

Hey! Who Turned Out the Lights?

Astronomers were busily tracking "Active Region 5395" on the Sun when suddenly it blasted-out a huge cloud of super-hot gas on March 10, 1989. Three days later, and seemingly unrelated to the solar blow-out, people around the world saw a spectacular, and entertaining, Northern Lights display. The distant solar storm 93 million miles away had silently set in motion a chain of events reaching from the Sun's fiery surface to the skies overhead. Most newspapers that reported this event thought that the spectacular aurora was the most newsworthy aspect of the storm. Seen as far south as Florida and Cuba, the most people in the Northern Hemisphere had never seen the Northern Lights dancing in their evening skies. But this particular explosion of matter and energy did much more than just dazzle and confuse the casual sky watcher as it painted the heavens with shifting colors and shapes.

At 2:45 AM on March 13, electrical currents created by the impact of this storm found their way into the electrical circuitry of the Hydro-Quebec Power Authority. Giant capacitors tried to regulate these currents but failed within a few seconds as automatic protective systems took them off-line one by one. Suddenly, the entire 9,500 megawatt output from Hydro-Quebec's La Grande Hydroelectric Complex began to waver. Power swings tripped the supply lines from the 2,000 megawatt Churchill Falls generation complex, and 18 seconds later, the entire Quebec power grid collapsed. The cascading of events lasted barely 97 seconds. It was much too fast for human operators to react, but it was more than enough time for 21,500 megawatts of badly needed electrical power to suddenly disappear from service.

For nine hours, large portions of Quebec were plunged into darkness. A thousand miles away, even Maryland, Virginia and Pennsylvania were affected as half of the capacitors in the Allegheny Power System went off-line. In many ways, it was a sanitized calamity. It was wrapped in a diversion of beautiful colors, and affected a distant population mostly while they slept. There were no houses torn apart, or streets flooded from powerful hurricanes. There was no dramatic TV News footage of waves crashing against the beach. There were no tornadoes cutting a swath of destruction through Kansas trailer parks.

The calamity passed without mention in the major metropolitan newspapers, yet six million people were affected as they awoke to find no electricity to see them through a cold Quebec wintry night. Some engineers from the major North American power companies were not so calm. They worried how this Quebec blackout could easily have escalated into a \$6 billion catastrophe affecting most US East Coast cities. All that prevented 50 million people in the US from joining their Canadian friends in the dark were a few dozen heroic capacitors on the Allegheny Power Network. *(Excerpted from the book "The 23rd Cycle". Author: Dr. Sten Odenwald)*

1. **If the solar storm took 3 days to travel 150 million kilometers to Earth, how fast was it traveling in kilometers per hour?**
2. **How much time elapsed between the arrival of the storm at Earth, and the time when the Quebec power system failed?**
3. **How long did the blackout continue?**
4. **What kinds of severe problems could occur in a typical city during a blackout in the daytime? In the nighttime?**

Space Weather: <http://image.gsfc.nasa.gov/poetry/weather01.html>