



U.S. Department of Energy

Office of Electricity Delivery and Energy Reliability

# DOE/OE GMD Space Weather Program

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# DOE's Interest in Space Weather and GMD

## Space Weather and GMD

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# Why Does DOE Care?

- NERC and DOE held workshop in 2009 to examine three main high impact low frequency events to the bulk electric system.
- GMD (natural threat) and EMP (man made) were considered one of the three threats.
- Conclusions of this workshop and of the studies agreed that consequences could be high and impacts long term.
- A positive result was formation of the NERC GMD Task Force.
- Another Result was Resolve at DOE to Fund Some Efforts to Better Understand the Problem.

## High-Impact, Low-Frequency Event Risk to the North American Bulk Power System

*A Jointly-Commissioned  
Summary Report of the  
North American Electric  
Reliability Corporation  
and the U.S. Department of  
Energy's November  
2009 Workshop*

DOE and NERC, June 2010

# Why Does DOE Care?

- A priority for the White House.
- Space Weather Strategy being developed by the White House and partners, including DOE.
- Space Weather Implementation Plan will follow the Strategy.
- DOE working closely with the Office of Science and Technology Policy at the White House on the strategy, implementation plans and other initiatives.

# DOE Strategy for Space Weather

## Advancing Science

Funded efforts to determine which transformers are more susceptible to GMD.

Support to *Sunburst* project which measures ground-induced currents (from GMD) on transformers. There were 10 monitors when we started, all in Eastern grid. There are now 41 monitors in all three major grids.

Cost share project to deploy 12 variometers in the Eastern grid to measure magnetic fields. These data can improve ability of utilities to accurately assess vulnerability to GMD.

**Path forward:** Support efforts to validate models of impacts. Potentially deploy variometers in West. R&D efforts to improve resilience of transformers.

## Partnerships

Working with industry directly and through our participation in the NERC GMD Task Force.

DOE laboratories are supporting advancements in protection and mitigation measures.

Co-sponsored two international workshops on space weather in February and March of 2015.

Supported domestic and international workshops with industry, academia, insurance, and government partners to explore solutions and best practices.

**Path forward:** Continue to work with international partners and with the White House, NASA, DHS, DOD, USGS, FEMA, and others to advance science on impacts, protection and mitigation solutions.

## Analysis

Electric power impacts associated with GMD and solar storms in the Western and Eastern Interconnects.

Studies in 2012 and 2014 on LPTs addressing industry's concern about long lead time to deliver. Updated study being considered.

Reports with NERC in 2010 and 2012 about the risks to severe GMD events on the bulk power system.

2013 Funded an International Electric Grid Protection Report

**Path forward:** Examine effects of GMD on system components and performance and share lessons learned on mitigation and protection technologies.

# DOE's Focus: Large Power Transformers

- In June 2012, OE completed a study, “Large Power Transformers and the U.S. Electric Grid.”
- Study addressed U.S. electric power industry’s concern about large power transformers (LPTs).
- Demand for LPTs is on the rise globally and domestically.
- LPTs require a long lead time, and transporting them can be challenging.
- Very limited capacity to manufacture LPTs in the U.S. at the start of the study.
- Updated study in April 2014.  
Considering another update.

**“The limited availability of [spare] extra-high-voltage transformers in crisis situations presents potential supply chain vulnerability.”**

*- A Framework for Establishing Critical Infrastructure Resilience Goals, National Infrastructure Advisory Council, 2010*

# DOE Interest in Large Power Transformers

- Several new large power transformer manufacturing plants built in US in past few years.
  - EFACEC in Georgia 2009
  - Hyundai in Alabama in 2011
  - Mitsubishi in Tennessee in 2013
- Other manufacturers upgraded current plants to allow production of LPTs
  - SPX in Wisconsin completed 50% expansion in 2012 to allow it to build more LPTs.
  - More upgrades expected.
- DOE updated LPT Study in June 2014.
- Have Proposed a Transformer Strategy

# Which LPTs Most Critical? Which LPTs Most Susceptible to GMD?

- This can be estimated, based on known information and modeling
- One of the first tasks funded under DOE support to *Sunburst*.
- Depends on Location.
  - Closer to Poles
  - Closer to Large Bodies of Water
- Depends on earth conductivity.
- Depends on magnetic/electric fields.
- Depends on type of transformer.
- Depends on age of transformer.
- Other factors at play as well such as system topology.

# GIC Data

- *Sunburst* measures actual ground-induced currents (GICs) on large power transformers (LPTs) during solar storms.
- 10 monitors in network when DOE began to provide some support to program a couple of years ago – all monitors were in eastern interconnect.
- DOE identified the most susceptible LPTs to GICs.
- DOE reported these estimates to owner operators and encouraged them to put in *Sunburst* monitoring nodes at the susceptible site.
- Industry partners agreed to install over 30 additional nodes.

# Magnetic Field Data

- The U.S. Geological Survey (USGS) collects these kind of data.
- USGS has five high resolution magnetometer observatories in the Continental United States (CONUS).
- With so few high resolution magnetometer observatories in the CONUS, magnetometer data will have to be modeled and estimated at most locations during GMD events.
- Solar storms can change magnetic fields on Earth which can generate electrical fields which can generate GICs through transformers.

# Benefits of GIC and Magnetic Field Data

- Can help scientists validate models or allow them to develop more accurate estimations and modeling.
- Better models will allow better risk assessments.
- Better risk assessments can lead to better decisions on where, when, how, etc. to accept or reduce risk.
- Better information can lead to more informed decision making:
  - Protection
  - Mitigation
  - Response

# Project to Collect and Integrate Variometer Data

- Decision is to deploy up to 12 Variometers.
- Develop criteria for determining best locations.
- Determine specifications for variometers.
- Evaluate and determine specific model(s) to purchase.
- Develop procedure and software to integrate magnetometer and variometer data.
- Develop installation guide.
- Install up to 12 variometers.

# Next Steps After Integrating Variometer Data

- Continue to collaborate internationally and within federal government.
  - Commerce (NOAA)
  - DHS
  - DOD
  - DOE
  - Interior (USGS)
  - NASA
  - FEMA
- Continue participation in the NERC GMD Task Force.
- Continue to investigate mitigation and protection.
- Propose R&D opportunities.

# Workshops

- February 2015 Co-sponsored a North Atlantic Space Weather Workshop with the White House and UK Government
  - Held at White House and State Department
  - Irish and Canadian representatives also attended
  - Main focus was impact to power grids
  - Public messaging was also an important focus
- March 2015 Co-sponsored a Workshop with NRCAN
  - Held in Ottawa
  - Focus on Transformers
  - Manufacturers Attended
- March 2015 Presented at LWS Institute Workshop on GMD
- April 2015 Participating in INL GMD Workshop.

# National Strategy

- Working with White House and Other Agencies to Develop a Space Weather Strategy
- Working with White House and Other Agencies to Develop an Action Plan to Implement the Space Weather Strategy
- Ongoing – More on this when released for public comment by White House

# For Additional Information and Inquiries

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