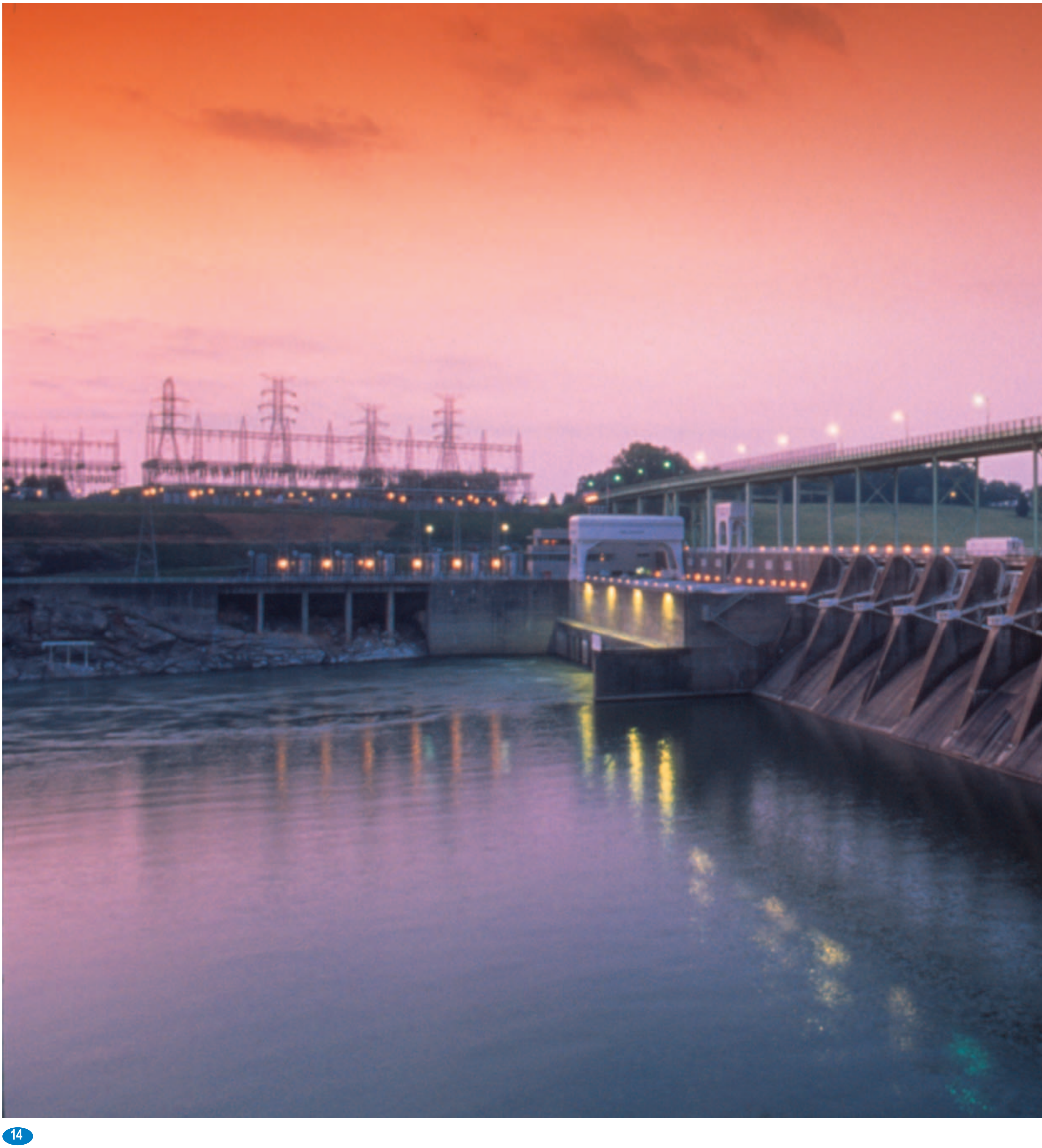
Electricity Is More Than a Bottom Line,

If we're not careful, the benefits of competition may be overshadowed by a loss of reliability.



