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An Electric Revolution

*Reforming Monopolies, Reinventing the Grid
and Giving Power to the People*



About the Author

Jay Stuller has written 10 books and more than 1,000 articles in publications that include *Smithsonian*, *Audubon* and *Reader's Digest*. He concurrently spent nearly 25 years at Chevron — writing its annual report, for its employee magazine and speeches for the Chairman of the Board. Stuller is a co-author with Bob Galvin and Kurt Yeager of *Perfect Power: How the Microgrid Revolution Will Unleash Cleaner, Greener, and More Abundant Energy*.

An Electric Revolution is sponsored by the non-profit Galvin Electricity Initiative.

The Initiative, launched by former Motorola CEO Robert W. Galvin with former EPRI CEO Kurt Yeager, has brought together many of the nation's leading electricity experts to reinvent our electric power system into one that is fundamentally more affordable, reliable, clean and energy-efficient. The Initiative has created innovative business and technology blueprints for the ultimate smart grid — the Perfect Power System. Based on smart microgrids, the system meets the needs of 21st century consumers and provides reliable, secure electricity regardless of nature's wrath or security threats.

To pave the way for Perfect Power and system transformation as a whole, the Initiative is advocating for new policies that reflect a set of guiding principles — the electricity consumer's bill of rights. For more information on the Electricity Consumer Principles, the policy framework or the Perfect Power System, visit www.galvinpower.org. Here you will find an array of information on every dimension of the intelligent grid transformation and the Initiative's goal of perfect electricity service for every consumer.



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BY JAY STULLER

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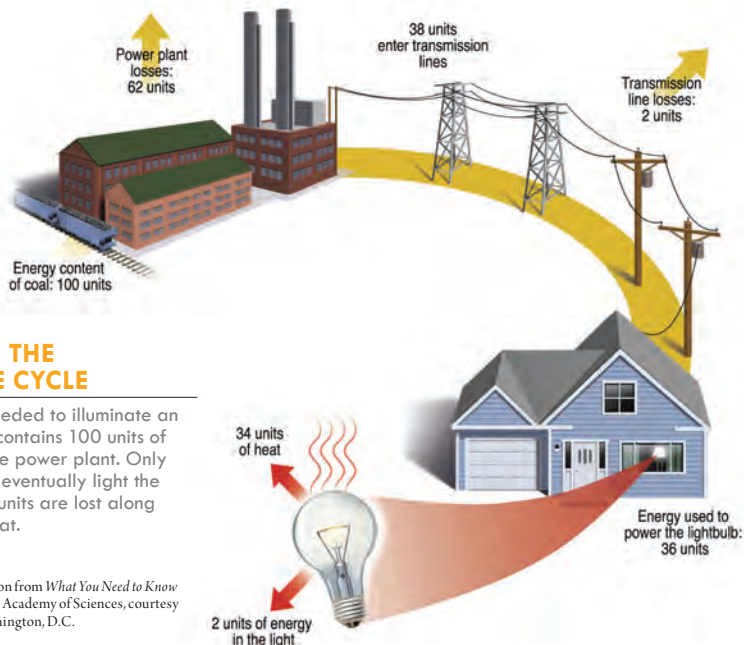


A 1776 of Energy

“... a long habit of not thinking a thing *wrong*, gives it a superficial appearance of being *right* ...”

So wrote Philadelphia journalist Thomas Paine in January of 1776, in the first line of *Common Sense*, a treatise that crystallized Colonial grievances against Great Britain and its monarchy, reinforcing American resolve for independence. Much of the proposition focused on the “absurdity” of hereditary succession. Paine also noted that while England had been ruled by a few good monarchs, it “groaned beneath a much larger number of bad ones.” Like most kings, George III acted in the interests of the crown, not those of the Colonial people.

Few Americans today give more than superficial thought to the nation’s electricity system dominated by regulated utilities that unilaterally control the production, distribution and sale of electricity — the lifeblood of our economy and quality of life. Fewer still



ENERGY LOSS IN THE ELECTRICITY LIFE CYCLE

Imagine that the coal needed to illuminate an incandescent light bulb contains 100 units of energy when it enters the power plant. Only two units of that energy eventually light the bulb. The remaining 98 units are lost along the way, primarily as heat.

Source: Reprinted with permission from *What You Need to Know About Energy*, 2008 by the National Academy of Sciences, courtesy of National Academies Press, Washington, D.C.

envision the need for an alternative. After all, this monopoly system has served the nation well, powering factories, lighting homes and driving labor-saving appliances during a century of economic growth. Electric utilities project the image of a responsible and trustworthy public servant, and their linemen perform clearly heroic work during storms — restoring power to homes and businesses where the lights don't seem to go out all that often.

The truth, however, is that every day about a half million Americans spend at least two hours without electricity. Brownouts, power spikes and minor interruptions shut down computers and bring high-tech production lines to a halt, costing the economy an estimated \$150 billion a year. Even more critical, more than a trillion dollars a year is lost to the U.S. through businesses that move to nations with higher quality electricity supplies. To consumers, who as a result pay among the world's highest electricity bills, the costs of unreliability and lost opportunities are invisible but real, buried in the price of goods and services.

Such failures are accompanied by astonishing inefficiency. In most situations, more than 90 percent of the thermal units that go into generating electricity never light a room or run a motor. The power is lost in the form of heat and steam going into the atmosphere at power plants, as heat bleeding off transmission lines and from

“instant-on” appliances, all of which adds another \$100 billion a year to the cost. Generating electricity also has a steep environmental cost, producing more pollution than any other single industry and more carbon dioxide than the entire transportation sector. In addition, nearly a quarter of the power generation investment is devoted to providing electricity for peak periods of demand. This stand-by capacity includes hundreds of plants used only a few hours each month, yet built and maintained at a consumer expense of nearly \$50 billion a year.

Operated with analog control technology dating to the 1950s and earlier, many of the components that make up the electricity grid are on the verge of failure. A large number of the nation’s power plants are at least 50 years old and operating on borrowed time, as are transmission lines, distribution substations and transformers. According to the Federal Energy Information Agency, as a result of decades of under-investment, renovating and expanding the grid to meet demand alone will cost \$1.5 trillion by 2030.

America is therefore at a critical inflection point, a metaphorical 1776 of energy. We can choose to maintain the grid as it now exists and is regulated, a course favored by most incumbent monopoly stakeholders who are as figuratively entrenched in law and society as was the British monarchy of the 1700s. Or, with a revolutionary, free-market change in the rules of how the industry operates, we can reinvent the system to best serve the needs of consumers.

The nation, in fact, has an unprecedented opportunity to create a 21st century grid that operates far more intelligently, reliably, efficiently and cost-effectively. It would stimulate the economy and expedite the development of clean energy while reducing the need for new conventional power plants. Most important, it would give consumers ultimate control over their electricity use and cost. It is a revolution that would compel utilities to evolve, to focus more on consumer needs and service quality.

This revolution is not a stuffy issue of the past, but in fact is remarkably relevant to younger generations. Social media, networking and entertainment all feed on electricity — and die when standby power fades. Also, with the emergence of practical electric cars, cleanly generated electricity is the most effective means of addressing carbon emissions and climate change. How it’s managed is perhaps the most critical issue facing our nation.



The regulated monopolies enjoy the same protection given to the telephone system prior to the 1970s, when rotary-dial phones came only in black, were owned by the monopoly and were rented to consumers who had no other option.

EARNINGS ENTITLEMENT

The investor-owned electric utility companies in the United States sell nearly three-quarters of the nation's electricity, and generally speaking, their executives and investors will not easily loosen their grasp of the status quo. These regulated monopolies enjoy the same protection given to the telephone system prior to the 1970s, when rotary-dial phones came only in black, were owned by the monopoly and were rented to consumers who had no other option. Utilities hold a similar and largely unchallenged control over electricity, and in most jurisdictions have the exclusive right to electrically connect buildings across roads, which effectively outlaws competition.

