



Transmission Grid Frailty? Blackout Potential Not Limited to the Northeast

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The result of the recent massive power outage in the United States and Canada was more than just a loss of electricity. There is also a tremendous loss of confidence in the grid. Customers and regulators are asking questions such as: Could it happen again? If so, where and how severe could it be?

Statistics alone suggest that this outage may not be the last major one we will see. ICF Consulting noted the following in a recent study:

- The cost of transmission congestion in the most developed wholesale power market in the United States, the PJM serving the mid-Atlantic region, has grown *eight-fold* in the past three years, reaching \$401 million in 2002. Nationwide, the figure is in the billions.
- The North American Electric Reliability Council (NERC) reports that power deals not fulfilled due to transmission constraints increased *five-fold* to nearly 1,500 instances in 2002 compared to 300 in 1998.
- According to the Electric Power Research Institute (EPRI), roughly 2 million businesses have lost \$46 billion per year in lost production due to power outages.

Why Didn't the Outage Happen Sooner?

According to the Edison Electric Institute (EEI), transmission investment has fallen \$115 million per year for 25 years, from about \$5 billion in 1975 to \$2 billion in 2000 (in 1997 dollars). In the same period, investment in generation grew dramatically, electric demand grew substantially, and the transmission system was used well beyond its original expectations. From 2002-2011, NERC projects an increase of just 5 percent in the line-miles of high-voltage transmission, while demand is projected to grow more than 20 percent.

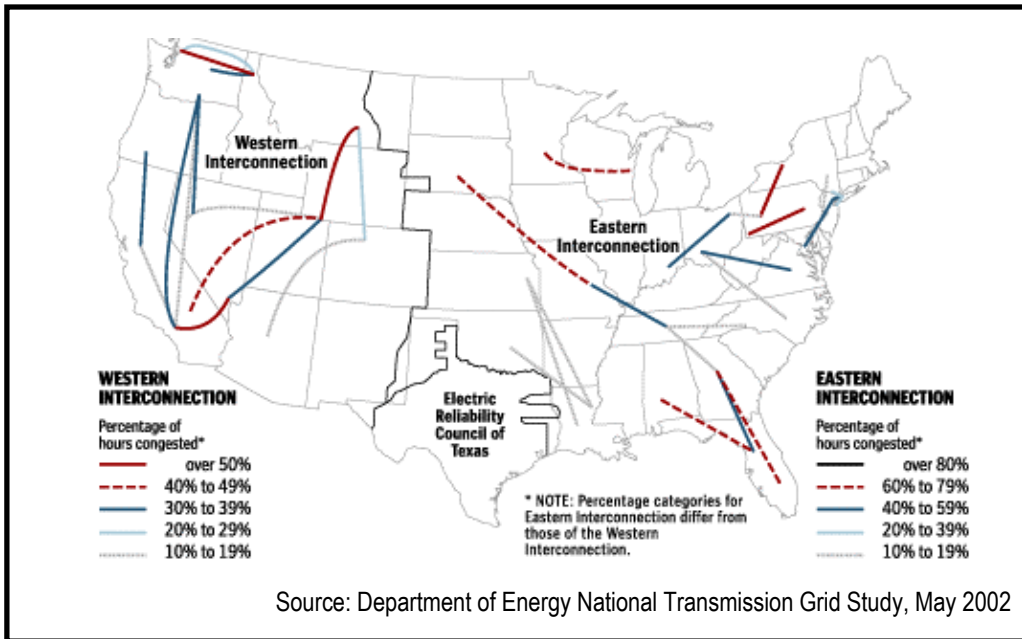
All this points to the increasing stress and loading of the transmission system that led to the August 14th breakdown. Fail-safe systems to shut off and isolate grid systems that

breakdown are not the long-term answer. System operators have done their best, given little maneuverability on already-crowded lines, and no mandatory reliability standards nationwide. Statistically it was only a matter of time before the system crashed under the strain. There has been a wave of responses to the blackout, including formation of a joint American and Canadian investigation to explore the causes of the breakdown. Regardless of the outcome of this collaborative investigation, the system will remain under-invested and over-loaded for years to come. The answer to the question above, "could this happen again," is a resounding **YES**. Therefore, we must examine the most compelling question: *where* are we most at risk?

*Many areas on
the transmission grid
aside from the
Northeast quadrant,
are heavily congested
—a potential
pre-condition
for blackouts.*

Transmission Congestion

The government recognizes that transmission congestion is a real issue. Government and industry know where the biggest problems lie. The figure below illustrates the major congested lines, over the past several years, in the United States:



To examine the “where next?” question, ICF Consulting carried out a detailed, forward-looking analysis for 2004 of where the grid appears to be most at risk. This analysis indicates that certain regions, by virtue of their lack of transmission, poorly placed generation, or both, are expected to cause congestion to a much greater extent than others. Congestion on the transmission system equals stress, eventually leading to a breakdown, much like cholesterol in the arteries makes the heart work harder, and when the major arteries are clogged, it is more serious.

To understand the extent of the potential concern, ICF Consulting forecast the number of discrete hours in which congestion will be recorded in any segment of the bulk power transmission network in 14 regions in the interconnected system in 2004. It is important to note that, due to the network’s integrated nature, problems in one region may cause congestion in another. ICF Consulting’s analysis is highly detailed. It incorporates the current configuration of the transmission system (every bulk power transmission line and several transmission interfaces are explicitly modeled); the location of every power plant above 25 MW; and the projected pattern of demand (which differs notably throughout the country). The table below shows the results of this detailed forecast and analysis for 2004.