It's a Lifeline


Photo of Ft. Loudoun Dam Courtesy of TVA

by Terry Boston

Nothing improved life more on the Boston family farm than when Upper Cumberland EMC and TVA brought electricity to Gordonsville, Tennessee. The access to low-cost, reliable electricity truly "brought good things to life" then. The benefits today may be offset by the negative effects of interruptions to that power in the computer-driven 21st century.

How many Tennesseans remember where they were and what they did when the Blizzard of the Century blew through east Tennessee in 1993, or when the Ice Storm of 1994 hit west and middle Tennessee—both storms knocking power out across the region? Many remember well because electricity is not like any other commodity. It is the lifeline to our homes and hospitals and the life blood of the new digital economy. Interruptions on a large scale can be catastrophic.

That was brought home to utilities and customers nationwide on a blistering day in July 1999 when two large cables at a Chicago substation failed, triggering a local blackout that sent hundreds of air-conditioning deprived residents to hospitals and, tragically, a few to cemeteries. At its worst, the blackout left more than 100,000 people without electricity, and thousands remained that way for the better part of three days.

This was only one in a string of blackouts during that summer that afflicted hundreds of thousands in New York City, Long Island, New Jersey, the Delmarva Peninsula, and four Gulf states. High-voltage transmission systems—designed to deliver vast amounts of power in all sorts of weather—strained to keep up with demand. Over the course of five tense weeks, two other blackouts hit Chicago, while other electric systems suffered with voltage problems and a few teetered on the brink of collapse.

The 1999 summer Chicago challenge was dwarfed by the disasters in California

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in 2000 and 2001. During the summer of 2000, California declared electricity emergencies 31 times. In the winter of 2001, rolling blackouts put hundreds of thousands of consumers in the dark in northern California, and there were plant closings and announcements that major corporations would not build or expand in California. Southern California Edison's bonds were derated to essentially "junk" status; and Pacific Gas and Electric filed for bankruptcy.

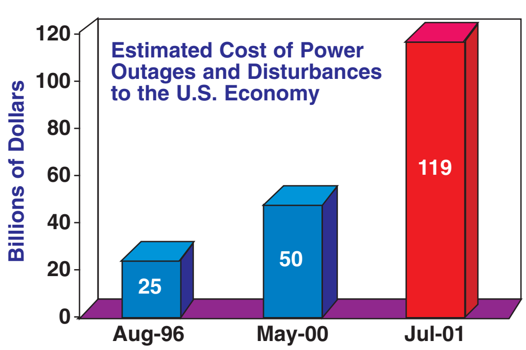
What was happening? Why was the world's strongest, most reliable electric grid scrambling to keep up with unusual, though not extreme, summer weather? Why was it hard for some transmission operators to make eye contact when asked about the prospects for meeting the customers' peak demand? The reasons are complex, and agreement is lacking, but many point to the pressures competition is placing on an industry still learning how to compete. In short, the move to restructure the electric utility industry has the industry trying to sprint toward competition before it can walk. As a consequence, the long-sacred industry focus on reliability is beginning to blur. Instead of filling its traditional role as a lifeline, electricity is in danger of becoming just a *bottom line*.

Lights Out

Blackouts—small or large—are nothing new, but the reasons for some of the 1999 summer blackouts and near misses are disturbing. For example, the U.S. Department of Energy cited Chicago's Commonwealth Edison for scrimping on its substation maintenance budget—which went from a high of $47 million in 1991 to just $15 million in 1998—as it shifted money into its nuclear program and preparation for competition.[1] Other systems, including TVA's, were threatened when operators were unable to predict the massive amounts of power flowing across their systems from eager new sellers on one side to eager new buyers on the other.

Unless transmission operators understand exactly where and when power will flow across their systems, lines already overburdened by severe weather can fail, triggering widespread disruptions. Looking at the numerous U.S. blackouts of 1999, DOE concluded that "… the necessary operating practices, regulatory policies and technological tools for dealing with the changes [resulting from a restructured environment] are not yet in place to assure an acceptable level of reliability."[2]

While many would welcome legislation to ensure reliability, the industry desperately needs something more: time. Unless the industry has time to strengthen the grid, understand the new pressures that competitive pricing brings, and develop the complex computer modeling and analytical tools needed to safely manage the phenomenal increase in electricity transactions, the grid may be headed for the most severe outages since the New York blackout of 1965. The Electric Power Research Institute estimates that the cost to the economy of power failures in the United States has soared to $119 billion per year.



