ENERGY UTILITIES FACE UNPRECEDENTED CHALLENGE, OPPORTUNITY

BY MARTIN ROSENBERG

ILLUSTRATION BY TOD KAPKE
These days, you are likely to bump into Penzias at events like the annual Energy Venture Fair, where startup energy technology companies court venture capitalists. The annual event was held in early November in Santa Clara, Calif.

Count Penzias among a growing cadre of thought leaders who are convinced that energy innovations will push the next wave of significant, worldwide social and economic change. Coming decades will be defined by a flowering of new energy technologies, just as computers and communications devices defined the recent past. Visualize your life before the advent of laptops and cell phones and then picture your life today, and you will better appreciate the magnitude of change that is coming in how we capture and utilize energy to move about, light our homes and spin the wheels of industry.

For the economically gigantic power and natural gas industries, the question of the moment is how to best prepare for the new epoch. To approach an understanding of the scale of spending that will be required, think Apollo space program or the erection of Egypt’s pyramids. The Edison Electric Institute (EEI), the Washington arm of the power industry, recently reported that electric utilities last year spent $46.5 billion, up 13.5 percent from the preceding year, on new generation, improvements to transmission and distribution lines and compliance with fast-evolving environmental standards. Yet many now believe that today’s level of capital investment is but the overture to spending on a vastly larger scale. A group of utility chief executive officers that recently met with EnergyBiz said their top concern was whether there will be adequate electric generation in years ahead, and how to best

By nearly any reckoning, U.S. utilities are technologically conservative, intent on continued operation of existing assets with as little upgrading as possible and deathly afraid of the risks of innovation. There are signs that this may be changing:

AEP, Duke, Xcel and others are planning to build integrated gasification combined cycle plants; 15 companies are planning to build nuclear plants; and, as noted, advanced metering investment is increasing.

Overall, however, the centralized baseload-driven worldview dominates, and utilities are generally unwilling to re-examine distributed generation and micro-grids. ConEd’s 123-megawatt demand-side RFP is an exception to the rule, not yet a sign of a new trend.

Large companies, such as IBM, HP, and Cisco, that are looking to expand their IT offerings in the utility world are still convinced that electric utilities are the most conservative and backward players. What they see is that customers will eventually force utilities to change as, for example, Internet bill paying becomes more common and customers are enabled to manage their own electricity demand. Security requirements and the effect of serious events such as Hurricane Katrina have created a drumbeat for more decentralized solutions for critical-care facilities such as hospitals, and may result in more distributed generation.

Pressure to act on carbon will also be an incentive for more innovation but these remain at an early stage and it is controls on coal-fired plants that will absorb most of the capital required to comply with any mandatory carbon controls that are eventually adopted.

Roger Gale is president and CEO of GF Energy.
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prepare their organizations for a significant ramp up in spending from current levels as future needs are met.

Daniel Yergin, chairman of Cambridge Energy Research Associates, a respected group of energy analysts, said generation resources must increase 20 percent by 2020. “The next couple of years will be a key period for companies to make a decision on what to build.” Rising and unstable natural gas prices recently make that decision much more complex than it was a decade ago, when utilities built a fleet of natural gas power generating units. Now nuclear and clean coal technologies beckon.

Whatever new generation is built, some forecast that a 20 percent boost in electricity output by 2020 may not be adequate. Energy consumption by that time will increase by 50 percent, Jeffrey R. Immelt, CEO of GE, told industry leaders at EEI’s annual meeting in June. Many believe a significant portion of a looming gap between power resources and demand can be addressed through leaps in efficiency. “How do we create the future?” Immelt asked. “We have a responsibility to bring new innovation and technology to the marketplace.” The end game, he said, is “To help make energy technology a core competency in this country.”

As levels of spending escalate, the paramount question will be whether the money is spent on appropriate technologies. The moment is ideal, some suggest, for utilities to think freshly about how to best accomplish their mission.

“The industry is anxious to be innovative,” said Clark Gellings, who thinks about such issues full time as the vice president of technology initiatives at the Electric Power Research Institute, in Palo Alto, Calif. “It struggles with how to go about it.”

By some yardsticks, America’s struggle has been anemic. Energy research and development spending has declined in recent years. In the last federal fiscal year, it fell 11 percent

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**DEMITING INNOVATION**

To get a fix on what is meant by “innovation” in today’s energy sector, EnergyBiz contacted a handful of startup enterprises that attended the Energy Venture Fair in Santa Clara, Calif. in early November to court investors.

