New insights into California electricity crisis may help prevent future crises

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Between 2000 and 2001, California experienced the biggest electricity crisis in the U.S. since World War II. Exactly how it happened, however, is complex. New research now reveals insights into the market dynamics at play, potentially helping regulators standardize the market and prevent future crises.

An energy market is complicated because electricity must be generated and distributed in real-time—all under the constraints of existing infrastructure, reliability requirements and physics. Despite a confluence of factors affecting supply and demand, and thus the price of electricity, the energy demand on the grid is usually correlated with the price in a normal market. But in 2000, when electricity prices in California spiked to $1,200 per megawatt-hour (several tens of times the average price at the time), the price was no longer correlated strongly with the energy load.

To analyze what happened, Fang Wang of Hunan Agricultural University in China studied the differences between the normal market in 1999 and the one in crisis during 2000. Wang explored the relationship between prices and energy loads before and during the crisis, developing a new statistical measurement to quantify the asymmetry in how the prices and loads were correlated.

If the correlation is different when the prices are increasing compared to when the prices are decreasing, then the correlations are asymmetric. Understanding this asymmetry, Wang says, reveals deeper insights that

explain why the correlation between prices and loads differed before and during the crisis.

"The results from this work uncover the truth of the power crisis from the new point of view of asymmetry between the prices and loads," he said. His results, published this week in the journal *Chaos*, from AIP Publishing, showed that the asymmetry was weak in 1999, but strong in 2000 during the crisis.

Measuring this asymmetry could help power companies and government regulators prevent future crises by better understanding the market and predicting whether prices will rise or decline. For example, Wang found that if the correlation between prices and loads are stronger during the periods when the prices are declining—that is, both the prices and loads are dropping—then prices will likely continue to decrease in the near future. That's the scenario Wang found to be the case in 1999.

If this situation were to happen again, companies running the power grid could sign fewer contracts, since they know electricity will be cheaper in the near future. Companies that generate electricity, however, may want to sign more long-term contracts to lock in current prices.

Wang showed that the reverse situation happened in 2000, that the correlations were stronger when prices were increasing: Both prices and loads rose in a strongly correlated fashion. In a similar future scenario, this trend suggests that prices will continue to rise, and in response, companies can pursue the opposite approach. Power-grid companies may want to sign more contracts while power-generation companies may sign fewer.

In either case, Wang's new approach could help achieve a better balance between prices and loads to avoid asymmetries—and future crises.

More information: Fang Wang, A novel coefficient for detecting and quantifying asymmetry of California electricity market based on asymmetric detrended cross-correlation analysis, *Chaos: An Interdisciplinary Journal of Nonlinear Science* (2016). DOI: 10.1063/1.4953012