Source: Electric Power Research Institute (EPRI)

The World's Largest Machine

Someone once called the North American electric grid—the massive conglomeration of generators, wires, switches, breakers, and related equipment that produces and moves electricity to almost every point on the continent—the world's largest machine. That is an apt description.

Originally, utilities were built to serve specific geographic regions and were physically isolated from one another. America literally had islands of electricity "haves" and seas of electricity "have-nots." In fact, the first dynamo in Dixie began operation on May 6, 1882, in Chattanooga, four months before Thomas Edison brought his Pearl Street power plant online for street lighting in New York City on September 4. However 51 years later, when TVA was created in 1933, only three percent of farms in the Tennessee Valley had electricity.[3]

As technology improved and power plants increased in size, the islands grew and began to connect with one another. Many of the connections were established to promote reliability in the wake of the 1965 New York blackout, allowing power to be routed in any number of ways to circumvent local problems. Today, a single massive, interconnected grid serves the eastern United States and eastern Canada, while two other grids serve Texas and the western half of the continent. On each grid, large transmission lines—some operating at up to 765 thousand volts—move electricity from generators to lower-voltage local distribution systems where smaller lines take it to individual consumers.

The transmission systems, built to operate like a state highway system and designed to move traffic or power around a region, are now being called upon to perform like an interstate highway system and move power across the nation. Tremendous investments in infrastructure will be required to upgrade the systems around the country.

The nature of electricity compounds the difficulty. Transmission is uniquely complicated because it moves electrons at the speed of light. Natural gas can be kept in tanks, and pork bellies can be stored in freezers, but electricity is consumed the moment it is produced. The challenge then is to make electricity instantly available in the exact amounts demanded 24 hours a day, seven days a week. If the amount of power delivered equals the amount consumed—every second of every day—and if power plants, lines, switches, breakers, and insulators all do their jobs properly, we have reliability. If any part of the machine fails, however, power is interrupted. Interruptions can range from a few milliseconds, unnoticed except by sensitive computer equipment and VCRs, to outages that plunge a single street or entire regions into darkness.

Balance between neighboring power systems is also critical. If one system undergenerates—either deliberately to exchange power, or accidentally because a power plant shuts down—imbalance results and electricity flows in from other systems like water through a breached levee. When that happens systems can overload and, because they are designed to prevent problems from spreading, automatically shut down. In the most extreme conditions—when weather forces heavy demand for electricity and equipment over a wide area gets loaded to the maximum—loss of a line may shift the burden to other lines, overloading them and causing them to fail. In those cases, power systems can begin to resemble a row of dominoes, which is what caused the 14-state West Coast blackout of 1996.

Enter Competition

Changes in national energy policy have encouraged the growth of independent power producers, electricity marketers, and brokers—all of whom differ fundamentally from existing utilities in that they don't own their own lines or have any obligation to serve the public. Consequently, these new entrants to the industry must rely on established transmission owners to provide the critical trade routes that move their product to market—even though at times they compete with those same transmission owners for capacity to serve native load customers. In fact, to promote competition, the Energy Policy Act of 1992 required utilities to provide these new players with transmission service virtually identical to the service they provide their own customers.

Historically, nature has posed the major threats to a reliable power delivery system. Tornadoes and ice destroy transmission structures; lightning knocks out equipment; trees grow and fall into power lines. While those hazards still exist, competition challenges reliability in ways we are just beginning to recognize and address. We know that the proliferation of new generators without adequate transmission, the exponential growth in transmission transactions, and the belief that broader regional transmission control alone will solve the basic inadequacies of the grid are combining to test even the most robust transmission systems.

The challenge is to make electricity instantly available in the exact amounts demanded, 24 hours a day.

Planning in a Vacuum

Location is always a key consideration in building a new generating plant. Historically, plants were built where the transmission system could handle or be made to handle the added power. Planning for new power plants always occurred in lockstep with planning for transmission. Plants were built where it made the most electrical sense, often near large concentrations of customers to minimize transmission problems and electrical losses from hauling power long distances.

