# The Economic Cost of the Blackout

*An issue paper on the Northeastern Blackout, August 14, 2003*

ICF CONSULTING


The recent power blackout in the northeast has revived the discussion on the need to upgrade the transmission infrastructure. While that debate has its own merit, a related and a potentially more threatening issue to be addressed is the vulnerability of our electrical grid to terrorist attacks.

ICF Consulting recently raised similar concerns in a hypothetical scenario of a terrorist attack on the transmission grid in California. In the simulation, we found a coordinated attack in California could lead to significant economic damages, both as a direct consequence of the attack, as well as through the ripple effects due to the strong inter-linkages between industry sectors. In this issue paper, we use some of the insights gained from the California simulation to measure the economic costs of the recent blackout and reiterate some of the lessons learned from the exercise.

***A coordinated attack on a power grid could lead to even more significant economic damages, both as a direct consequence of the attack, as well as through the ripple effects resulting from the strong inter-linkages between industry sectors.***

## What was the cost of the Northeast Blackout of 2003?

One way to estimate the economic costs of a power outage is to calculate consumer's willingness-to-pay (WTP) to avoid such outages. This gives a measure of the "cost of reliability" of electrical services measured in terms of the valuation of the service placed by its customers. Several studies provide survey-based estimates of this WTP for different groups of electric customers. To estimate the total economic cost of this blackout, we multiply the average value of electricity for the affected customers (including residential, commercial, industrial, and others), by the preliminary data on the magnitude and duration of this blackout.

Based on previous analyses by ICF Consulting, we can assume that the value of electricity to consumers (measured as their WTP to avoid outages) is approximately 100 times the retail price of electricity. For example, an analysis done on the 1977 outage in New York City that resulted in a loss of more than 5,000 MW and lasted for 25 hours estimated that the direct cost was about \$0.66/kWh (for example, losses due to spoilage, and lost production and wages), and an indirect cost of \$3.45/kWh (due to the secondary effects of the direct costs).[1] Thus the total unit cost of that blackout was \$4.11/kWh or over \$4,000/MWh in 1977. The national average retail price of electricity in 1977 for all customers was about \$34/MWh.[2] Similar ratios were identified during the simulation scenario on the California grid.

Though the data for the August 2003 outage is preliminary and further refinements will be necessary, we calculate initial estimates of the economic costs of this outage based on these ratios above. Instead of providing only a point estimate for the total cost, we define a range that is 80 times and 120 times the appropriate retail electricity price for the lower and upper bounds, respectively. Also, since there is considerable seasonal and regional variation in electricity prices, we use the August 2002 average electricity price of \$93/MWh for the affected region (provided by the Energy Information Administration) to calculate the value of electricity to the customers affected by this outage.

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Details on the exact extent and duration for different blackout stages are sketchy. According to the North American Electric Reliability Council (NERC) the initial blackout that started around 4:00 p.m. (EST) on August 14, 2003, resulted in a loss of 61,800 MW and affected more than 50 million people. NERC also reports that by 11:00 a.m. (EST) on August 15, about 48,600 MW of lost power was restored, leaving a residual loss of about 13,200 MW. Finally, at 11:00 a.m. (EST) on August 16, NERC announced that "virtually all customers have been returned to electricity service".[3] The precision of the cost estimate is directly correlated to the accuracy of the unconfirmed reports on the extent and duration of the outage. Since much of the data is still being collected, ICF Consulting made reasonable assumptions regarding the "recovery path" from this outage to give an overall picture consistent with the information reported by NERC.

| Approximate Start Time | Approximate End Time | Lost Megawatt | Duration | | Cost of Blackout ($ Billion) | |
|---|---|---|---|---|---|---|
| | | MW | Hour | MWh | Lower Bound | Upper Bound |
| 8/14 - 4 PM | 8/14 - 8 PM | 61,800 | 4 | 247,200 | $1.8 | $2.8 |
| 8/14 - 8 PM | 8/15 - 6 AM | 30,900 | 10 | 309,000 | $2.3 | $3.4 |
| 8/15 - 6 AM | 8/15 - 10 AM | 15,450 | 4 | 61,800 | $0.5 | $0.7 |
| 8/15 - 10 AM | 8/16 - 12 AM | 13,200 | 14 | 184,800 | $1.4 | $2.1 |
| 8/16 - 12 AM | 8/16 - 10 AM | 6,600 | 10 | 66,000 | $0.5 | $0.7 |
| 8/16 - 10 AM | 8/17 - 6 AM | 2,000 | 20 | 40,000 | $0.3 | $0.4 |
| 8/17 - 6 AM | 8/17 - 4 PM | 1,000 | 10 | 10,000 | $0.1 | $0.1 |
| **Total Economic Cost** | | | | | **$6.8** | **$10.3** |

