Conversation with John Kappenman on August 6, 2013

Participants

- John Kappenman – Owner, Storm Analysis Consultants
- Ben Rachbach – Research Analyst, GiveWell

Note: This set of notes was compiled by GiveWell and gives an overview of the major points made by John Kappenman.

Summary

GiveWell spoke to John Kappenman as part of its shallow investigation into philanthropic opportunities to mitigate geomagnetic storms. Mr. Kappenman is the owner of Storm Analysis Consultants, which consults with the US government on the geomagnetic storm threat and mitigation measures. Conversation topics included the threat posed by geomagnetic storms, mitigation strategies, stakeholders, and philanthropic opportunities.

Threat posed by geomagnetic storms

Physics of the threat

In 1989, a geomagnetic storm caused blackouts in Quebec. If it had been slightly larger, it likely would have caused blackouts in the US as well. In a given year, there is a 1 in 30 to 1 in 50 chance that a geomagnetic storm could cause widespread damage to large transformers across a country the size of the US. These transformers are critical to the function of the electrical grid.

Storms could be as much as ten times larger than the 1989 storm. Such a storm could wrap around the globe, causing large transformers to fail across the world. In a given year, there is a 1 in 100 to 1 in 200 chance of such an event. Although geomagnetic storms tend to be more intense near the poles, recent research suggests that the risk is global.

Over the past few decades, new research has painted an increasingly worrisome picture of the threat. Mr. Kappenman expects this trend to continue.

Threat to the grid

A large geomagnetic storm could result in a years-long global blackout. Large transformers destroyed by geomagnetic storms would have to be replaced to restore the function of the grid. Large generators might also be affected and have to be replaced. There are few extra transformers currently on hand. Under normal conditions, factories would take about four months to assemble one transformer. One factory could make 30-50 transformers per year. There are about 500 transformers in the US that might need to be replaced in the event of a large geomagnetic storm.

Transformer and generator manufacturers depend on many services that would be interrupted by large-scale power outages. These include just-in-time delivery of materials from around the world, transportation, and access to a highly skilled work force. Nations are likely to impose restrictions on the export of raw materials as well as transformers. Given all of these factors, it could be years before the grid was restored.

If the grid were down, there would only be limited potential to use alternative energy sources. Many people have natural gas generators at their homes to use in case of emergency, but the extraction and transportation of natural gas requires electric power from the grid. Oil and gasoline production requires power from the grid for extraction, refinement, and transportation. Wind and solar power are likely to remain usable, but they currently represent a very small portion of our infrastructure.

Threats to human welfare

Developed economies depend on power from the grid for a large variety of activities, from refrigeration of medical supplies to transportation of potable water. If the grid went down, normal economic activities would likely grind to a halt.

The example of the Fukushima nuclear plant after the 2011 earthquake and tsunami in Japan shows that nuclear power plants are dependent on the grid to keep them in a stable state. A global loss of grid power could cause hundreds of nuclear plants around the world to melt down.

There is potential for international conflict over transformers or the raw materials to manufacture them. Also, societies may collapse as economies freeze and government services have to be suspended.

Mitigating the threat posed by geomagnetic storms

Mitigation strategies

GIC blocking devices

Mr. Kappenman believes that ground-induced current (GIC) blocking devices are the best option for protecting against the threat to the grid posed by geomagnetic storms. Similar to an isolating foundation that prevents some of the Earth's motion from being transmitted to a building during an earthquake, GIC blocking devices prevent the Earth's charge from being transmitted to the transformer in a geomagnetic storm.

GIC blocking devices have been shown to be feasible: they were tested in the 1990s and are currently being marketed. A paper that Mr. Kappenman coauthored determined that installing GIC blocking devices in transformers around the US would cost one billion dollars, which could be paid for by a 45 cent increase per person in annual electric bills.

Most operators would prefer to keep GIC blocking devices on hand and install them when solar monitoring indicates a high probability of geomagnetic storms. Solar monitoring is good enough that we are very likely to have advance warning of geomagnetic storms.

Shutting down the grid

For now, since power companies do not have GIC blocking devices on hand, the safest response to a forecast of high risk of geomagnetic storms would likely be to shut down the grid for the duration of the period of high risk. This would protect the grid from harm. However, the grid might have to be shut down for days. Shutting down power across the US would be in itself an economic disaster costing billions of dollars. Installing GIC blocking devices would be cheaper than shutting down the grid even once.