Through regulations that ostensibly protect consumers, utilities are entitled to a fixed return on how much they invest in facilities to meet maximum demand, while charging consumers for the average cost of providing power even though the cost is much lower during many periods of a day. Since utilities earn essentially nothing from innovation and believe they will simply lose revenue on such investments, they have no incentive to improve service reliability, efficiency and quality. While most highly admired companies are dedicated to serving consumers, it can be argued that a utility primarily serves not those who buy power, but the regulatory agency that sets its rates.

Since utilities are regulated primarily at the state level, there are essentially 50 different sets of rules and regulatory bodies, in addition to federal regulation of

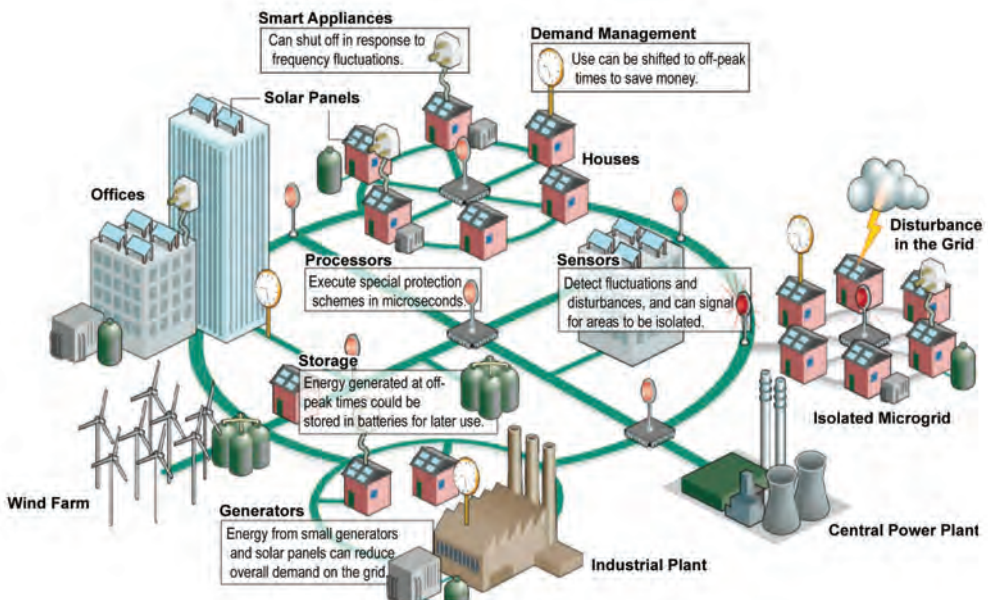
companies that transmit electricity across state lines. Like utility executives, regulators are skeptical about the benefits of reform, and perhaps instinctively resist. Proponents of reinventing the grid thus face opponents who sincerely believe that the existing system, however flawed, still meets the needs of the average consumer.

Because facts suggest otherwise, there's a certain absurdity in leaving the system unchallenged. We live in a digital era that requires near-perfect power quality, but which is served by slow and imperfect analog technology. It's like operating a railroad with switches that take 10 days to open or close. In addition, forcing consumers to pay for the system's invisible inefficiencies is akin to commercial taxation without representation.

There is a very relevant and well-known precedent, however, for reforming a monopoly that no longer serves the nation well. As Bob Galvin, the retired CEO of Motorola and leader of the cell phone revolution, so wisely observed back in 2005: *"Electricity is where the telecommunications industry was 30 years ago: a lot of pent-up innovation and a regulated monopoly business model which lacks the incentive to innovate."*

SMART GRID

A vision for the future – a network of integrated microgrids that can monitor and heal itself



The deregulation of the archaic telecommunications system in the 1970s triggered massive innovation, leading directly to cell phones, the Internet, the iPhone and other technological advances now so necessary to our lives. Telecommunications became far more intelligent through the computerized capability to instantly recognize and adapt to changing circumstances.

THE INTELLIGENT GRID

The same could be said for what's often called the smart grid, though the word "intelligent" is a more precise descriptor. An intelligent electricity system begins by providing consumers with meters that transmit the price and usage of power in real time, and with electronic controls that enable the user's devices to automatically adjust power consumption during peak periods of demand and avoid higher prices — sometimes called "prices to devices." These would replace today's iron curtain of utility-controlled meters over which consumers have no control. Such a grid would enable a seamless and constant two-way flow of electricity and information between power providers and consumers.

The reformed grid also would allow homeowners and businesses with solar panels, wind turbines or other forms of distributed generation to sell any excess power produced back to the grid — at fair market rates that reflect the full value of the service. A truly intelligent grid also would allow consumers in an apartment building, office park, campus or an entire community to combine, or aggregate, their power use in order to secure the most competitive rates and share excess production. These new aggregations — conceivably many thousands of independent islands of power — would effectively transform office and retail buildings, homes and electric vehicles from power pigs into power plants that augment rather than drain the nation's electricity supply.

These smaller entities also would be tied together in a network of intelligent *microgrids*. Each would have two-way controls that are linked to still other



microgrids and the bulk electricity grid, automatically routing power to where it's needed at the speed of light and incorporating a self-healing function that isolates and corrects outages, providing uninterrupted service. What's more, the interconnectivity of these distribution microgrid networks could smooth out the spikes of peak demands, eliminating the need to build additional and expensive standby power plants.

Many technologies for an intelligent grid are already commercially available. Recognizing the profound benefits to the economy and environment, the U.S. Department of Energy's Smart Grid Investment Grant program awarded \$4.3 billion to 100 projects during 2009, most of which regrettably emphasize only *semi-intelligent* electric meters. Alas, fewer than 20 of the projects are designed to give consumers the real tools and information needed to make informed choices. More than 90 percent of the money is simply going to shovel-ready projects, using meters with limited features that retain a utility's control of electricity use and price data. The unfortunate result is that these less-sophisticated devices — which in some cases are leading to mysterious overcharges — are not only giving smart meters a bad reputation among consumers, but also raising suspicions about utility motives and predatory practices.

The barriers to reform are the product of an industry that understandably guards its vested interests and a public that, lacking clearly articulated alternatives, does not yet realize anything is wrong. A Harris Interactive poll conducted in January 2010 found that roughly two-thirds of Americans had never even heard of a “smart grid” or “smart meters.” While the same number agreed that they would cut their energy use if they were capable of tracking it, 42 percent were simply unable to either agree or disagree with the statement: “The electricity system is fine the way it is and a smart grid is not necessary.”

However, as citizens, businesses, media and civic leaders increasingly recognize and express frustration with the system's faults and the huge price it is extracting from every citizen, officials at both the state and federal levels cannot turn a deaf ear. They must either encourage or force utilities to adapt. Voters' demands for reform can thus produce a reinvented electricity system that properly serves the country and its people.



A Nation in Peril

As much as any decade in U.S. history, the one most recently concluded certainly tested national resiliency. In his book, *The Age of the Unthinkable: Why The New World Disorder Constantly Surprises Us and What We Can Do About It*, author Joshua Cooper Ramo describes how ideas and institutions that we once relied upon for our safety are failing. How is it that a global war on terror could produce more dangerous terrorists? How could a struggle to fend off a financial crisis accelerate its downward progress? Just a few years into the new century, he suggests, “we’ve arrived at a moment of peril that not long ago would have seemed unimaginable.”

Fear of how effectively the government would manage a pandemic flu virus is colored by how well it dealt with Hurricane Katrina. Ten years after the World Trade Center towers fell, an empty excavation site remains in their place. The busted



KATRINA left downed powerlines.

real estate bubble and deflated stock market have dashed millions of Baby Boomer plans for a comfortable retirement. Indeed, today's children are the first-ever U.S. generation whose economic and quality of life prospects are projected to be fewer than those of their parents. Most recently, the Gulf of Mexico oil disaster has threatened yet another major energy resource. And in the wake of the Great Recession, the entire nation wonders if another shoe is about to drop.

In *The Age of the Unthinkable*, Ramo looked at the physics of a sand pile as a metaphor for that shoe. When sand is piled grain by grain, it forms a perfect pyramid-shaped cone. Eventually, one or more grains will inevitably cause a side to slough off in an avalanche; the problem lies in predicting when. The cone of sand looked stable, but could give way at the drop of a single grain. One physicist calls the phenomenon “organized instability,” likening it to a fundamental force of nature that affects clouds and civilizations alike.