Specifically, for this analysis, we assume that the initial outage of 61,800 MW lasted for 4 hours and then half of that was restored, with the other half (30,900 MW) being the shortfall for another 10 hours. Given that the next announcement from NERC was issued approximately 18 hours after the start of the outage, we assume that another one-half of the unserved 30,900 MW was restored after 14 hours and the remaining loss of 15,450 MW lasted for the subsequent 4 hours. This gives a total of 18 hours for the first phase of the blackout. Using similar arguments for the remaining period of the blackout, we assume more than 13,000 MW of customer load was lost for another 14 hours after which 6,600 MW was the shortfall for another 10 hours. Finally, on the third day of this blackout, 2,000 MW was the loss for 20 hours and another 1,000 MW was the shortfall for the final 10 hours of this blackout. This gives a total outage period of 72 hours.

Using this scenario and the average electricity price for the affected region from August 2002, the economic cost of this outage is estimated to be between $7 and $10 billion for the national economy. Further refinements to these estimates are likely as new details about the outage pattern are released.

## How could terrorism complicate matters?

Although the cost of the August 2003 blackout is not expected to prove devastating for our $10 trillion economy, it is important to keep in mind that a terror-induced blackout could prove significantly more costly and have potentially debilitating impacts on the affected region as well as the entire country. As the economy tries to recover from recession, a sabotage-related shock that could affect such a huge area of the country could significantly increase the cost burden and prove fatal for the recovery.[4] Some of the added costs from a terrorism-related transmission grid attack would be:

- Damage to equipment – a terrorist attack could not only lead to a transmission grid malfunction, but also could lead to significant damage to the equipment, resulting in higher costs and more time required for repair and replacement.
- Hangover effect –In the simulation referenced above, the most significant economic burden was borne by the tourism industry as people became nervous and avoided travel even after electricity was fully restored. A similar blackout caused by a terrorist attack would lead to substantially higher costs to the hotel, airline, and other service industries that are directly impacted by tourism.

It is important to remember that the economic costs of the blackout would have been significantly higher had it been caused by a terrorist attack.

The need is even greater now to think about the critical infrastructure asset—electric transmission grid—and ways to improve its security and reliability. Here are some of the areas of critical infrastructure protection (supported by a White House report) that need further study:

- Understand the level of dependencies between different parts of the transmission grid so that we can establish protection priorities and strategies.
- Study the need for increased redundancy in our transmission infrastructure and build it making greater investment in reserve equipment. Increased generation will improve the reliability of the whole network and reduce its vulnerabilities.
- Identify critical equipment stockpiles so there is minimum delay in recovery and restoration and analyze ways to standardize equipment and increase component interchangeability.

- Increase distributed generation such as through promoting combined heat and power technologies (commonly called cogeneration technologies) to relieve transmission bottlenecks.
- Analyze the risks faced by these critical facilities, as well as the steps we can take for the actual physical protection of our nation's assets, so that we are better prepared to guard against such events.

Another important component of a successful critical infrastructure protection strategy is to have adequate economic policies in place that harden the economy against such disruptions. This component assumes increased significance as the economy recovers from an economic recession. A terrorist attack on vital infrastructures will also do serious harm to the tourism industry, resulting in significant unemployment as well as substantial costs for the insurance industry. According to reports in The New York Times, preliminary estimates of the insurance industry burden of this recent blackout put the figure at $3 billion.[5]

[1] See US Congress, Office of Technology Assessment, "Physical Vulnerability of Electric System to Natural Disasters and Sabotage", OTA-E-453. Washington, DC, US GPO, June 1990.
[2] See Annual Energy Review 2001, Table 8.6 available at www.eia.doe.gov/emeu/aer/elect.html
[3] See a series of press releases and media briefings available at the NERC web site at www.nerc.com
[4] ICF Consulting estimated that a simulated attack on California's transmission grid could lead to about $18 billion damage. Although California is the single largest state economy with a population of more than 34 million, the northeast blackout is estimated to have affected over 50 million people.
[5] See, for example, "Insurers Say Most Policies Do Not Cover Power Failure", in The New York Times, August 16, 2003.

# About ICF Consulting

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