 percent, and reshape the way the remaining supply is used, drastically cutting the city's carbon footprint and residents' energy bills. Indeed, the Electric Power Research Institute has found that investing \$100 per customer annually in smart technologies could save consumers an average of \$500 per year—a net savings of \$400.

What's happening in Boulder may be just the first hint of the smart grid's potential. Indeed, if history is any guide, adding digital intelligence to our grid will open up possibilities that stretch the limits of our analog imaginations. Who, in the early days of the Internet, envisioned YouTube or Google Earth? Drew Clark, of IBM's Venture Capital Group, which scans the horizon for the next big thing in digital technology, sees the smart grid as a Web-like platform for innovation. "Picture something akin to an iPhone store," he explains, "a place where tens of thousands of entrepreneurs are building 'apps' and services to address critically important challenges, like shifting to renewable energy as rapidly as possible or making our energy system more efficient."

Adding digital intelligence to electric devices also opens the way for sweeping innovation in dozens of other industries, from automaking to appliance manufacturing. (Imagine if your air conditioner could e-mail the repair shop when it detected a technical problem, or if your refrigerator could inventory its contents and automatically place orders for missing staples with an online grocer like Peapod.) And with innovation comes productivity gains, job creation, and rapid economic growth. But the clock is ticking. Presuming other countries will be smartening up their grids—and many of them already are—the one that does so quickest will have the first-mover advantage in developing software and other tools, meaning it

will likely be a market leader for years to come. These facts are not lost on lawmakers: a growing number have come to see overhauling our grid as a promising route to getting America back on its feet and securing its leadership position in the world. Senator Maria Cantwell, a Washington State Democrat, has called it the "largest economic opportunity in the twenty-first century."

**B**ut to get these benefits, we have to overcome the stumbling blocks that are built into our Byzantine regulatory system. The retail electricity market in the United States is made up of more than 3,000 power companies, each with a government-granted monopoly. Though some are publicly owned municipal utilities and community cooperatives, the vast majority of our power supply—roughly 75 percent—is delivered by private firms, whose first concern is their bottom lines. And in most parts of the country, how much profit they make continues to depend on how many power plants they build and how much power they churn out. Thus there is little incentive to invest in smart technologies that help customers use energy more efficiently. In fact, doing so works against their interests.

Those companies that do try to add digital technology to the mix or explore novel business models continue to have trouble getting the plans by state regulators. There is simply no place in regulators' calculations (which in many cases are still based on Depression-era rules) for factors like money saved by *not* building power plants, much less for the broader benefits that come with a smarter grid. A case in point: last year, Duke Energy, one of the nation's largest power companies, sought approval from the South Carolina Public Service Commission for a program called Save-a-Watt, which would allow it to get paid for every power plant it avoided building, but regulators vetoed the plan.

Congress has begun to grapple with this dilemma, but most of the solutions it has settled on so far only nibble around the edges of the problem. (For instance, the Energy Independence and Security Act of 2007 requires regulators to study the broad societal benefits of smart grid investments and consider taking them into account.) The notable exception is the stimulus package, which provides \$4.5 billion in matching grants for smart grid projects.

This could help overcome the inertia that has kept power companies from investing in smart technologies at all. But it will take at least twenty times that much money to outfit our entire grid with digital intelligence. And technology alone will do only so much good. To be sure, once there are digital sensors on the lines, power companies can better manage the flow of electricity, which will lead to fewer blackouts. They can also detect and repair problems remotely—no more sending trucks to hunt for felled power lines. But this is only the first step to unlocking the smart grid's potential, just as the old IBM mainframes with their centralized control of information were just the first stage in the computer revolution. It was only with the arrival of PCs, which put computing power in the hands of ordinary people, and of the Internet, which linked those computers into

vibrant interactive networks, that we got the tsunami of innovation that brought us previously undreamed-of ventures like eBay and Twitter.

When it comes to turning our electric grid into a thriving network, smart meters are the key. Once customers have a detailed minute-by-minute breakdown of their electricity consumption, they can become active players in managing our power supply. But first they have to be given the data in a form they can use. Ideally, this means an open nonproprietary format, so third parties can package the information in ways that are useful to consumers. In March, Google sent former astronaut Edward T. Lu to press Congress on this front. "Personal energy information belongs to consumers," Lu said, "and they should control who has access to it."

However, many power companies are reluctant to provide customers with detailed data about their energy use, much less in a format that could be used by third parties. Doing so would loosen their grip on the monopolies they've held for the better part of a century. Instead, many utility executives see smart meters as simply another tool for streamlining their own operations—by, for instance, getting rid of meter readers.

Giving customers detailed information about their energy use is just half of the equation, however; the other half is offering them the option of time-based pricing. That way they can save money by using energy in a manner that makes the entire system cleaner and more efficient. Also, giving people the tools to save by making smart energy choices will feed demand for things like smart appliances and energy management software, which means there will be more room for entrepreneurs to profit by finding creative solutions to our energy woes—and more incentive for them to do so. But in most parts of the country, regulators have refused to allow rates to fluctuate, arguing that it's too risky for consumers. (Smart grid enthusiasts counter that allowing some customers to move to time-based pricing doesn't mean all of them have to. And besides, if dynamic pricing were combined with smart technologies, even consumers who used energy during periods of peak demand would probably see their bills drop, because the entire system would be so much more efficient.)

In lieu of offering time-based pricing, some utilities have proposed that *they* be allowed to adjust the settings on people's appliances or pick the charging times for their cars. But the Big Brother overtones of this approach make it a hard sell. Last year, when the Northern California power company Pacific Gas and Electric tried to get permission to reach into people's homes and adjust their thermostats, it triggered a nationwide outcry—not to mention a rash of conspiracy theories.

What can Washington do to clear away these regulatory hurdles, given that the most vital pieces of the electricity network are controlled by states? Smart grid advocates have floated a variety of ideas. Some, like Dan Delurey, head of the Demand Response and Smart Grid Coalition, favor a series of small steps, like setting a national standard for lowering peak demand. If states were required to shift, say, 10 percent of energy consumption away from periods of peak usage, he argues, it would change the face of the industry. "Once lowering peak is established as a goal, utilities have every reason to invest in things like smart meters and distributed storage, and to offer options like time-based pricing," Delurey

explains. "This one stroke could change the entire landscape." The sweeping climate bill that was introduced by Representatives Henry Waxman and Ed Markey in April would move the country in this direction by requiring states to set their own goals for lowering peak demand.

Other smart grid advocates favor a more direct approach. Bracken Hendricks, who studies energy issues at the Center for American Progress, has proposed creating a national fund that offers grants for smart technologies and then requiring states that take the money to meet certain criteria—for instance, giving customers the option of time-based pricing, or breaking the link between power-company profits and the amount of energy produced. This could help overcome the inertia that has scuttled investment in smart technologies, while making sure these tools are put to good use.

Such measures are sure to be controversial because they would wrestle some control of vital infrastructure away from states. But without bold action on the federal level, we will never see the full potential of the smart grid, and many of our national energy goals, such as widespread deployment of renewable energy, will remain out of reach. No one knows this better than those who have devoted themselves to remaking our power system. "The smart grid will never be what it could be, and we as an industry will never really succeed, unless the regulations are overhauled," says Corsell of GridPoint. "That is the bottom line."

[Return to Special Section Table of Contents](#)



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