U.S. DEPARTMENT OF
ENERGY
Cybersecurity, Energy Security, & Emergency Response

Space Weather Preparedness
Space Weather Enterprise Forum

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Cybersecurity, Energy Security, and Emergency Response

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Office of Cybersecurity, Energy Security, and Emergency Response (CESER)

CESER MISSION

The Office of Cybersecurity, Energy Security, and Emergency Response (CESER) leads the Department of Energy's emergency preparedness and coordinated response to disruptions to the energy sector, including physical and cyber-attacks, natural disasters, and man-made events.

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

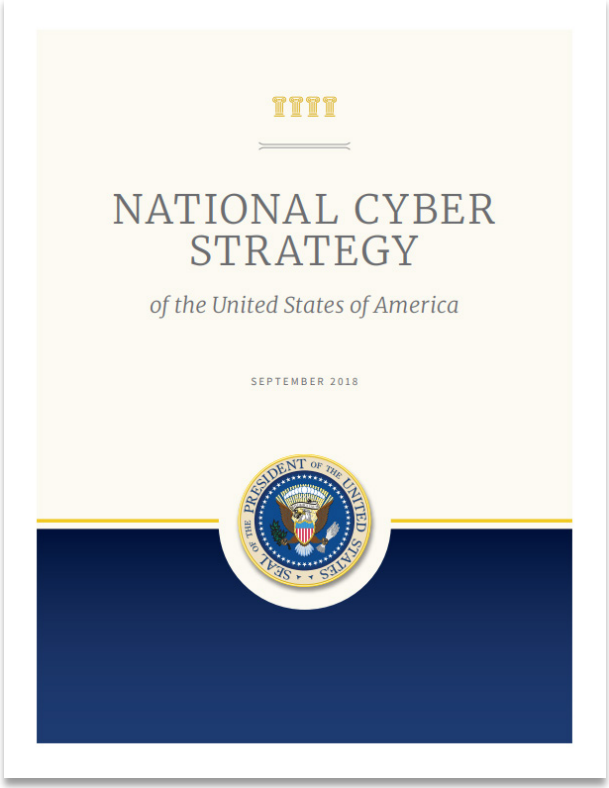
Situational Awareness

- **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

National Cyber Strategy



- First fully articulated national cyber strategy in **15 years**.
- Outlines actions to
  1. **Defend the homeland** by protecting networks, systems, functions, and data;
  2. **Promote American prosperity** by nurturing a secure, thriving digital economy and fostering strong domestic innovation;
  3. **Preserve peace and security** by strengthening the United States' ability— in concert with allies and partners — to deter and if necessary punish those who use cyber tools for malicious purposes; and
  4. **Expand American influence** abroad to extend the tenets of an open, interoperable, reliable, and secure Internet.

Executive Order on EMP

Section 5 (e) of the Executive Order states:

The **Secretary of Energy** shall conduct early-stage R&D, develop pilot programs, and partner with other agencies and the private sector, as appropriate, to characterize sources of EMPs and their couplings to the electric power grid and its subcomponents, understand associated potential failure modes for the energy sector, and coordinate preparedness and mitigation measures with energy sector partners

DOE's Coordinated Path Forward to Address both EMP and GMD

To accomplish the goals of the Joint EMP Resilience Strategy and the new EO on EMP and the National Space Weather Strategy and Action Plan, DOE is building a new national program, **CE-SMART,** via a hub-and-spoke model