While no decade has ever been without its disasters, there are prophets who believe that for the U.S., things today can only get worse. In *America for Sale: Fighting the New World Order, Surviving a Global Depression, and Preserving USA Sovereignty*, author Jerome Corsi contends that there are forces outside the country that intend to purchase the nation's assets, while insiders pursue policies that outsource the most valuable jobs and would erase all borders. In leaning toward the apocalyptic, Corsi is tapping into a popular gestalt. Several doomsday films have rumbled through theaters in the past year featuring similar themes. A tiny grain of sand suddenly ends everything.

THE SUPERPROJECT PROTOCOLS

Global catastrophe aside, troubling trends do exist. When Boston's Big Dig ended in December of 2007, it was the last big public works project on the national drawing board. As Louis Uchitelle wrote in a *New York Times* feature on America's “Superproject Void,” major infrastructure projects such as the

We need a revolution in our way of thinking and in the institutions we use to manage the world if we are going to keep up with such a dynamic system.

— Joshua Cooper Ramo

Erie Canal, the Transcontinental Railroad and the Interstate Highway System long characterized the nation's ambition. The feats also shared a common trait: Each in some way integrated distant markets, which in turn led to real economic growth and the creation of shared wealth. Major projects, including the Hoover Dam and electricity grids, have paid for themselves many times over.

With public infrastructure investments on hold, the private manufacturing of hard goods is also in decline. "In the 19th and 20th centuries we made stuff," wrote political analyst David Brooks in the *New York Times*. Today, the U.S. produces protocols, or sets of instructions. "A software program is a protocol for organizing information," Brooks explains. "A new drug is a protocol for organizing chemicals. Wal-Mart produces protocols for moving and marketing consumer goods."

Protocols are extremely valuable. While a piece of steel can be put to one use at any given time, an idea can be used by many simultaneously. Continued economic success, Brooks argues, depends upon inventing and embracing the new protocols. To make them work, he writes that "a nation has to have a good operating system: laws, regulations and property rights." This is what economists call "adaptive efficiency."



BOSTON'S BIG DIG

American business has repeatedly shown that when given even the most meager of incentives, entrepreneurs adapt quickly and efficiently to bring forward ideas, products and services. Upstart companies rise up and compete with each other — think Yahoo! and Google — while still newer complementary enterprises integrate with the established, such as Twitter and Facebook. This is called “self-organization” and it’s yet another fundamental of nature.

“When you spread power instead of hoarding it,” Ramo writes, “you discover benefits that you couldn’t have imagined in advance.” Decentralized groups bend and adjust far better than an organization following orders from central command. It is an arrangement that “exists in the most resilient systems in our world.”

The democratization of energy gives rise to a new distributed social vision in the 21st century that will change our economic, cultural and political institutions as dramatically as the Enlightenment vision that accompanied the first industrial revolution two centuries ago.

— Jeremy Rifkin, *Leading the Way to the Third Industrial Revolution and a New Distributed Social Vision for the World in the 21st Century*

Today’s electricity grid is a product of self-organization that started in the 1880s. Despite its imperfections, the system is more than infrastructure made of steel boilers, concrete and wires. Utilities use protocols in serving their customers. In North America, eight Independent System Operators (ISOs) centrally coordinate, control and monitor the transmission of power, some within a single state and others across borders. In many ways, these operators are the brains in today’s grid — the protocols between utility generation plants — making the decisions to move bulk power to where it’s needed. In a new intelligent grid, these operators would remain as an essential piece of its electronic

nervous system, with consumers serving as the decentralized and added-value capillaries.

Despite the nation's proven resiliency, public confidence appears shaky. Battered by lingering wars, deindustrialization and difficulty in creating unifying legislation instead of partisan conflict, the U.S. seems to be waiting for that grain of sand that will collapse the pile — an event or development we can't prevent or stop.

There is one thing within our control: We must declare independence from the past and not allow the electricity enterprise to continue to drift into senility at the intolerable, growing expense to our nation and all its citizens.

The transformation of the electrical system would in essence be a collective super-project — unconventional and driven by many thousands of decentralized and yet self-organizing public and private interests — an enterprise that runs on sophisticated protocols, bringing together the best aspects of America's past, present and future. It is an endeavor that would produce new U.S. jobs that can't be shipped to other countries, and in turn would create wealth, reliability and security. How the nation can attain this is well-informed by what was done in the past.





The Edison Paradox

During the last decades of the 19th century, America's emerging electrical infrastructure was up for grabs. Thomas Alva Edison put his inventions and investments behind direct current (DC) technology, a form of electricity that at the time required the generation source to be near the consumers, a model of distributed power. The other competitor was alternating current, or AC, which used centralized power plants and with high voltages pushed electricity through wires over much longer distances. The choice between the two was called "the War of the Currents."

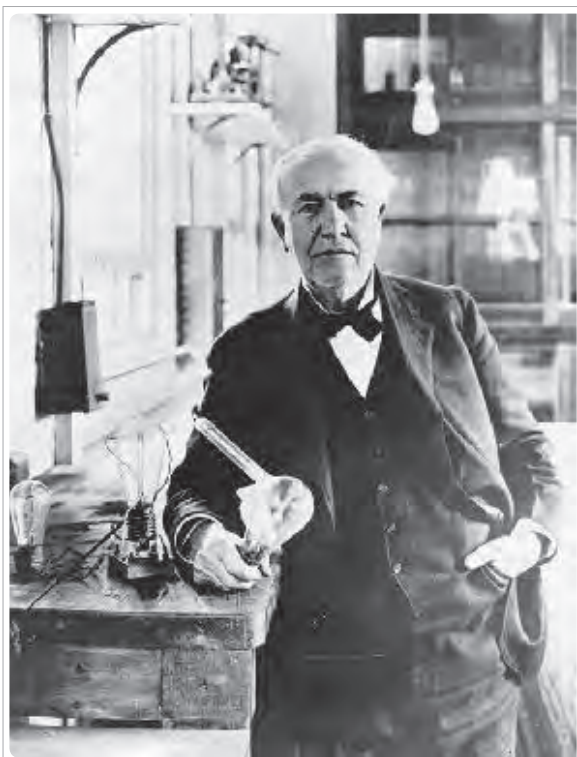
The nation's greatest inventor held an amazing 1,093 patents, including the invention of the phonograph, a motion picture camera and, of course, the electric light bulb. Many of Edison's ideas revolved around connections between seemingly unrelated materials and purposes. Even as he worked on many versions of the incandescent lamp, he also was considering

an entire system that would illuminate the room and more. “The same wire that brings the light will also bring power and heat,” he stated. “With the power you can run an elevator, a sewing machine, or any mechanical contrivance, and with the heat you may cook your food.” His business model was based on providing innovative consumer services *in addition* to producing and delivering electricity.

In September of 1882, Edison opened the first American electricity generation station in the heart of Manhattan’s financial and news district. Six coal-fired dynamos supplied direct current to 85 customers, with enough energy to illuminate 400 light bulbs. Each bulb burned whiter, steadier and more cleanly than any gas lamp, giving a fortunate few the first glimpse into the 20th century.

But the station was also a dirty, loud and ungainly cluster of machines. Edison’s choice of direct current meant that generating plants had to be within a mile of the end-users. It was a concept suited for the available technology and the United States in the 1880s, especially heavily populated urban centers. By 1886, Edison’s firm had installed 58 power stations and some 500 isolated lighting plants in factories, department stores, hotels and apartment buildings. Had his original vision been followed to its logical conclusion, we might well have spent the past 100 years generating electricity much as we do heat, with a furnace in a closet or basement.

While Edison’s consumer service-based vision was ahead of its time, the technologies at his disposal were not. America began to spread out from cities.



THE VISIONARY Thomas Alva Edison

A former Edison protégé, Nikola Tesla, developed a practical generator that produced alternating current, with voltages that were easily transmitted over long distances and regulated with transformers. Ever-larger centralized generation plants became a compelling option at a time when electricity demand was doubling every decade.