According to this data, the most congested regions in the integrated system are New York and California. In New York, inexpensive north-to-south power flows from Canada and the upstate New York region to the downstate and New York City area are constrained. In California, congestion constrains power flows between northern and southern California. Additionally, in some hours, power flows from other states to California are constrained. In our overloaded system, even less densely populated regions (such as the South Central, Central, South and Tennessee Valley Authority regions) cause congestion more than 40 percent of the time. The existence of significant amounts of congestion on the transmission grid can be an important precondition for blackouts.

ICF Consulting Forecast of Regional Demand Resulting in Congestion in 2004

Region/ State	Hours of Future Congestion Caused ICF 2004 Forecast	% of Total Hours*
California	8,271	94%
New York State	7,474	85%
Florida	5,416	62%
South Central (AK, LA)	4,668	53%
Central (OK, KS)	4,206	48%
Tennessee region (TVA)	3,872	44%
South (MS, AL, GA, SC)	3,774	43%
South Atlantic (VA, NC)	3,726	42%
New England	3,094	35%
Mid-Atlantic (PA, NJ, DE, MD)	3,074	35%
Upper Midwest (WI, IL, MO)	2,028	23%
Midwest (WVA, KY, IN, MI, OH)	1,966	22%
Northern Midwest (ND, SD, NE, MN, IA)	1,654	19%

*There are 8,760 hours in a year; however, 2004 is a leap year so there are 8,784 hours. This forecast assumes various projections for natural gas prices and generation unit availabilities that may be different from actual market conditions. Generation dispatch has been based on production cost rather than a bid-based market.

A related issue is that several regions have very brittle systems and are poorly interconnected with others. An earlier analysis by ICF Consulting estimated that over \$150 million of investment in transmission in the South and South Central regions would be necessary just to restore acceptable grid stability at current levels of power flow. Even greater investment would be required to actually increase power export capacity, which currently is minimal. Further north, Wisconsin has only four heavily loaded interstate connections with the rest of the United States, while Minnesota has eighteen and Illinois has twenty-five, according to American Transmission Company. The fewer the interconnections, the less an area is able to utilize regional resources, and the more probable that contingencies (outages of generation or transmission lines) in that area could cause congestion or blackouts.

Note that the analysis in this paper and the results shown in the table above are not a forecast of where the next outage will occur, but simply an assessment of where certain preconditions exist. We can only estimate the potential severity of any future outage. The power system is too complex and influences on the system, such as weather conditions and economic activity, are too dynamic to make such a forecast. However, the analysis highlights areas for concern associated with the recent loss of power.

Future Recommendations

ICF Consulting recommends the following eight-point plan as a prescription to treat the aging patient known as the nation's transmission grid:

1. Establish a Federal "Marshall Plan" to build or upgrade high voltage transmission capacity in the most congested corridors. The argument is at least as strong for this as for the Federal Highway System. As we have seen, without power, economic activity practically comes to a halt.
2. Set and enforce transmission reliability standards (much as reserve margins are determined for generation) which NERC or a similar body should enforce.
3. Implement a new approach to transmission planning under uncertainty. Existing transmission planning based on pre-open access market models is inadequate in anticipating potential power-flow patterns and expansion needs.
4. Assess the need for new transmission regionally and establish greater regulatory certainty. Power flows do not respect state boundaries, so state regulators on their own cannot guarantee the reliability of the grid. To balance state and regional/federal authority, state regulators should be required to jointly consider new transmission lines under the auspices of a regional transmission organization (RTO) or other entity.
5. Create Federal legislation to provide "backstop" authority to build lines if states or regional organizations defer lines that the FERC or DOE believes are necessary.
6. Establish incentives for performance. In the UK, National Grid was allowed to retain millions of pounds in exchange for reducing transmission congestion by hundreds of millions of pounds. The United States should make a similar bargain with our utilities.
7. Exploit new technologies, such as FACTS (Flexible Alternating Current Transmission System) and superconductivity, to push more electricity through existing lines and corridors.
8. Employ private investment to supplement the funds that utilities have available. Many utilities are in difficult financial straits and may wish to leverage outside investment to secure capital. Pension funds, equity investors, and others should be attracted to the fixed rates and stable returns that transmission offers.

Now is the time for action, before we receive another reminder of the frailty of our transmission system.

About ICF Consulting

ICF Consulting is a leading management, technology, and policy consulting firm. Drawing upon extensive industry knowledge, distinguished professionals, and innovative analytics, the firm develops solutions to complex energy, environment, emergency management, community development, and transportation issues. ICF Consulting's approach to these issues is strengthened by its expertise in information technology, organizational improvement, program management, and communications. Since 1969, ICF Consulting has been serving major corporations, government at all levels, and multinational institutions. More than 1,000 employees serve these clients from key business centers in the Americas, Europe, and Asia.

For more information contact:

Elliot Roseman
Phone: 1.703.934.3859
E-mail: roseman@icfconsulting.com

Philip Mihlmester
Phone: 1.703.934.3560
E-mail: pmihlmester@icfconsulting.com