**CLEAN ENERGY SYSTEMS**

Keith Pronske, president and CEO
Has developed zero-emissions fossil-fueled power generation technology.

“innovation requires breaking preconceived notions of how things should be done. You know you’ve innovated when people say, ‘That’s so simple — why didn’t we think of it sooner?’”

**COASTAL HYDROGEN ENERGY**

Jonathan Neff, CEO
Has developed new technology for producing hydrogen from water in a cost-effective way.

“innovation is a way of doing something that is more cost effective, environmentally friendly or has lower energy requirements than the previous technology.”

**ENERPULSE**

Daniel Parker, CEO
Has developed pulse plug, which looks and fits like a spark plug, but due to its integrated pulse circuit is 20,000 times more powerful and increases fuel economy.

“innovation — the process of working in the gap between what exists and what could be, implementing change.”

**MARIAH POWER**

Mike Hess, CEO
Has developed low-cost renewable energy turbines for residential and business markets.

“innovation is extending the utilization of a product or process. Innovation should influence the entire structure and culture of a company and become as noticeable as the products and technologies it spawns.”

**INTER-AMERICAN**

Jeremy Jordan, vice president
Has developed technologies, primarily nitrogen removal, for small-scale natural gas treatment.

“We define innovation simply as breakthrough, whether it’s marginally or significantly enhancing an existing product or service, or creating a new market altogether.”

*Compiled by Lynsay M. Montour*

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**Daniel Kammen on Utility Innovation**

**ENERGYBIZ** What should utilities be doing to be more innovative?

**KAMMEN** Use carbon accounting, and where possible support a carbon tax, like Pacific Gas & Electric in California, to get meaningful carbon evaluations into the mix. Support plug-in hybrid technology to refuel from the grid at night.

**ENERGYBIZ** What are the barriers they must overcome?

**KAMMEN** Capital. Supporting plug-in hybrid electric vehicles puts the utilities in competition with the oil companies.

**ENERGYBIZ** What is the business case that can be made for utility innovation?

**KAMMEN** As a holder of long-term capital stock, in an industry where we know that carbon taxes will eventually come online, early investment in innovation will lead to large savings down the road when these changes are implemented.

**ENERGYBIZ** What is the business and strategic case for stepped up utility spending on R&D?

**KAMMEN** With the revolution in renewable energy, the payoffs may be large from innovations in low-cost and large-scale wind, solar, and biomass investments. That makes this sector far more attractive to the utilities than it was before.

**ENERGYBIZ** Which utilities are the most innovative — and what makes them so?

**KAMMEN** Those in states with renewable energy portfolio standards have shown, so far, that greening their energy mix is often cheaper and easier than one might think. Twenty-three states and the District of Columbia currently have them. Texas, now the national leader in installed wind capacity, achieved this somewhat by accident. Windfarms, developed in response to the state requests, keeps coming in at lower and lower cost, so the number of turbines has continued to grow there, with more than 2,200 megawatts in place so far. The requirement to install low or no carbon technologies has been a major driver so far.

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from the preceding year, and a respected science group has predicted that federal energy R&D will drop 18 percent by 2009, Daniel M. Kammen, director of the Renewable and Appropriate Energy Laboratory at the University of California-Berkeley, reported in a co-authored report last fall. “In the early 1980s, energy companies were investing more in R&D than were drug companies; today, drug companies invest 10 times as much in R&D as do energy firms,” Kammen wrote in a fall 2005 article in *Issues in Science and Technology*, co-authored with Gregory Nemet.

Another academic voice, Thomas J. Overbye, professor of electrical and computer engineering at the University of Illinois at Urbana-Champaign, writing in these pages two months ago, faulted energy industry leaders for “not providing policymakers and the public with much of a vision for electricity’s paramount role in our future energy economy.”

Given the recent period of sustained high oil prices, there are some signs of growing political support for federally funded energy R&D. Venture capitalists and private investors are looking at energy investment opportunities like never before. But while the seed money may be starting to flow for R&D, some want to make sure that utility executives are actively preparing themselves, their organizations and their business strategies to champion emerging new technologies.

Among those worrying about that issue, count Daniel Arvizu, head of the National Renewable Energy Laboratory, perched in the hills of Golden, Colo. NREL was established during the Carter administration after the Arab oil embargo in the 1970s, and it has seen its federal support wax and wane over the years. Yet it is on the global cutting edge in researching solar power, wind energy and alternative fuels. “I have talked to utility executives,” Arvizu said. “I am encouraged by the amount of interest they have in renewables. But it

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really isn’t central to their thinking. There is much more opportunity space there than many of them realize.”