Tesla found a backer in George Westinghouse, who saw the economic advantages of large central generation plants near the source or delivery point for coal, and of shipping the power long distances over wires. One generator could supplant hundreds of the smaller Edison-style units. In theory, a centralized system confined pollution from burning coal to a more limited area, remote from population. For all of Edison's brilliance, Tesla and Westinghouse won the technical and economic battle of the currents in a nation starving for electricity.

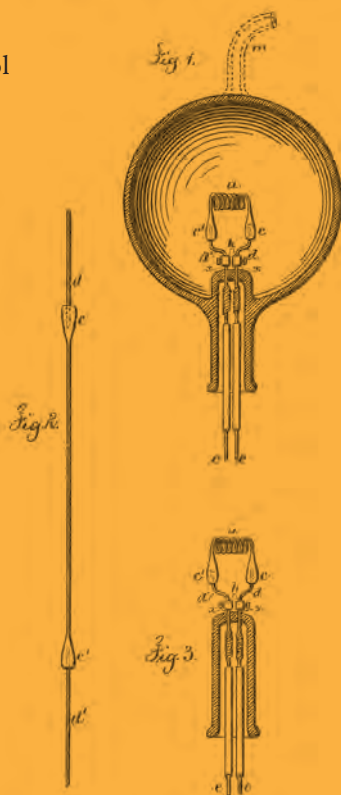
By 1908, the profound importance of electricity was already timelessly highlighted in stone over the entrance of the then-new Union Station near Capitol Hill in Washington, D.C.: *"Electricity — Carrier of Light and Power, Devourer of Time and Space, Bearer of Human Speech over Land and Sea, Greatest Servant of Man — Itself Unknown."* A century later, more insightful words have never been written.

SEEDS OF MONOPOLY

The fledgling electricity business entered its second stage of development — a period that has echoes today — around the turn of the century. At its center was yet another Edison disciple, Samuel Insull, who eventually headed Chicago Edison. Insull understood that if his firm was to prosper, it must reduce the number of small and aggressive firms offering competing supplies of electricity. He began to stimulate demand, offering discounts to farmers and other new consumers while buying almost two dozen utilities. Leading a company

T. A. EDISON.
Electric-Lamp.

Patented Jan. 27, 1880.

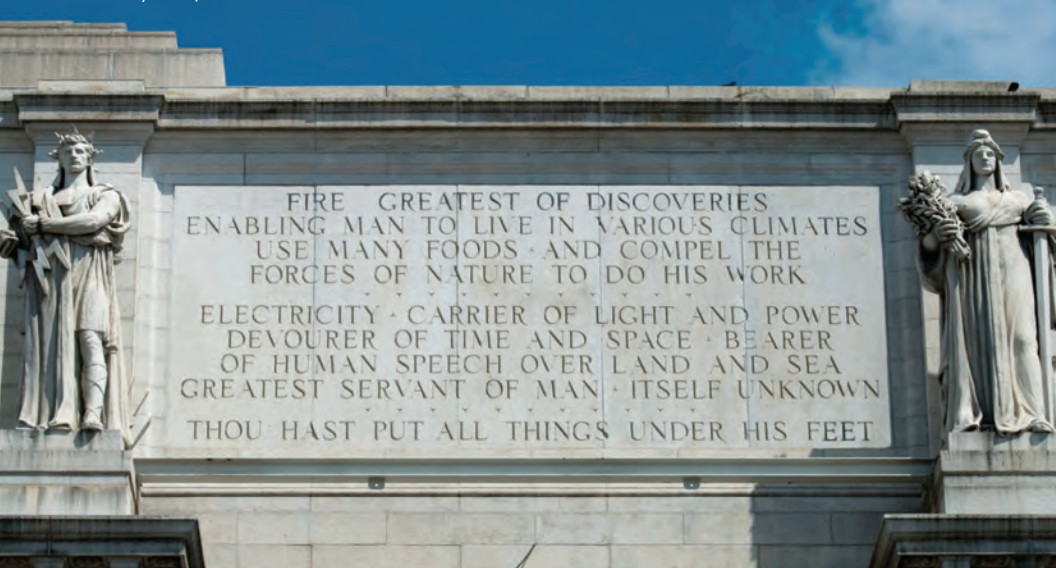


now called Commonwealth Edison, Insull argued that electricity was a natural monopoly, so vital to homes and factories that it should come at a cheap price for everyone and from a guaranteed source.

As capital-intensive as railroads, the evolving electricity business developed high barriers to entry by new competitors. Insull argued that duplicate power plants and wires would be “economically wrong,” and that states should regulate the industry. Having worked the back rooms of Chicago politics, he also knew that campaign contributions would encourage regulators to supervise utilities with a light hand. Emerging state regulations killed off power systems owned by towns and cities. The monopoly lowered prices further, which increased electricity consumption and helped America modernize at a rapid rate even during the 1930s. It also curried political favor.

States passed laws that allowed regulators to set rates that earned utilities fair returns on their investments. The way to earn even more guaranteed money was to make ever-larger investments in generation plants and transmission lines in order to sell more electricity. Insull eventually fell from grace in a political

Photo Credit: Terry Boston, PJM Interconnection



UNION STATION in Washington, D.C. – inscription above the entrance

The same wire that brings the light will also bring power and heat. With the power you can run an elevator, a sewing machine, or any mechanical contrivance, and with the heat you may cook your food.

— Thomas Alva Edison

corruption scandal, but electric power became a necessity that fed the country's appetite for refrigerators, washers, hair dryers and radios. From the 1940s until the early 1960s, power consumption grew twice as fast as the rest of the economy. Economies of scale meant that every new centralized power plant was cheaper and bigger than its predecessors. And as long as the economic benefits continued to accrue to everyone, the monopoly system remained intact.

Progress, however, came to a halt in the mid-1960s when both electricity demand growth and the economies of scale slowed dramatically, but Insull's natural monopoly still continued to dominate. Guaranteed rate structures and a lack of competition bred several generations of change-averse utility executives, who saw little merit in keeping pace with technological breakthroughs. Top university graduates no longer viewed electricity as glamorous and promising. The combination of rising costs and artificially constrained prices created an economic shutdown on investments for service improvement. In fact, since the mid-1990s, the electric utility industry's annual depreciation expenses have exceeded new construction costs.

The paradox of all of this is that Edison had much of it right, especially with his notion of distributed electrical generation for businesses and communities alike. Emerging technologies have now virtually eliminated the natural monopoly argument supporting the wholesale production and retail delivery of electricity. Stiff regulation and guaranteed profits were effective in growing the system, but they now limit a mature industry in dire need of renewal. While public electric utilities played a huge role in making America great, technologies and circumstances have made it the time to give power directly to the people.



Microgrids: Where Technology and Consumers Connect

Reinventing the national electricity grid would not only be a jobs-producing super-project — easily exceeding the magnitude of the interstate freeways — but also a protocol for innovation, organizing the creation and distribution of power into something akin to an energy Internet. At the heart of this proposition are literally thousands of smart microgrids, encompassing large buildings, office parks, resorts, universities and entire communities. Augmenting and working in concert with the bulk grid, microgrids will incorporate alternative and renewable power generation, which in turn will expedite investments in such resources and reduce the reliance on conventional power sources.

