



# Electric industry may lead pack in disaster safeguards

Preparation and recovery already part of the business

Unintended consequences of regulatory change

The shifting fortunes of funding

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Massoud Amin, a mathematician with EPRI, was attending a disaster risk management workshop outside Washington, D.C., Sept. 11 when pagers and cell phones began going off in the room.

The workshop, whose attendees included White House and Department of Defense (DOD) officials, quickly ended with word of the World Trade Center and Pentagon attacks.

"It was indeed ironic that we were engaged at the very moment of the attack in a conference attempting to find realistic technical ways to mitigate disaster," said Amin.

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What is even more ironic is that the DOD late last year opted to stop funding its share of the \$30 million, five-year project Amin is leading on behalf of EPRI to design a "self-healing" electric transmission network. The DOD money ran out Friday, at the end of the current federal fiscal year.

Across the Potomac River, Nancy Wong, a senior executive with the U.S. Office of Critical Infrastructure Assurance and a former information technology specialist with Pacific Gas & Electric, had been expecting her agency's funding to end Sept. 30, too. Her job, to make the idea of national infrastructure security meaningful to bottom-line-focused executives, had been a challenge.

"In peacetime, the issue is difficult to communicate and articulate," she said. After the attacks, her agency's funding is not only secure, but industry leaders are seeking her out for information and direction.

Indeed, Wong's office, which reports both to the Department of Commerce and to the National Security Council, may emerge as one of the front-line agencies in the newly identified task of assuring "homeland security."

At one time, industry executives had trouble understanding at a "gut level" the importance of infrastructure security, Wong said. Sept. 11 changed all that.

"The phones have been ringing off the hook," she said.

### Shifting fortunes

The shifting fortunes of Amin and Wong are only part of the changes brought about by the Sept. 11 attacks. The gas, oil and electric industries as a whole may have larger roles to play, serving as models for other sectors of the economy. The electric industry in particular may have much to offer.



After all, the electric infrastructure is quite vulnerable to disruption. Hurricanes, tornadoes, ice storms, fires, blizzards and even solar flares periodically disrupt electric service. Given these natural disasters, the events of Sept. 11 make it possible to imagine the effects of a disruption that is both purposeful and malicious.

"A disruption could be done easily with supplies from a shopping center," said Robert Burns, a senior researcher with the National Regulatory Research Institute at Ohio State University.

Even smoke from a New Mexico forest fire last year caused an outage, and electric outages cost the economy dearly. A report issued last June by EPRI put the economic loss at between \$104 billion and \$164 billion a year. Another \$15 billion to \$24 billion may be lost due to power quality issues.

California faced the highest costs for both outages and power quality issues, between \$13.2 billion and \$20.4 billion a year. Texas ranked second (\$8.3 billion to \$13.2 billion) and New York third (\$8 billion to \$12.6 billion).

### Strength through vulnerability?

The industry's vulnerability may also represent its strength. So many redundant systems are in place that a single malicious act probably would not knock out the system, said Edward Mosey, a spokesman for the Bonneville Power Administration (BPA). But with 15,000 miles of transmission lines in four Pacific Northwest states, defending BPA against a person or group intent on damaging it may prove difficult. In the 1970s, BPA dealt with an extortionist who destroyed several transmission towers in an attempt to collect money.

Even so, Mosey said, there is "virtually no place on the system that can't be served from multiple facilities." Power lines can be substituted, spare parts are kept in stock for substation repairs, and backup equipment can be called on in an emergency. "We can't anticipate every eventuality, but the system is very strong."

Indeed, many utilities regularly respond to natural disasters by implementing detailed and well-rehearsed recovery programs. In California and Florida utilities have periodic full-scale disaster drills to practice for inevitable earthquake and hur-



ricane threats.

Utilities that do business in places where natural disasters occur regularly may be better prepared to deal with the highly visible issue of infrastructure security precisely because they get a lot of practice, Wong said.

Part of her job at the Office of Critical Infrastructure Assurance is to help show industry executives they may already have the business case and recovery plans in place to deal with a deliberate attack.