Today, however, power plants are built wherever it makes the most economic sense for the growing number of new players. The most attractive locations seem to be where natural gas pipelines converge with transmission interconnections between utilities near a creek, river, or ground water source. The pipelines provide fuel for the plants; the interconnections allow quick access to market. However, the existing transmission facilities may not be adequate or may be used up by the introduction of more generators, exposing everyone who depends on the transmission system to greater risk of interruptions.

We are not talking about a mere handful of new power plants. Along the Gulf, states near natural gas wellheads are seeing hundreds of requests to connect from independent power producers with a combined generating capacity that the existing grid cannot possibly accommodate. At the same time, due to environmental and land-use concerns, building new lines has never been more difficult.

While new plant owners must pay for any transmission upgrades necessary to connect to the grid, most question the need for improvements, and less than one percent have been willing to pay for firm transmission when they connect.

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Operating Conflicts

Adopting the mindset of blue-water sailors—always assume that the boat is trying to sink and do your best to keep it afloat—transmission operators are doing their best to ensure reliability. Doing so is no easy task. Each day on the TVA system alone, hundreds of thousands of calculations are made to determine the demand for power, which lines will load up, which plants to run, which to keep on backup, and which to shut down for maintenance. Operators also need to know which lines, substations, and switching equipment must be available at any given time, and those they can afford to take out of service temporarily for maintenance. Finally, they must know how much power will be flowing across their systems from producers to consumers. Without that detailed information, the transmission system is extremely vulnerable, and ensuring reliability is simply not possible. With the necessary information, better tools are needed to instantly analyze the data and enable us to provide relief to the right place at the right time.

Since electricity follows the path of least resistance and respects no political or system boundaries, utilities sometimes find their lines clogged with power they neither generated nor planned for.

Competition means more power is flowing longer distances across the grid as the number of deals between suppliers and customers grows exponentially. TVA had about 24,000 interchange transactions with other utilities and marketers in 1996; in 2000 it had 250,000. Since electricity follows the path of least resistance and respects no political or system boundaries, utilities sometimes find their lines clogged with power they neither generated nor planned for. Because of the limited ability to predict how thousands of transactions will take place from moment to moment, power from most utilities (including TVA) sometimes inadvertently flows into or through neighboring systems.

In times of crisis, the added traffic can confound the efforts of operators to prevent a calamity. On a hot day in August 1999, thousands of megawatts flowed through the TVA system, three-quarters of it unplanned. The result: despite all its efforts, TVA was one thin mishap away from a widespread blackout. During the summer of 2000, large north to south transfers were caused by thousands of transactions driven by weather and high natural gas prices, loading the lines TVA had built to serve local customers to their voltage limits. During the summer of 2001, with lower natural gas prices, power flows going from new gas-fired plants along wellheads in the Gulf states loaded up the TVA transmission lines with flows to the north. In the future, as hundreds of new plants are added to the grid, these inadvertent power flows—and the problems they cause—will only increase.

Competitive pressures can bring out rogue behavior in many organizations. During the summer of 1999, for example, one midwestern utility had more demand for electricity than it could supply. Normally in such circumstances, the price of power rises when demand exceeds the supply. If a utility cannot meet its contractual requirement, it should interrupt non-critical usage and keep critical loads such as hospitals from being at risk. Instead of interrupting lucrative sales when power prices were exorbitantly high, however, the utility simply allowed its system to become a "black hole" on the grid. Because electricity flows to where it is needed, the utility sucked in power from other utilities without paying the high prices for it and increased the risk of blacking out its neighbors.

Beginning in 2000 in California, some generators, marketers, natural gas companies, and independent power producers selling in the California market worked to manipulate the system to influence market prices. Generators scheduled (or claimed) spurious outages to create shortages and drive up the price of power. Some entities low-balled expected demand, then when the market price was set based on low demand, came back into the market to purchase additional power at artificially low prices. Marketers sold energy at prices above the clearing price set by the California Independent System Operator. In early September, three marketers were ordered by the Federal Energy Regulatory Commission to pay refunds to California electricity buyers for selling energy above the clearing price in the last week of June. "The California Public Utilities Commission has raised some residential rates as much as 37 percent and some commercial rates 38 percent. Some industrial rates have risen as much as 49 percent and agricultural rates as much as 20 percent."[4] In contrast, retail power cost in the TVA region is 17 percent below the national average, and the transmission system in FY 2000 and FY 2001 was 99.999 percent reliable—65 percent below the average outage time benchmarked in the United States.