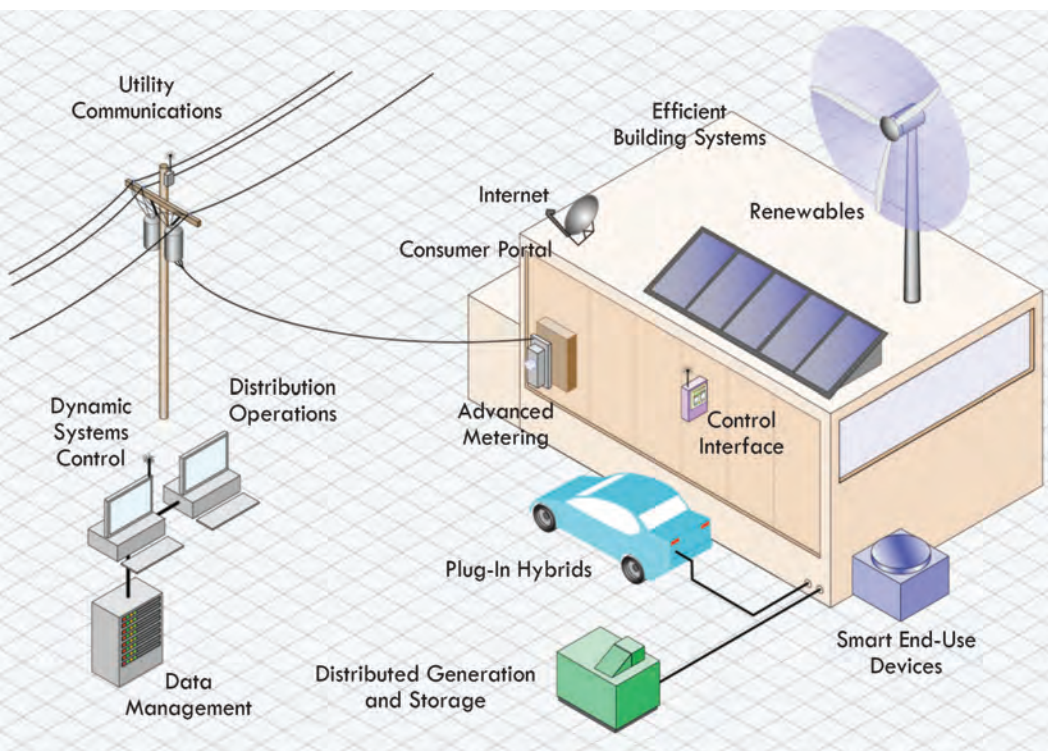
While the present electromechanically controlled bulk power grid is analogous to a one-way radio broadcast, a network of microgrids would function more like the Internet, providing an instantly accurate, real-time, two-way flow of energy and

information. Moreover, as alternative power generation systems are installed on homes and large buildings, microgrids can efficiently route any excess electricity produced to where there's a shortage, reducing the need for expensive new and environmentally detrimental conventional power plants. Intelligent controls providing electricity rates in real time will enable consumers to make informed choices on consumption — using in-house computerized automated capabilities. This interwoven and strengthened power system will provide the unfailing electrical service reliability required in the digital era.

While a holistic, robust and all-encompassing system of community microgrids will clearly take a decade or more to implement, the end result is a consumer-controlled virtual utility. The technical areas of innovation needed to enable an intelligent distribution grid already have been identified and are within reach. They include:

- **Merging electricity and telecommunications** to enable electronic appliances and devices to automatically exchange electricity and information with the bulk power distribution grid so that consumers can choose the most cost-efficient and convenient times for using power.
- **Electronically controlling and monitoring the distribution system** in order to direct the flow of power with pinpoint precision, anticipate disturbances and correct them before they occur, saving the high costs of outages.
- **Transforming today's one-way electric meter** into a two-way consumer portal that enables electricity, price signals and demand decisions to flow back and forth at the direction of the consumer.
- **Seamlessly integrating local power resources**, including solar power and plug-in hybrid electric vehicles, allowing consumers to purchase and sell excess power while helping states meet clean energy standards.

In this highly feasible future, utilities will operate under different rules, with incentives that emphasize reliability, efficiency and a lighter environmental footprint. Full deployment of these innovations could produce a 30 to 50 percent reduction in carbon emissions and a similar improvement in energy conservation. And it would represent a true paradigm shift in how power providers interact with consumers.



CAPABILITIES OF A SMART MICROGRID

This revolutionary system design meets U.S. energy challenges and maximizes consumer and business value.

Look at what distributed computing did for the IT industry. We wouldn't have millions of software engineers if we still relied entirely on mainframe computers hooked up to dumb terminals. Why? It's too expensive, with access limited to the privileged. Distributed power is real democracy.

Today's electricity users are not engaged with the industry beyond flipping switches and paying bills. One Google executive likened electricity use to being forced to shop in a grocery store where the prices are hidden, and paying a lump sum at the end of the month. Electricity consumers don't know about and can't shop in other stores that might offer money-saving options. This concept is foreign to almost any other industry — on its own a reason for reform.



Giving Consumers True Power

Our nation was founded on the principle of decentralized opportunity, not centralized control. Change comes when leaders step forth, backed by growing and informed public support, to advocate what is right. The proposal must be accompanied by a candid acknowledgment of the deficiencies of the existing structure and its governance.

The change also has a noble purpose. Articulating the problems of the current system is neither anti-business nor subversive, but a product of rational and objective thinking. Indeed, if we look at today's electricity industry with what Thomas Paine called "simple facts, plain arguments and common sense," the need for reformation is self-evident.

An Electric Revolution must start with the notion that electricity consumers deserve the same rights as they have in every other industry. Only then will the current rules begin to change.

We the people of the United States, in order to achieve more Perfect Power service, reestablish innovation, ensure consumer empowerment, provide for the common welfare, promote environmental protection and secure the blessings of electricity for ourselves and our posterity, do ordain and establish this electricity consumer bill of rights . . .

The following principles for that transformation serve as a **bill of rights for electricity consumers**:

- All electricity consumers have the right to receive information on the ever-changing, real-time price of electricity — called dynamic pricing — and the means and incentives to use this information to their best advantage.
- All electricity consumers have the right to system reliability and service quality that protects life and safety under all conditions, and meets the needs of today's digital society.
- All electricity consumers have the right to hold their utilities accountable to a publicly open set of performance standards.
- All electricity consumers have the right to buy their electricity services from any source they choose in open, competitive markets.
- All electricity consumers have the right to sell the excess power they produce or store back to the grid at a fair market price.
- All communities have the right to improve their electricity distribution system, with the full cooperation of their utility, to best serve citizen needs.

For a typical U.S. household, the costs and benefits of comprehensive grid modernization are significant. For communities and their citizens, a revolutionary adoption of microgrids woven into a modernized and intelligent bulk power grid — a fundamentally smarter version of what exists today — could yield benefits that typically repay its development costs at least four times over



DYNAMIC PRICING Do laundry during off-peak hours to lower your bill.

within five years of installation. Beyond that, the potential for value and growth is limited only by the nation's need for energy and control of carbon emissions.

Qualitative benefits include more equitable electricity rates; improved customer satisfaction; continued innovation; robust, free-market competition; expanded and higher-quality retail offerings; and perhaps most important, greatly reduced vulnerability to natural disasters or attacks, including computer assaults from terrorists.

In addition, an intelligent grid promises still other benefits for consumers. Consider the cost of power outages and wasted energy. While that \$300 billion annually is a remote number, it breaks down to more than \$2,000 per year for every household in the country. An intelligent grid can easily reduce these costs to consumers by at least 75 percent. For example, an intelligent grid that automatically provides real-time price signals to household appliances can,



SOLAR PANELS installed on a residential roof

at the homeowner's discretion, save significant power and money. Electricity prices can easily soar five times higher during peak periods when collective demand is the highest, such as late afternoons or during heat waves. Knowing precisely when this happens, with corresponding price incentives, would enable consumers to automatically shift energy-intensive tasks — such as drying laundry — to hours with low demand and reduced prices.

The capital costs of plants with the reserve capacity to meet peak demand — which are most often idle — are embedded in rates paid by all consumers. If regulations allowed the collective consumer base to shave peak demand, the need for such plants would largely vanish. It is an exchange, so to speak, of kilowatts for negawatts, putting money and power back into the pockets of consumers.

One of the greatest benefits to individuals and communities of an intelligent distribution grid revolution is the opportunity for job creation and increased income. Direct jobs would come from installation and service of intelligent

and green grid systems. Communities with intelligent and reliable grids would attract modern digital-based industries, which also generate high-value employment and tax revenue. Moreover, on the national scale this is essential to successfully competing in today's global economy.

The right to sell *all* of a consumer's distributed power production is an exceptionally important development, enabled by what's known as retail net metering and a "feed-in tariff." While a growing number of utilities allow customers to feed electricity back into the grid, financial credit typically stops when production equals consumption. When the meter is "zeroed out," the extra power goes to the utility for free. This policy impedes the adoption of alternative generation sources. In much of Europe, feed-in tariffs are standard for homes and businesses that produce their own and surplus electricity and have helped make Germany a world leader in solar energy.