Agreed, says Amory Lovins, the chief executive officer of Rocky Mountain Institute, in Snowmass, Colo., and a MacArthur Fellow who calls himself an "experimental physicist." Many utility executives, he said, “are talking too much to each other and not paying attention to what is going on in the world market.” Decentralized renewable power and co-generation facilities now provide one-sixth to one-half of all electricity in 13 industrialized countries, Lovins said. In Denmark, they provide 52 percent. “Any companies that build more central power plants — I would like to short their stock,” Lovins said. The best utilities of the future, he said, will “invest first in efficiency and load management.”

Lovins is not likely to get much argument from many utility executives. However, change in the utility field is often glacial. One problem is the inherent conservatism of utilities. As Gellings of EPRI described it, “there is an overall reluctance to be earlier adopters of anything.”

That iceberg of reluctance may be melting. Consider Peter Darbee, the chief executive officer of Pacific Gas & Electric.

POISED FOR CHANGE

HOPEFUL SIGNS IN THE POWER INDUSTRY

BY CLARK W. GELLINGS

Some suggest that the electricity industry lacks innovation. While there are a number of statistics that tend to confirm this, upon closer examination, the answer is not clear. For every statistic mentioned in pointing to the lack of innovation, there is evidence that at least the signs of innovation are present. The historic development of the electric power industry has been dominated by the quest for ever-lower commodity costs. During the first 70 years of the 20th century, this quest for lower costs was consistently successful as rapid demand growth, coupled with economy-of-scale advances in both production and delivery technology, led to electricity cost reductions that averaged some 20 percent per decade.

By 1968, the innovation that led to the extended period of declining cost that the electricity sector had enjoyed came largely to an end. The lack of innovation, as well as diminishing economy-of-scale returns, inflationary pressures, slowing demand growth, higher fuel costs, and rising environmental requirements, all converged to challenge the traditional declining cost commodity business model and structure of the electricity utility industry.

Has this challenge been met — are there solutions on the horizon likely to change this reality? Is the electricity industry innovative or not? There are reasons to be optimistic. There is little innovation in electricity use as it seemingly continues to grow unchecked.

Over the past century, the role of electricity has grown steadily in both scope and importance. Developments in key digital technologies, such as microprocessors, electric lighting, motor drive systems, computers, and telecommunications have continuously reshaped life, as well as commercial and industrial productivity.

The increasing utilization of electricity forces pressure on the increasing need for energy overall — where is the innovation in electricity use?

Electricity is, in fact, a means for saving energy. Electricity — at the point of end use — is far more effective, overall, in reducing the need for energy. In almost every application, electricity can replace fossil fuels and result in an overall reduction in energy use.

Overall energy R&D is declining in both the public and private sectors. Energy R&D in the U.S. reached a high of about $12 billion in 1980 and has declined to a little more than $3 billion today — pointing to a sharp decrease in the resources available to initiate innovation.

There are clear and unambiguous signals that the support for, and interest in, energy R&D has begun to change. Budgets are increasing — albeit slightly — in both the public and private sectors.

Most of the technologies used in today’s power delivery system are decades old and there has been little innovation in many years.

There are, in fact, a number of innovations that have been brought forward in the industry — albeit not fully deployed. For example, a wide array of thyristor-based digital control systems, wide-area systems monitoring and communications, and highly sensitive anticipatory condition monitors, have been demonstrated and could revolutionize the reliability, capacity and operability of the nation’s electricity transmission and distribution network. Superconductivity represents another potential breakthrough technology that could fundamentally improve the efficiency of both power delivery and end use.

Consumer electricity bills are rising dramatically.

The average residential price of electricity in 1984 dollars has fallen from 18¢ a kilowatt-hour in 1920 to approximately 6.5¢ today. Relative to health care, phone service and the cost of cars and housing, the average electricity bill is 85 percent of what it was in 1985 while the other services are between 115 percent (cars) and 148 percent (health care) of the 1985 bills.

The end-use efficiency of energy utilization has stagnated.

The U.S. is improving its end-use energy efficiency at a rate of about 1 percent per year. However, there is a potential for reducing the consumption of electricity by between 54 and 44 percent — if all existing technologies and those under development were deployed.

The efficiency of installed generation has stagnated — with little improvement since 1960. It was 30 percent in 1958 and 32 percent in 1997.

The industry is on the verge of engaging in the renewed deployment of two major new resources: nuclear generation using advanced light-water reactors, and the demonstration of initial post-combustion carbon-capture technologies to advance the possible use of coal, which is critical to meeting the nation’s energy needs.

