U.S. DEPARTMENT OF
ENERGY

Infrastructure Security
& Energy Restoration

Prepare. Respond. Adapt.

Space Weather Impacts to the Electricity Sector / Power Distribution

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Infrastructure Security and Energy Restoration

The Infrastructure Security and Energy Restoration (ISER) Program is the lead for Emergency Support Function #12 (Energy) under the National Response Framework, and is the Energy Sector-Specific Agency for national efforts, in cooperation with public and private sector stakeholders, to enhance the preparedness, resiliency, and recovery of the U.S. energy infrastructure. **Three Resource Areas; Ten Programs**

Preparedness and Exercises

- **Goal:** *Lead Federal, State, and private sector partners to an enhanced level of coordination and preparedness for energy emergencies.*
- **Programs:**
  - Energy Sector Exercises
  - SLTT Energy Assurance
  - SSA Responsibilities
  - **Risk and Hazards Analysis**
  - International & Defense
  - Cyber Preparedness

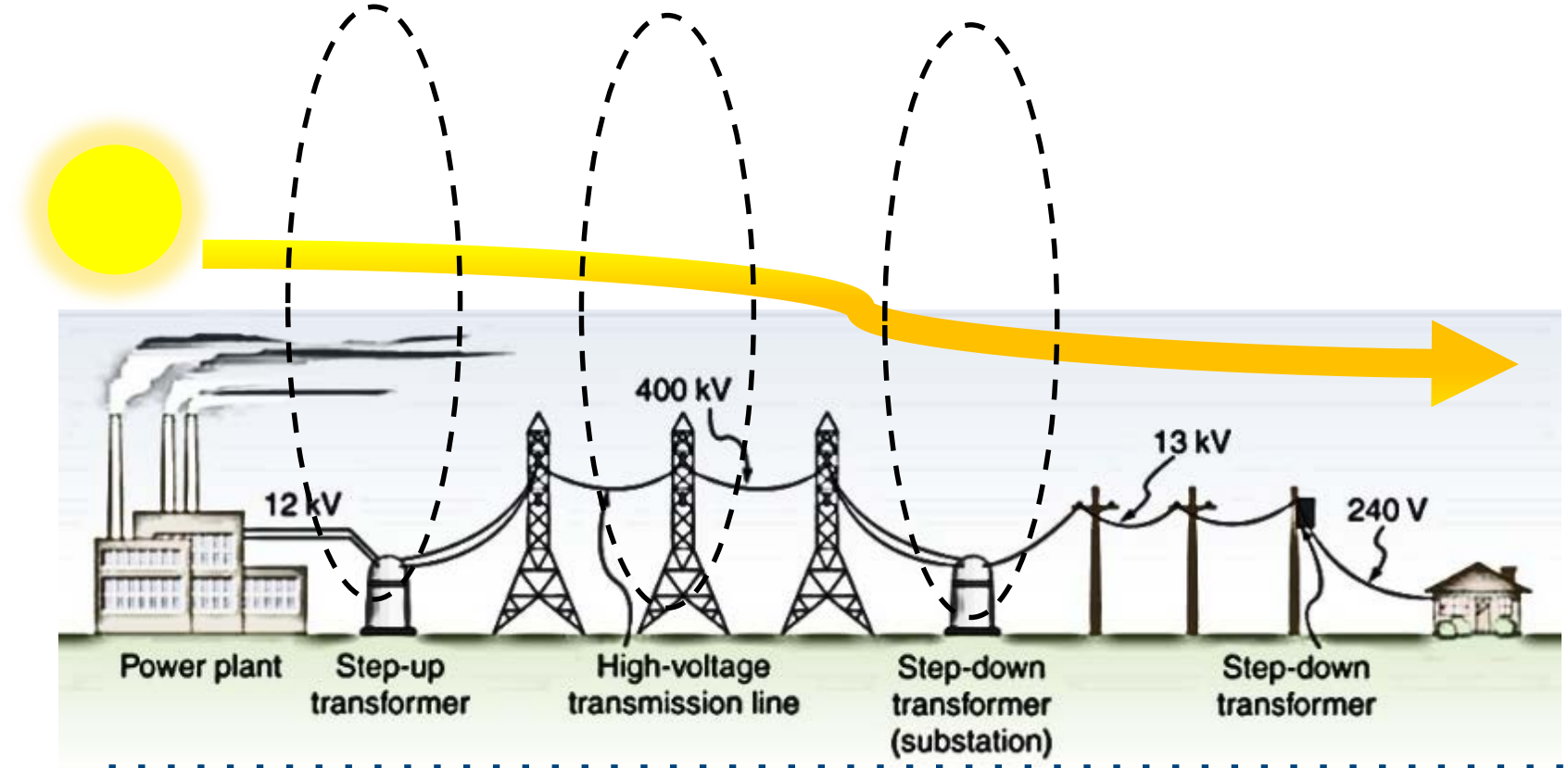
Situational Awareness

- **Goal:** *Provide definitive situational awareness of power and fuel availability and infrastructure to support better prediction of, and recovery from, energy emergencies.*
- **Programs:**
  - Energy Sector Situational Awareness
  - Situational Analysis

Emergency Response and Recovery

- **Goal:** *Facilitate the response and recovery of the energy sector via coordination of private, state, local and federal activities and information sharing.*
- **Programs:**
  - Emergency Response
  - Cyber Incident Coordination

How Does GMD Impact the Grid?



Impacts to Grid Are Possible, But Are Rare

- Extreme (G5) geomagnetic disturbances (GMDs) are *Rare*
  - Typically only 4 every 11-year solar cycle
  - Last one was October 2003

- Significant impacts even from a G5 GMD are *Extraordinary*
  - There have been 29 G5 storms since 1932
  - Only two led to both transformer damage and electrical service interruptions
    - March 1989
    - October 2003

- DOE and grid operators worry about the G5+ Mega-GMD

March 1989: 9-Hour Quebec Blackout

- March 10, solar event starts at Sun
- March 12, voltage fluctuations seen on the Hydro-Québec (H-Q) transmission grid
- Early March 13, Earth's magnetic field fluctuated violently, H-Q's grid protection system triggered, and a blackout resulted very quickly

- After evaluating the event, H-Q
  - Recalibrated protection systems so that in future solar events they would both protect individual equipment/systems and maintain grid viability
  - Modified operating procedures for storms to reduce power flow on lines and direct-current interconnections, and suspend major switching operations
  - Installed series compensation on power lines to enhance grid stability
- Changes proved effective in subsequent solar storms; similar practices implemented by other utilities

What DOE Is Doing to Address GMD

- Planning

- Analyses
  - Grid Vulnerability
  - Transformer Susceptibility
  - Monitoring & Mitigation Requirements/Assessments

- Monitoring
  - GICs
  - Magnetic Fields

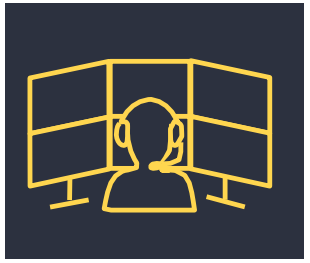
- Mitigation/Protection
  - Pilot Program to Deploy Mitigation on Grid

Summary of Potential Impacts to Customers

Like many other risks and hazards, GMD can cause a number of potential consequences, including

- Long- or short-term losses of power
- Reductions in power quality
- Temporary reductions of power as a conservation measure

ISER is working with its Federal, state, local, industry, and other partners to increase our preparedness for GMD—directly and by leveraging our efforts for other risks and hazards



Questions?

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