According to U.S. Secretary of Commerce Gary Locke, once the smart grid is more fully deployed nationwide, it will help reduce power demand by more than 20 percent and bring nearly a half-million jobs online.

— Remarks at the 21st Annual Energy Efficiency Forum
June 16, 2010
Washington, D.C.

Advocates for the disadvantaged express concerns that an Electric Revolution would leave the poor behind, that clean energy would burden budgets already stretched perilously thin. While the less affluent in the nation probably can't invest in solar panels and sell excess power now, they would benefit from intelligent, consumer-empowering meters and home automation, supplied at no cost by entrepreneurial microgrid operators. Lower energy prices and new job opportunities would be a disproportionate advantage to the less fortunate — the hallmark of insightful social policy.



A Primer on Reform

Throughout most of the past century the main players in utility regulation have been the utilities' own attorneys and lobbyists, state public utility commissions and state elected officials. The Federal Energy Regulatory Commission regulates the transmission and wholesale sale of electricity across state lines and monitors and investigates energy markets. One of the nation's largest industries, electric utilities have immense political and economic leverage. As a result, electricity issues are often shrouded in detail, rhetoric and complications that baffle the general public.

The plain fact is that the electricity business is terrifically complex. By its nature, it is an extraordinarily capital- and technology-intensive, politically constrained enterprise where even the best-intended proposition can get picked apart with caveats, exceptions and reminders of previous plans gone wrong. For example, the federal Energy

Independence and Security Act of 2007 offered a number of excellent policy choices. But while it encouraged states to make changes, it didn't hold them accountable. As a result, relatively little progress has been made in the absence of coherent leadership.

Indeed, prior to the 2008 election both major political parties stated that transforming the electricity system was essential to the nation's future. Alas, with the exception of the marginal Smart Grid Investment Grant Program, Washington has found itself engaged in other more partisan matters.

With support from consumer advocacy groups, several progressive state legislatures have been pushing for change, but often meet fierce utility and regulatory resistance. Even so, a quiet side of the revolution is under way in the states that have implemented reforms. Based on their experience, the following are protocols for comprehensive electricity system reform:

REFORMS THAT EMPOWER CONSUMERS AND BUSINESSES

- **Consumer access to data and improved meters:** Give consumers access to data about their electricity use so that they are better equipped to save energy and money. Also, allow intelligent meters and automation systems to be installed by consumers or third parties. Establish national standards for those meters and eliminate the one-way utility information control systems now in use.
- **Aggregation:** Establish rules that allow communities, campuses, multi-tenant buildings and facility owners to efficiently combine or aggregate meter loads, both to streamline billing and so they can purchase electricity that costs less or is more environmentally friendly, or both.
- **Retail competition:** Allow communities, businesses and consumers to buy electricity services from whomever they choose, enabling them to obtain power from low-carbon and renewable sources directly. Free markets provide the proven incentive for innovation.

REFORMS THAT VALUE CONSUMER ACTION

- **Price transparency:** Intelligent meters connected via the Internet or other communication devices must provide consumers and their appliances with

electricity pricing information that reflects how prices vary throughout the day. This is at the heart of a consumer-centric smart grid.

- **Net metering:** Establish rules that allow customers and aggregated communities to sell local distributed generation back to the grid at appropriate rates. An enabling policy is the feed-in tariff, which encourages investments in distributed power generation.
- **Ancillary service payments:** Compensate customers when they provide services such as conserving energy during peak periods and investing in renewable energy, especially in response to state and federal carbon-reduction legislation.

REFORMS TO ELIMINATE MONOPOLISTIC REGULATORY BARRIERS

- **Streamline interconnection rules and processes:** Interconnection standards are the technical requirements and legal procedures that would allow a utility customer to make two-way connections, a prerequisite for net metering. States should adopt a consistent, transparent set of provisions that facilitates these connections in the most consumer-friendly ways.
- **Enable the post-meter device market:** Eliminate utility company control over selling and installing in-home devices that help consumers manage electricity use. Allow entrepreneurs to offer consumers the most innovative choices at the most reasonable prices.
- **Microgrids:** Eliminate laws that prohibit local governments and third parties from aggregating demand and owning electricity systems that cross public rights of way. Establish rules that allow privately owned microgrids and district energy systems that are designed to provide the highest quality service at the lowest cost.



REFORMS THAT IMPROVE UTILITY ACCOUNTABILITY

- **Reliability targets:** Establish much more stringent reliability standards, with incentives and penalties that require utilities to provide electricity quality that meets the needs of 21st century consumers.
- **Intelligent grid program oversight:** Establish detailed grid performance goals — including metrics, reporting and program requirements — to ensure that aggregated power areas and utilities are held accountable for providing reliable power and spending repair and upgrade dollars most effectively.
- **Performance-based rates:** Compensate utilities based on their overall performance, taking into account energy efficiency, innovations and customer service, instead of simply the amount of electricity they sell.



An Inconvenient Experiment

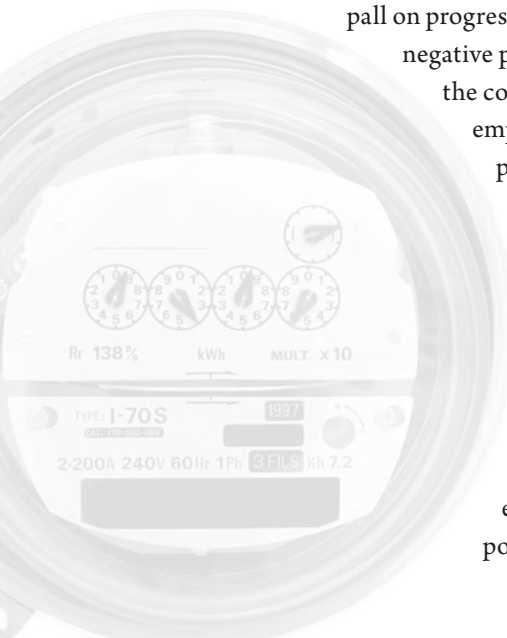
Historically, the central problem in developing competitive electricity markets is the need for a system operator to manage complex, short-term power grid interactions and maintain system reliability. The key is to continuously maintain the balance of power supply and consumption under all conditions. In the past only utilities could master the task. But complex consumer digital demands combined with aging analog controls have seriously eroded utility companies' ability to maintain operational control, leading to increased unreliability and insecurity. An intelligent deregulated system using digital controls is essential to meeting 21st century needs.

To many in the electric utility industry, deregulation is a word with exceptionally negative connotations. Market reforms attempted in California during the 1990s turned out particularly badly, bringing about

changes that were more “destructuring” than deregulation, yet carried a whiff of regulatory glasnost. What the state put in place was a volatile combination of bad economic theory and worse political practice, which ultimately put California and its rate-payers at the mercy of Enron’s traders at the zenith of the firm’s malevolent power. This was the equivalent of leaving the state’s front door unlocked and posting a sign welcoming burglars.

California’s inconvenient experiment began with the creation of a group of isolated wholesale markets, contrary to the well-established competitive business model that emphasizes development of both wholesale and retail markets. In effect, California created a volatile wholesale market structure, but maintained a closed retail electricity market with fixed sales prices. Fundamentally this disconnect cannot work, since efficient retail pricing and incentives are essential if consumers are to benefit from competition. California’s true problem was not deregulation, but rigid retail price regulations, coupled with the prohibition of long-term wholesale supply contracts that led to bankrupt utilities.

It was a serious act of mismanagement by the state government and its public utility commission. California is still paying for a debacle that cast a nationwide pall on progress toward deregulation and still gives negative propaganda to opponents of change. But the conclusion that deregulation and consumer empowerment cannot and do not work is patently untrue. What is true is that details matter, which means including wholesale and retail markets in the process so that dynamic, transparent pricing will give consumers an incentive to adjust their demand for electricity accordingly. Above all, state governors and legislators need to act wisely and courageously on behalf of their electorate and not be driven by short-term political expediency.



