USF researchers build model to analyze deregulated electric power market

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(TAMPA, Fla.) August 3, 2004 - With the approach of the one year anniversary of the power black out that hit portions of the midwest and northeast United States Aug. 14, and as the power woes of a recent summer are still fresh in the hearts and minds of Californians, how solid is our power footing today, not only in terms of the physical reliability of the power generation and the transmission grid, but also the economic reliability of the power market?

"I was not surprised by last year's outage," said University of South Florida electrical engineering professor Ralph Fehr. "Portions of the nation's neglected power grid are operated well beyond design limits, with no means of penalizing abusers. We can expect another outage if the grid does not keep pace with consumption."

And, what of California's rolling blackouts? Can they happen somewhere again?

"The California power failures were the result of market design flaws," Tapas Das, a professor of industrial engineering in the USF College of Engineering said. "When the California legislature fixed the price of power there was no demand elasticity in the market, so the suppliers created shortages by reducing production, which drove up prices and resulted in rolling blackouts as well."

According to Fehr, who specializes in power systems, the equipment making up the power system in California was performing as designed; it was the economic component that failed.

"The blackouts caused by economic failure were just as significant as those caused by equipment failures," suggested Das, who is a principal investigator on USF's grant from the National Science Foundation to study this issue. "We have a good understanding of equipment reliability, but economic reliability remains a largely unexplored area."

Can the same unfortunate scenarios develop in other regions of the nation where the power industry has either been deregulated or is being considered?

Yes, said Das, unless market equilibrium is properly examined to ensure no players have the same kind of market power exercised in California.

"Ideally, in a well designed market, no one would have a significant market power and prices would remain stable near the marginal cost," he said. "Increased competition should induce producers to upgrade their technology, become more efficient and deliver cleaner power."
USF researchers have created a mathematical model they think will be useful for the deregulated electric power industry in developing market design strategies aimed at assuring consumers of competitive pricing and ample, unmanipulated supplies of electric power. Good market design, said Das could make the world of deregulated power more economically reliable by placing the 'layers' of the deregulated market -- power generators, transmission marketers and retailers -- into a mutually beneficial state of 'market equilibrium.'

Noting that the electric power is a unique commodity, Das emphasized the importance of economic design of the electric market in assuring reliable power supply.

"A poor market design can bring down a power system, even when the physical system is quite reliable," said Das.

In an effort to benefit the market and consumers, the USF team of Das, Fehr, Louis Martin-Vega, dean of the College of Engineering, and Kandethody Ramachandran, a professor in the Department of Mathematics, has developed a comprehensive mathematical model based on game theory that takes into account almost all of the possible features of the deregulated power market structures. They have also developed a computationally viable solution strategy for the mathematical model. The model and solution strategy together provide a framework under which deregulated market structures could be examined and designed. They will study several major components of the power market: auction strategies in energy and transmission sectors, wholesale bidding and contracts in the day ahead market (DA), the real time (RT) market, and in the long term bilateral markets.

"The interdependence of these components is critical to the decision making processes of the participants," Das said. "A noncooperative market system allows for participants to adopt strategies that can change daily, hourly or minute by minute. Our ability to clearly understand the impact of these changing strategies on the resulting energy price structure is critical to the success of deregulated markets."

Rather than learn from painful market failures, as in California Das and colleagues aim to solve power market design problems before they create shortages and sort out how the market is likely to perform.

"The programs and computer models improve our ability to study market behavior before a market is put in place," Das explained.

In order to groom the next generation of power industry decision makers, the USF team hopes to soon offer a course based on their research for USF graduate students from a variety of backgrounds, including engineering, business, and mathematics, who are interested in careers in the power industry. They also hope to offer several Web-based courses for professionals already working in the power industry. These courses will be designed to educate power industry professionals about various economic reliability issues of deregulated electric markets, market design and analysis strategies. Increased awareness and education, said Das, will increase our acceptance of the electricity market deregulation ideas, and perhaps we will all benefit, as in the cases of airlines, banking and finance deregulation.
Das and colleagues recently published their research in the Institute of Electrical and Electronics Engineering’s (IEEE) journal IEEE Transactions on Power Systems (Vol 19, No. 2, May, 2004.) Funding for their work comes from the NSF’s division of Electrical and Communications Systems, and also through the NSF’s special ITR (Information Technology Research) initiative.

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