All signs suggest that when it comes to power industry innovation, there are some noteworthy, positive trends emerging.

Clark W. Gellings is vice president of innovation at the Electric Power Research Institute.
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SPARKING INNOVATION IN THE
ELECTRIC POWER SYSTEM

By Kurt Yeager

Thomas Alva Edison, the father of electricity, once famously said that genius is 1 percent inspiration and 99 percent perspiration. For the last 30 years, the U.S. electric power system has lacked both. The Galvin Electricity Initiative, a nonprofit launched by former Motorola Inc. chief Robert W. Galvin, was founded on the recognition that we can no longer skate by on Edison’s 1 percent, and on the sweat, courage, ideas and investments of the past. Already, reliability problems cost the economy more than $100 billion per year. Without an infusion of innovation and a great deal more hard work, Edison’s towering achievement will become an albatross around the neck of our nation in the emerging digital age.

To spark this innovation, Galvin engaged a team of engineering and technology experts to think beyond conventional infrastructure and regulatory issues and across all the elements in the technology and value chain for electricity production, delivery and use across its broad range of applications.

The end result will be tangible projects that demonstrate the viability of an electric power system that never fails to meet consumers’ expectations for reliability, efficiency, convenience, affordability and choice.

The basic building blocks for such a system are intelligence, independence and flexibility. The fundamental limiting innovation is the digital control and automation of all power circuits. This replaces today’s analog, electromechanical switching with real-time, power-electronic controls. The resulting capability provides an intelligent, instantaneously self-correcting and optimizing power system that can incorporate distributed power generation, renewable energy and storage resources as practical reliability and capacity assets.

With the research and planning nearly complete, the initiative is now focusing its efforts on the implementation of local microgrids and incorporating these breakthrough technology innovations to best advantage. These microgrids effectively act as intelligent, quality enhancing, consumer service capillaries on the existing bulk electricity distribution arteries.

These are real energy systems that meet the existing needs of commercial enterprises. The initiative has identified the projects and will support the design of the individual power systems. That is the spark. The actual building will be done by a new generation of Edisons, innovators and entrepreneurs whose visible achievements will lead the way to systemwide quality transformation.

Kurt Yeager, the head of the Galvin Electricity Initiative, is the former president and chief executive officer of the Electric Power Research Institute, who had worked in investment banking and telecommunications before heading to the San Francisco-based utility. In a recent conversation, Darbee lauded Lovins the way an earlier generation of CEOs might have praised Edison and Westinghouse. Innovation, Darbee said, should be viewed as “a way of doing business.” Innovative energy companies must assemble a diverse team of employees, encourage risk-taking and then work on the most promising and significant new ideas that emerge, he said.

New ideas abound. Some deal with reliability in an advanced economy. Milton Holloway, chief operating officer for the Center for the Commercialization of Electric Technologies, a nonprofit Texas group that includes utilities, co-ops, universities and high-tech firms, said, “Utilities in the past have just not kept up with their need for improved power quality.” A memory chip manufacturer can lose $20 million from an outage that lasts an hour or so. Grid innovations that would prevent such outages, Holloway said, are “at our fingertips.”

Many utilities, aware that profound changes in the business are imminent, have appointed key executives to monitor and coordinate response to significant opportunities. Two leaders at very different kinds of power entities relish their roles as innovation quarter-backs in their organizations.

Kate Jackson, in charge of research and development at the Tennessee Valley Authority, which generates 33,000 megawatts to serve 8.6 million people, said that until recently, uncertainty over the future of regulation and rules governing operations have deterred significant investments in innovations. “Now that we’re getting more clarity on the rules, the incentives for investing in certain technologies are clearer,” she said.

TVA is helping develop a rooftop solar collector that uses fibers to transport light from outside to inside a structure. TVA is working with another company to develop new ways to stabilize voltages and extend the capabilities of the transmission grid. New electronics that will give customers greater control of their own power consumption “opens up a whole new box of very exciting opportunities,” she said.

Eileen Buzzelli, director of technology at FirstEnergy, an Akron, Ohio-based utility with 4.4 million customers, said, utilities are faced with a confluence of unprecedented challenges. They must figure out what to do with billions of dollars worth of aging infrastructure, cope with the imminent retirement of thousands of veteran employees and respond to growing public alarm about utilities’ contribution to global warming and other environmental pressures. “The real challenge as a utility industry is to create a culture of innovation,” she said, bringing it “to the next level.”
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