A PLACE FOR UTILITIES

Fortunately, many other states recognized the flaw in the California debacle and are creating more elastic markets for entrepreneurs and consumers. Further propositions for deregulation also must include a manageable “off ramp” for utilities, leading to a new road that *includes them* in the development of an intelligent grid. No matter how much solar and wind power the nation develops, it will be many decades before the electricity produced by utility power plants is not needed, if ever. The nation thrives on electricity, and as re-chargeable electric automobiles are developed, still more electric power will be needed. With a reinvented grid, those who know how to make and move electricity are critical resources. Utilities will always “follow the cheese.”

The federally led nationwide elimination of monopoly businesses in favor of competitive free markets has overwhelmingly succeeded in the airline, trucking, railroad and telecommunications industries, among others. Several states, including Texas, Pennsylvania, New York, Massachusetts, Ohio, Illinois and Connecticut, have begun opening retail electricity markets to competition, poisoning them to take full advantage of intelligent grid technology. Elsewhere, however, the inclination is to resist. As an astute energy research executive once pointed out, while a few utilities are warming to the idea of microgrids, most view them “as an existential threat to their business models.”

Utilities, however, can perhaps gain confidence from an analogy described in *The Age of the Unthinkable*. While many factors contributed to the demise of the former Soviet Union, author Ramo believes that it finally imploded only when the army officers, factory managers, mayors and other elites who managed the nation’s daily work simply let it go. He suggests that these individuals knew that if and when the empire fell, it was they who would be in the best position to pick up the pieces in Russia and the newly independent republics. The idea also carries a ring of truth in the case of AT&T, the deregulated phone monopoly that thrives in today’s competitive communications world. While no industry is ever deregulated without disruption, utilities are in an excellent position to follow the AT&T example and profitably implement many aspects of reform.



Grains of Sand

The holy grail of modern architecture is a design for a zero-energy building, or ZEB, that uses efficiency, solar and other power systems to produce as much electricity as it takes off the grid. While there are challenges, a Chicago-based architecture firm has designed a 71-story skyscraper that will soon open in China, which will be 58 percent more energy efficient than conventional skyscrapers. And it's clear that as more efficient solar panels are developed, an increasing number of homes and ZEBs will be built, including structures that produce more electricity than they use.

In California's Silicon Valley, one firm recently revealed a power plant in a box, a collection of small fuel cells that efficiently produce electricity from a variety of fuels, including natural gas, ethanol and landfill gas. A *Fortune* magazine report indicates that at least three large firms are developing small nuclear power plants, designed to be buried more than 15 feet underground, operate with few moving parts

and produce enough electricity for a mid-sized town. When tied into a series of interlaced microgrids, these islands of power will be parts of the framework of a new intelligent national grid.

The Electric Revolution is gaining federal attention, evident in a request from the President's Executive Office of Science and Technology Policy for consumer input on an intelligent grid transformation. Meanwhile, several states are taking the lead in creating policies and changing regulations, which will benefit consumers and pave the way for a reinvented system. For example:



In **TEXAS**, after seven years of retail electricity competition, consumers now have dozens of retail electricity service providers from which to choose. Fierce competition has maintained pressure on electricity prices, even as fuel costs have risen. Beyond prices, the competitive market has significantly enhanced investment and job growth in Texas, which was named the “Top State for Business” in 2008.



In **PENNSYLVANIA**, state policymakers and industry experts have encouraged competitive electricity markets for more than a decade; rates there that were 15 percent above the national average are now 5 percent below. All costs from construction overruns, refueling delays and inefficiency are borne by the utility investors, not their customers.



The **ILLINOIS, OHIO, MASSACHUSETTS** and **CALIFORNIA** legislatures have empowered local governments to form “virtual microgrids” to purchase clean power by aggregating residential meters. This also gives communities the ability to deploy home automation, encourage efficiency and integrate clean local generation. This creates revenue from ancillary services while lowering electricity supply costs. Ohio law also has mandated that utilities make dynamic pricing available for all consumers.



NEW YORK has been a leader in offering consumers dynamic pricing and other programs that value their participation in the electricity market. Consumers are rewarded for reducing electricity demand and increasing conservation via payments and lower electricity bills.



Thanks to forward-thinking senior state officials, **NEW MEXICO** is committed to implementing the first statewide intelligent green grid, with at least half of its electricity coming from renewable energy sources delivered through community microgrids.

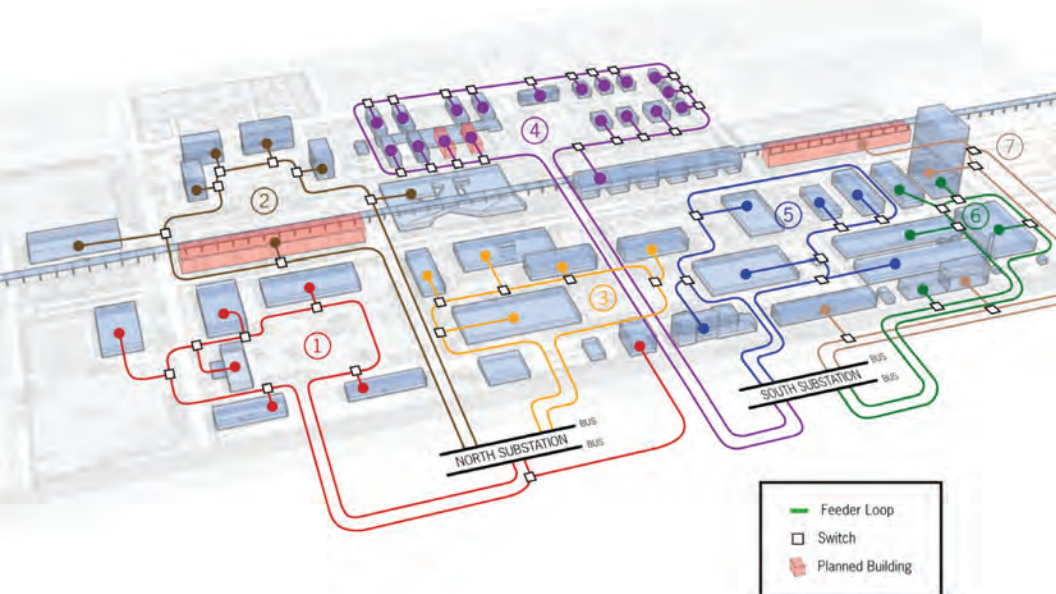


OREGON has implemented net metering and interconnection standards that put the state “at the head of the class,” contends a New York-based group that promotes safe and clean energy policies. Oregon’s program has an aggregation rule that allows farmers and factories that may have more than one meter on their property to use net metering credits over several sites, opening the way to cost-efficient use of renewable energy.

The ability to readily expand clean distributed power systems is being demonstrated by a growing number of projects, including a 12-megawatt Perfect Power microgrid system at the Illinois Institute of Technology (IIT) in Chicago.

PERFECT POWER AT IIT

Illinois Institute of Technology’s 12-megawatt, campus-wide microgrid system



Conceived and launched by the Galvin Electricity Initiative in collaboration with Commonwealth Edison, Endurant Energy, S&C Electric, and in part thanks to a \$7 million grant from the U.S. Department of Energy, the project is a model for how to modernize local electricity distribution grids nationwide. Unlike most communities, however, universities typically own and control their infrastructure.

When complete in 2013, the prototype will solve a major IIT problem. With a system built largely in the 1960s, IIT's energy infrastructure was nearing the end of its useful life. In the harsh Chicago winters, IIT experienced an average of three or more major power outages each year, costing more than \$500,000 annually in restoration expenses, lost productivity and the incalculable value of ruined experiments. To remedy the problem, IIT is modifying its existing stand-by turbines for a fast-start capability, enabling them to fill in if the utility's incoming electricity supply fails or to supply power to the grid if needed.

Controlled with advanced meters and switches, this capability also will enable IIT to earn revenue from the utility for providing the power response and services, which will ultimately include solar power and controls that optimize building efficiency. Moreover, the redundant design and intelligent service will provide continuous energy to IIT buildings, no matter what transpires off-campus.

