Don't Choke:

How to Transform Technology

Infrastructure investment has been on a starvation diet. Here's how to feed the need.

By Kurt Yeager

In October, the North American Electric Reliability Council (NERC) issued its first long-term reliability assessment report in its new role as the nation's federally mandated reliability organization. The report found that under current trends the U.S. electric power system may not be able to meet customer demand in much of the country 10 years from now.

While this estimate made headlines around the country, it was hardly shocking news to those of us in the field. What should be alarming, however, is the continued belief that we can incrementalize our way out of this impending crisis by installing more of the same outmoded technology.

Because of its life-support investment diet, the electricity infrastructure has grown dangerously vulnerable to all manner of reliability, security, and service infirmities. The 2005 Energy Policy Act provides an important initial stimulus for this transformation.

Transformative change will require massive shifts in every aspect of the electricity sector, from how we define reliability to how electricity is regulated and sold. It will require a working consensus that electricity is more than just another form of commodity energy, but is instead the underpinning of our modern quality of life and the nation's indispensable engine of prosperity.

A transformed electricity enterprise confidently and sustainably will provide the nation's most essential platform for technical innovation, productivity growth, global competitiveness, and continued economic prosperity. In hard numbers, a conservatively estimated $2 trillion per year in additional revenue could be available to both the private and public sectors by 2020 if the electric-power system were transformed wholly into one that is substantially more efficient and totally reliable. This would enable the nation to generate the additional wealth necessary to deal with the growing societal, security, and environmental challenges of the 21st century. It stands to reason, then, that the flip side of this equation could choke our economy in the global marketplace.

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The Growing Need for Technology Transformation

With that understanding, we can then take the first step in this transformation process: accepting that we must do more than just react to a greater number of consumers in the future. Instead, we need to meet fundamentally different needs—needs that exist in subsets of society today but will become nearly universal in the next decade or two.

Today electricity can benefit from a healthy spirit of discontent with the *status quo*. The fundamental principle is that "quality always saves."

The Galvin Electricity Initiative—a nonprofit, public-interest project founded by former Motorola chief Robert W. Galvin—recently released a report that considered consumer needs for electric service in the year 2025.

Using scenario-planning techniques, the Galvin team of technological and electricity experts and futurists first sorted through current trends to discern the fundamental factors driving what consumers will need from their electric-energy service by 2025. The team determined that consumers will require service that recognizes the need for much greater energy efficiency, has substantially reduced environmental impacts, and can power a wholesale shift from yesterday's electro-mechanical or analog society to a fully digital one. It is no great leap to realize that the existing system, regardless of how expanded in capacity, still will not be capable of meeting these needs even a decade from now.

Interruptions in the electricity supply cost American consumers an estimated $150 billion a year. In other words, for every dollar spent on electricity, consumers are spending an additional 50 cents or more on the other goods and services they purchase to cover the costs of power failures. In a fully digital world, the existing "3 nines reliability standard" and its accompanying costs will be even more devastatingly inadequate. Even the slightest disturbances in power quality and reliability cause loss of information, processes and productivity. Interruptions and disturbances measuring less than one cycle (less than 1/60th of a second) are enough to crash servers, computers, intensive care and life support machines, automated equipment, and other microprocessor-based devices. In addition, a much larger fraction of electricity load is controlled electronically and is thus also susceptible.

Digital Domain

Digital-quality power, with sufficient reliability and quality to serve such devices, now represents about 10 percent of total electrical load in the United States. This demand for Internet-quality power will grow at a compound rate of 17 percent a year through at least 2010—roughly in line with shipments of high-end servers. The available digital-quality power load is expected to reach 30 percent by 2020 under business-as-usual conditions, and as much as 50 percent if the power system is revitalized to provide digital-grade service to all those who would need it. The implications for the nation's productivity and job creation are profound.

In a world where resources are even scarcer than they are now, a system that continues to lose two-thirds of the energy it consumes also will be wholly unacceptable, and even could be dangerous. As climate change continues to threaten our world, the system's emissions and inefficiencies will become a serious liability in the global marketplace. A transformed power system, however, can help steer national energy and security policies to emphasize U.S. fuel diversity and independence, placing electricity at the center of a strategic thrust to develop a clean, sustainable portfolio of domestic energy options together with enhanced end-use efficiency and reduced dependence on unreliable and expensive foreign energy sources.