Build It and They Will Come

A viable mechanism for product delivery is crucial to business success. What would happen to a manufacturer whose company fleet was frozen, with no additional delivery trucks and no alternatives provided? Production would peak at the level of product that could be delivered. That is not what's happening in the electric utility industry. Nationally, electricity sales are growing at a rate of about two percent annually, closer to three percent in the southeastern region. To meet this growth and possibly make large profits during periods of extreme demand, new generating plants are being built at an unprecedented rate. At the same time, investment in transmission systems nationally has almost bottomed out. In business terms, we are turning out product and piling it dangerously high on our delivery systems. To make matters worse, those trucks are not necessarily going where, or when, they were scheduled.

Most of the nation's extra-high-voltage transmission lines were built after the infamous blackouts of the mid-60s. They were intended to enable bulk deliveries of power over long distances in the event of emergency—thus ensuring reliability. Today, however, those lines are largely used for day-to-day commerce. New players in the market argue that transmission owners still have the right to curtail transactions to protect reliability, but transmission providers know that every curtailment runs the risk of being challenged politically, publicly, and in the courts.

The societal cost of having enough transmission capacity is small compared to the societal cost of having too little, yet industry wide, transmission is not being built to support the new market. In 1990, utilities' 10-year plans called for a total of 13,000 miles of new transmission lines.[5] After passage of the Energy Policy Act in 1992, those plans began to nosedive. By 2000, only 5,800 miles were planned.[6] TVA, I'm pleased to note, has not followed this trend. While the miles of planned transmission lines in the United States have been halved, TVA has more than doubled its transmission capital budget. In 1999, we built about 125 miles of transmission line. In 2000, we added 120 miles, and we will add another 120 miles in 2001.

The Public Good

Handled properly, competition can bring benefits to society. Regions like the Northeast that have been plagued with high power costs may one day see lower rates. New participants in the industry may play an important role in bringing about this parity, and they should be encouraged to take part. Obstacles to a fair, open, and diverse marketplace should be removed, but carefully and for the right reasons. The public has far too much at stake to allow competition to jeopardize reliability. Already, the pendulum has swung so far in the direction of open competition that reliability has been compromised.

New participants in the industry tend to think of electricity as only a commodity, to be bought and sold like pork bellies. They are fond of comparing electricity to natural gas, which can be stored and does not travel at the speed of light. They seek an industry structure in which they can trade electricity without limits, but as long as electricity follows the laws of physics and is dependent upon instantaneous transmission—until it can be stored efficiently for later use—we cannot afford to treat it as a simple commodity. The risks to society are far too great to permit this mindset to govern energy policy. New players, policymakers, and even many established utilities must come to realize that electric system reliability doesn't happen by itself. It takes planning, resources, and time to ensure that the nation's electric grid will continue to operate smoothly.

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The North American grid can become a balanced playing field—accessible to all, supportive of open competition, and robust enough to withstand the worst that nature and growth can throw at it; or it can decline into a choked and inefficient war zone where interruptions are commonplace, as industry players try to outdo each other in search of short-term profit. Restructuring can help create that balanced field by encouraging new generators to enter the market and relieve the current shortage of electricity production. Without comparable improvements in transmission, however, we may be putting out the fire with gasoline. ■

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1. U.S. Department of Energy, Report of the U.S. Department of Energy's Power Outage Study Team (Final Report) (Washington, D.C.: March 2000), p. 15.
2. Ibid, p. S2.
3. Tennessee Valley Authority, A Student History of TVA (Knoxville, Tenn.: TVA, 1984), p. 7.
4. Jason Leopold, Major Business News, *The Wall Street Journal,* September 17, 2001
5. Lines of 230 kilovolts and greater.
6. North American Reliability Council, Reliability Assessment: The Reliability of Bulk Electric Systems in North America (Princeton, N.J.: NERC, various years).