At a \$20 million cost, the campus microgrid system will pay for itself within five years. Along with eliminating the need for a new \$5 million substation, it allows ComEd to defer a \$2 million upgrade to a substation that serves IIT. The Perfect Power microgrid will save between \$500,000 and \$1.5 million annually by reducing power use during periods of peak demand, and will supply electricity back into the grid. With \$3.5 million of the project devoted to research, the social benefits of the project are profound, especially if it is replicated. Other community microgrid initiatives include:



Not that far from IIT is **NAPERVILLE, ILL.**, which is virtually outage-free. Named one of *Fortune* magazine's "Small Business' Best Places to Live and Launch" in 2008, Naperville owns and operates its own microgrid-like electricity system, which provides more than 80 percent

higher reliability than its predecessors. With \$10.9 million from the U.S. Department of Energy's smart grid grant program, Naperville will deploy more than 57,000 intelligent meters, allowing consumers to follow in real time the cost of electricity consumption and lower costs by shifting their use of power.



The city of **LEESBURG, FLA.**, is transforming electricity service quality and efficiency for all of its 23,000 electricity consumers via a truly intelligent community microgrid network that incorporates distributed generation, electronic monitoring and control, and a smart meter network providing time-differentiated rates.



The city of **DANVERS, MASS.**, plans to deploy more than 12,000 smart meters for its entire customer base while upgrading its cybersecurity system and automating outage management.



In **FORT COLLINS, COLO.**, the city plans to install 79,000 intelligent meters and in-home dynamic response systems that include in-home displays, smart thermostats, and air conditioning and water heater control switches. It also will automate its power distribution system and enhance grid security.

These steps by states and communities are like tiny grains of sand falling upon the cone-shaped pile. At some point, one or more grains will cause it to collapse, changing the shape of the nation's electricity service, its economics and environmental impact.





A Call to Action

In a piece on the ideological gridlock that so cripples rational discourse in Washington, D.C., columnist E.J. Dionne Jr. noted that, “The most vibrant reform alliances in our history have involved coalitions between populists (who stand up for the interests and values of average citizens) and progressives who fight . . . for institutional changes to improve the workings of our democracy.” The formula sounds fitting for electricity system reform.

Even while large institutions control the electricity business and the regulatory system, individual consumers have a profound role in change, if only because individual consumers have votes — for city council positions, mayors, state legislators and members of Congress. Individuals can patronize entrepreneurial businesses that develop alternative power, intelligent microgrids and distributed power generation. Such businesses and individuals also can urge government officials to consider the

economic and environmental potential of aggregated power from business and industrial parks, campuses and city-wide microgrids. Individual citizens also can ask utility representatives for answers about real-time pricing and truly intelligent meters, and install smart appliances and tools such as programmable thermostats and energy management systems. All of these steps build a foundation for bringing about change.

There are dozens of websites devoted to developing intelligent grid technologies and systems, some of which focus lobbying pressure on state regulatory agencies, and others on the Department of Energy and the Federal Energy Regulatory Commission (FERC). Although elected officials in Washington may seem remote and detached, individual voices are powerful, as evidenced in the town hall meetings during the health care conversation. Social media are also useful for generating support for electricity reform, an issue that should find favor with populists, progressives and especially younger generations, whose lives are so filled with digital devices that depend on high-quality electricity.

Indeed, U.S. Representative Edward Markey (D-MA) introduced federal legislation in March of 2010 called the Electricity Consumers' Right to Know Act (H.R. 4860), which if passed would ensure that all utility customers have free access to timely and secure data on their electricity prices and consumption patterns. As an Amendment to the Public Utilities Regulatory Policies Act (PURPA) of 1978, this bill also reinforces a recommendation that FERC develop national standards for providing consumers with such data, and requires state regulators and utilities to formulate consistent policies. Not only is H.R. 4860 a positive step on its own, but it also could pave the way for comprehensive legislation consistent with the Electricity Consumer Principles. But as with any matter in Washington, broad and vocal support is critical to its passage.

Although the details of electricity management are complex, demanding retail electricity competition and two-way meters that show consumption and a transparent price isn't a rocket science kind of request. The idea of long-term financing for communities that want to develop microgrids is quite basic. So, too, is the suggestion of aggregated islands of distributed power generation, which can earn a fair price for any excess power fed into an interwoven grid. Although the technical aspect of uniform national interconnection standards

“Challenge the status quo and don’t settle for anything less than perfection.”

— Robert Galvin
founder, Galvin Electricity Initiative

is best left to engineers and scientists, most citizens would agree that smoothly incorporating all of the nation’s microgrids and their clean power resources into the bulk power grid is a wise move indeed.

Citizens also must demand a shift in regulatory policy so that it’s no longer acceptable for an unchallenged utility to decide what’s best for consumers. Policy should enable businesses to compete to fulfill consumer needs — and even create new ones — with the best ideas winning in the marketplace. When an unlimited number of the best and brightest creative minds, including those of consumers, have the freedom to improve the system, the potential for success is unlimited, with perfection almost assured.

The nation’s leaders, including elected officials in Washington and the 50 state capitals, need to hear this from citizen-consumers. Just as the American Revolution finally erupted from public frustration with a government that did not respond to legitimate concerns, the same is true of an Electric Revolution. It hinges on the collective voices and actions of a people who recognize how adversely they and future generations are affected by an increasingly dysfunctional electricity system.

The unreliability, inefficiencies, waste, environmental impact and resulting extreme costs are clear. So is the resistance to change from those who make and regulate electricity, however instinctive it might be to defend the status quo. While the establishment can be excused for its natural inclination to preserve a known system, a failure to intelligently evolve — to support, enhance and embrace the far superior intelligent alternative that’s now developing — is unforgivable. In fact, reforming and reinventing the nation’s electricity system is nothing more than simple common sense. 🌱

WHAT YOU CAN DO TO JOIN THE ELECTRIC REVOLUTION

1. CHAMPION THE REVOLUTION.

Visit www.galvinpower.org and share the link for *An Electric Revolution* with your family, friends, neighbors and co-workers. The more they understand and advocate for change, the closer we will get to system transformation.

2. BECOME A FRIEND OF THE GALVIN ELECTRICITY INITIATIVE.

Visit www.galvinpower.org and click on Connect to stay updated on revolutionary news. Join our e-mail list, follow us on Twitter at @PerfectPower and become our Facebook friend.

3. PRESSURE YOUR POLICY MAKERS TO LEAD THE REVOLUTION.

Whether it's an election year or not, your opinion — and vote — matters to candidates in your community, county, state legislature and U.S. Congress. Let them know by phone, e-mail and/or face-to-face meeting that they need to join the Revolution to gain your support. Look up your elected representatives and their contact information at USA.gov (www.usa.gov).

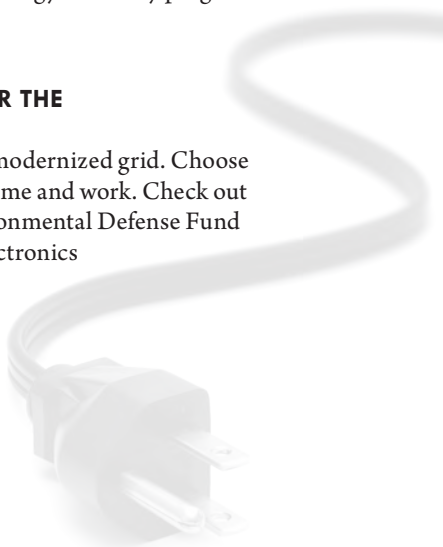
4. HOLD YOUR UTILITY SERVICE PROVIDER ACCOUNTABLE.

Learn how to read and understand your electricity bill. Ask your utility how they are helping to modernize the grid and request energy efficiency programs that can help you conserve and save you money.

5. PREPARE YOUR HOME AND BUSINESS FOR THE REVOLUTION.

Make sure your home is ready to plug into the modernized grid. Choose energy-efficient materials and appliances for home and work. Check out EnergyStar (www.energystar.gov) and the Environmental Defense Fund (www.edf.org) for ideas, as well as your local electronics and appliance retailers.

For more information, please contact Crystal Borden at cborde@galvinpower.org.



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PRAISE FOR AN *ELECTRIC* REVOLUTION

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