Based on these identified drivers, matched with innovative technology opportunities at the consumer interface, the Galvin Electricity Initiative is completing a blueprint for such a transformed system. By "system," we mean all the elements in the chain of technologies and processes for electricity production, delivery, and use across the entire spectrum of residential, commercial, and industrial applications. This blueprint for renewal incorporates an array of breakthrough technical innovations that enable the system to automatically recognize problems, instantaneously find solutions, and continuously optimize performance to meet the expectations of each consumer. The enabling technological building blocks include power electronic controls, miniaturized sensors, distributed generation and storage, direct current circuitry, advanced building systems using smartly efficient end-use devices, integrated communications, and ultrafast simulation computational capabilities.

Get Smart

In broad strokes, the architectural framework we are building envisions a self-healing, electronically controlled, smart electricity supply system of extreme resiliency and responsiveness—one that is fully capable of responding in real-time to the billions of decisions made by consumers and their increasingly sophisticated microprocessor agents. This system architecture can be applied at any scale, from individual buildings to entire distribution systems. The micropower generators, renewable resources, and energy storage capacity that these technically transformed systems incorporate also provide immediate ways to simultaneously reduce carbon emissions, improve energy efficiency, and ease the strain on the stressed bulk power grid. »

Supplemental power is available when needed through easy-to-use demand-response measures at the consumer interface.

The combination of enabling technology and dynamic pricing changes the value proposition to the consumer from "I flip the switch and hope the lights come on," to one of instantaneously engaging a diverse array of value-added services.

The elements we propose in our architectural framework are not unique to our project. The Gridwise Alliance, Intelligrid, the Modern Grid Initiative, and others have been doing excellent work in creating and advocating for the technologies and changes that we seek. However, by focusing on the consumer interface, we believe our initiative can most rapidly transform retail electricity service reliability and quality at the lowest cost while sustainably using the nearly $1 trillion existing bulk electricity infrastructure to the best advantage.

What is unique about this initiative is that this system, when constructed, will be no less than perfectly reliable. It never will fail, under all conditions, consumers' expectations for electricity confidence, convenience, choice, and value.

The Galvin Initiative also moves far beyond the theoretical. We currently are collaborating with existing commercial enterprises, utilities, and entrepreneurs to create "Perfect Power" prototype installations that help raise the public consciousness concerning the opportunities for superior electricity service. The fundamental value proposition is demonstrating consumer value measurable in dollars-per-kilowatt-hour, compared with the cents-per-kilowatt-hour that consumers pay for electricity.

Numerous Reasons

The reason for pushing ahead to local, consumer-focused prototypes is manifold. First, the most confident and sustainable engine for quality improvement is enabling innovative, self-organizing entrepreneurs to commercially engage in the electricity enterprise. Second, the quickest path to challenging the performance *status quo* and demonstrating quality transformation is to target the transformative innovations on the consumer interface with the bulk power system. Third, this approach initially circumvents the relatively intractable, rigidly regulated monopoly bulk electricity infrastructure while using it to best advantage as the primary energy source for the microgrids.

Radical as this all may sound today, it is in fact rooted deeply in history. This vision is reminiscent of Edison's original vision for the electric power industry. Edison did not envision an industry that sold only electricity as a commodity, but rather created a network of innovative technologies and services that provided illumination and other services. In this time of rapidly rising electricity costs, regulators and utilities alike need to engage consumers and begin to provide this superior value proposition.

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discounts, shown from both perspectives, vary as fuel prices and IER vary.

To the extent that all of the thermal energy is not fully utilized, the potential cogeneration discount will be reduced. For example, if the amount of used thermal energy in assumption A3 were 40 units instead of 50 units, the PURPA operating standard would fall to 57.1 percent [40/(30+40)*100%]. The amount of perceived thermal savings falls. The values in Tables 2(40) and 3(40) would be replaced by Table 3 (40) and Table 4 (40), respectively.

If QFs were forced to compete with merchant generation, one could expect the QFs to discount their electric generation production costs up to 90 percent of their thermal savings. However, the perceived amount of thermal savings can vary greatly depending on the IER and the amount of thermal energy utilized. In addition, as the price of natural gas varies, the amount of discount in dollars per megawatt also varies.

Given the disparity in the perception over the amount of thermal discount available and the recent volatility in natural-gas prices, the elimination of the utility must-purchase obligation can lead to an unanticipated major reduction in QF cogeneration production and the loss of social benefits directly related to the fuel savings attributed to CHP.

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Endnotes

1. New PURPA Section 210(m) Regulations Applicable to Small Power Production and Cogeneration Facilities, Oct. 20, 2006, *Docket No. RM06-10-000, Order No. 688.*
2. In an electric production simulation model run, when QFs were dispatched solely on the production cost of electric generation, QF production fell by about 50 percent. When an $8/MWh discount to production costs was applied, QF output »