An order from the president is the most likely trigger for such a shutdown. However, it is uncertain whether a president would take such a step. The president has some related powers under the Constitution and laws passed by Congress. For example, laws allow him emergency control over coal-fired power plants and nuclear plants. However, the false alarm rate for major geomagnetic storms is high. A false alarm would damage the president's power, so the president may be reluctant to shut down the grid.

Other options

Other means of mitigating the risk to the grid from geomagnetic storms are more expensive and less effective. These include building more robust transformers. Replacing transformers all around the world, however, would be prohibitively expensive.

Mitigation stakeholders

Interest in researching and protecting against geomagnetic storms increased after the 1989 storm caused the Quebec blackout.

Government

FERC/NERC

At the federal level, the Federal Energy Regulatory Commission (FERC) regulates the power industry. FERC lacks the power to devise regulations itself. Instead, FERC asks the North American Electric Reliability Corporation (NERC), a non-profit set up by the power industry, to devise standards to mitigate the risk from geomagnetic storms.

NERC's process for setting these standards is supposed to be an open process allowing all stakeholders to participate, but, in practice, only electric power companies come to the meetings in large numbers.

Once NERC devises standards, FERC can either accept the standards or remand them to NERC for amendment. Currently NERC is working on new standards for mitigating the risk from

geomagnetic storms, which will be made public in one to two years from now. At that point, advocates for the public interest will have to decide whether to encourage FERC to accept or remand. It is unclear how long it might take to arrive at adequate standards through this process. So far, there has never been a design code for grid components that takes the threat of geomagnetic storms into account.

Other US government regulation

Congress has considered bills to require power companies to mitigate the geomagnetic storm threat. In 2010, the House passed the GRID Act, which would have required protections against the risk from storms. The bill died in the Senate, however. The bill was revived in 2013 as the SHIELD Act. It has yet to be voted on in either chamber.

Mr. Kappenman has presented to the President's Commission on Critical Infrastructure Protection on the threat from geomagnetic storms. The president has little authority to make and enforce regulations requiring electric utilities to mitigate the threat from geomagnetic storms.

In 2013, Maine passed a law requiring power companies to protect the grid within the state from geomagnetic storms.

The US leads the world in responding to the threat of geomagnetic storms. The UK and other countries are starting to move in the same direction as the US.

Electric utilities

Although mitigating GIC damages would clearly be in the social best interest, it may not be in the best interest of power companies. The costs of a long-term blackout would generally be borne by power consumers rather than by electric utilities.

Also, Mr. Kappenman said that some utilities would not be able to raise rates to recoup the costs of mitigation. This is because rates are set by regulators and are based on the overall financial situation of utilities. Utilities can ask regulators to look at their balance sheets and set a new rate based on the present situation. Because interest rates are currently so low, utility operating costs are low. Even if they undertook geomagnetic storm mitigation, utilities' balance sheets would look healthy to regulators, so if the utilities asked regulators to reevaluate rates, regulators might actually lower rates.

Electric utilities often argue that the risks posed by geomagnetic storms are overstated.

Insurance companies

The insurance industry is concerned about the insured damages that may be caused by geomagnetic storms. If insurance companies charge more for insurance to electric utilities that have not taken steps to mitigate the threat from geomagnetic storms, this may provide the incentive necessary for power companies to take steps to mitigate the threat.

Opportunities for philanthropy

Currently, advocates for the public interest have little money to advance their cause. Mr. Kappenman, for example, draws from his personal savings to finance travel to NERC meetings. In contrast, the power industry has lots of resources that it uses to oppose regulations. Philanthropists could sponsor more advocacy for the public good. Some advocates would like to go to NERC meetings but lack the funds to do so, so philanthropists could provide financial support to enable them to attend.

Philanthropists could also pay for GIC blocking devices, or advocate for public ownership of GIC blocking devices. This would avoid having to force reluctant power companies to purchase the devices themselves.

Alternatively, philanthropists could fund research on the threat or on mitigation measures. A variety of research is currently ongoing.

People and organizations for GiveWell to talk to

- Power company representatives
- FERC
- Proponents of the SHIELD Act
- The Electric Infrastructure Security Counsel, an NGO advocating for increased attention to threats to infrastructure including geomagnetic storms

All GiveWell conversations are available at http://www.givewell.org/conversations