Indeed, out of all the business sectors, the "physical industries," which include oil, gas and electricity, may be best equipped to deal with issues of service disruptions, Wong said. "They do it for a living."

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BPA, for example, is working on nine transmission upgrade projects valued at some \$615 million. These upgrades are scheduled for completion by autumn 2005. While the projects were planned well before Sept. 11, they will improve system reliability, relieve congestion points and allow electric flows to bypass a corridor that is down—all key elements in hardening a system against possible attack.

#### New uncertainty

But even with such ongoing, long-term investment, Wong worries that competitive and regulatory changes may add a new level of uncertainty.

After all, the electric grid was built by a public/private partnership between regulators and investor-owned utilities. As Wong sees it, the partnership built a system that was both robust and resilient. Robust in the sense that it had physical toughness; resilient in the sense that it had enough redundancies to assure reliability.

With competition and deregulation, the public/private partnership is unraveling. One thread left hanging is just who will propose and, later on, pay for future efforts to enhance the grid's robustness and resiliency.

"People haven't thought that through," Wong said.

The issue came into clearer focus last spring when Connecticut authorities blocked construction of a transmission line across Long Island Sound to Long Island. The officials said the line would not bring enough economic benefits to Connecticut.

"We need to overcome state and local parochialism," said Phil Sharp, a former U.S. congressman and senior fellow with the Kennedy School of Government's Energy and Natural Resources Program. A Democrat, Sharp agrees with the Bush administration that the Federal Energy Regulatory Commission should have eminent domain power when it comes to siting interstate transmission lines.



"I don't know the full range of attitudinal change among policymakers, but I would say it is significantly easier to site facilities today than it was" before Sept. 11, Sharp said.

### **Looking for substitutes**

Issues of robustness and resiliency may be felt more keenly in the electric industry than in the transportation industry, for example, another critical national infrastructure.

After all, when air travel stopped after the attacks, people resorted to cars, buses and trains. Although the airline industry has been hurt, the transportation system's resiliency lay in its ability to fall back on substitutes.

"With electricity, what is the substitute?" Wong asked. Good question.

And that's where Amin and his EPRI/DOD project may fit in. The project, called the Complex Interactive Networks/Systems Program (CIN/S), begun in 1999, recognizes that "interactive networked systems" like the electricity grid are vulnerable to attack and local disturbances.

These, in turn, can lead to widespread, almost instantaneous failures. The CIN/S project was laying out the theory and process behind building an intelligent infrastructure, which would have the smarts to essentially stop the dominoes as they fell, minimize the damage caused by already fallen dominoes and restore the system by making it stronger than before.

In layman's terms, CIN/S would enable the electric infrastructure to "heal itself, then become more resilient," Amin said. Before the Defense Department's change of heart last year, this sort of a self-healing network was a decade away from reality.

### **System, heal thyself**

Had such a "smart," self-healing system been in place in August 1996, a major blackout may never have taken place.

Instead, two disruptions along transmission lines in Oregon tripped generators at the McNary dam on the Columbia River system. This failure led to a separation of the Pacific Intertie at the California-Oregon border and a cascading blackout across 13 states and Canadian provinces. Amin and others contend that, with the "intelligent controls" of a self-healing system, all of that could have been avoided by shedding 0.4% of load for 30 minutes.

Much of CIN/S work to date has been theoretical; in 28 months the project produced 330 papers and 13 reports, written mostly by academics at some two dozen universities.



That's all necessary groundwork, Amin said. He views the North American electric grid as one of the largest machines operating in the world today. But despite its size and importance, the grid's precise operation isn't well known. This is especially true in light of the rapidly growing number of wholesale and long-distance transactions. These strain the system in ways it was never designed to endure.

By using methods from statistical physics, which studies the probability one event will cause another event, the CIN/S team had hoped to create artificial intelligence models that would simulate how the electricity grid works.

Next month, the CIN/S team will meet to figure out how much of the project can be salvaged and moved from theory to development, production and possible deployment, even with a 50% cut in funding.

"These are really critical issues we have ignored for a long time," Amin said.