Test Facilities & Analytic Capabilities

Sandia National Laboratories

EPRI, INL, LANL, LLNL, ORNL, SRNL, others

Grid-scale Testing Facilities

Large Energy Component Capability

Power Electronics Simulation

Understand and address impacts of EMP & GMD

Potential Efforts

Model impacts on oil and natural gas systems

Assessments

Test energized large power transformers at scale

Simulate combined effects of multiple waveforms on a large grid

Unclassified waveforms for E1, E2, and E3

Mitigation tactics and resilient equipment design

Center for Simulation, Modeling, Analysis, Research, and Testing

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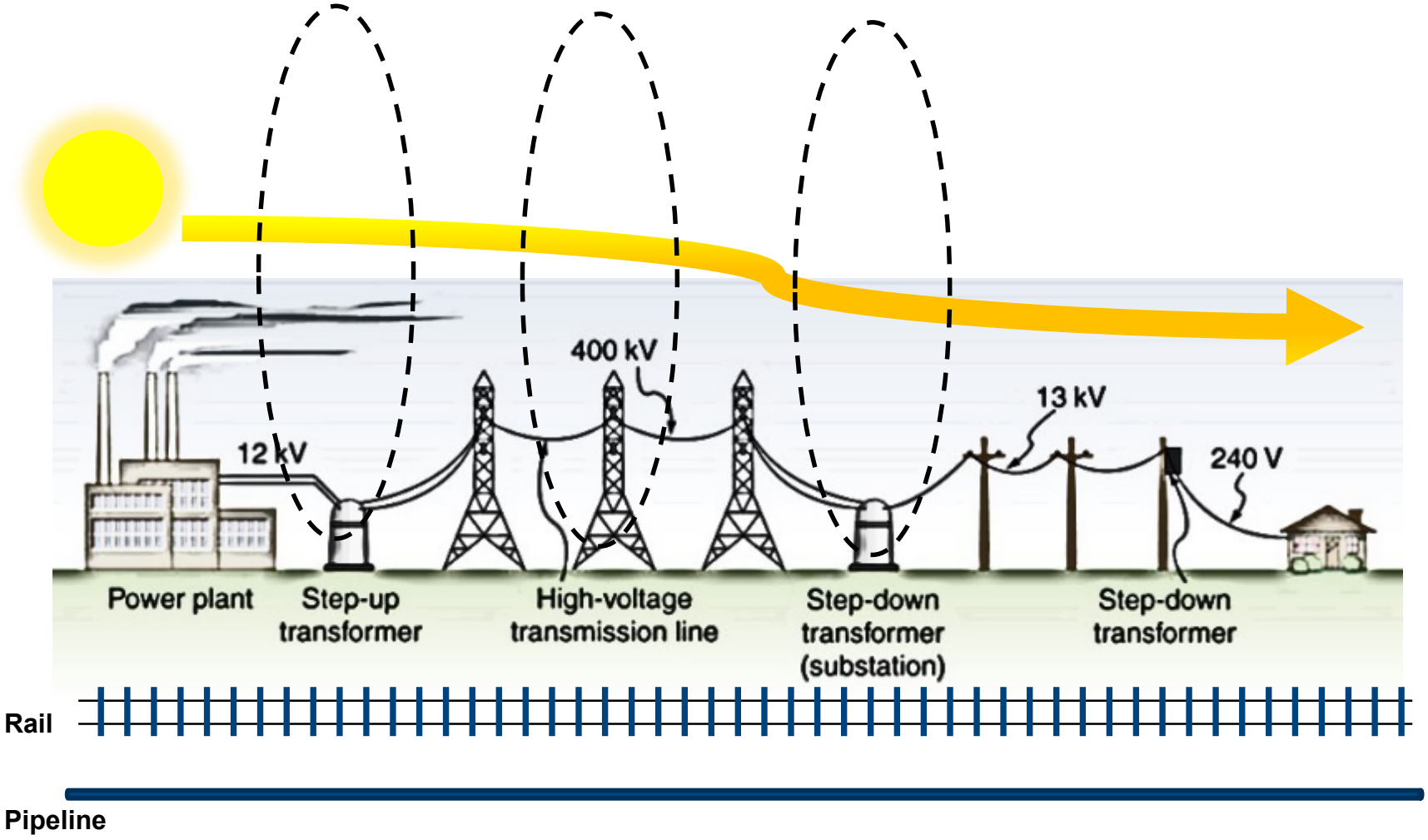
GMDs Induce Currents into Long Conductors



Space Weather Effects

- **GIC Effects on Transformers:**
  - Causes half-cycle saturation with quasi-DC current
  - Significantly increases core noise and vibration
  - Creates harmonics
  - Increases absorption of reactive power
  - Causes voltage instability
- **GIC Effects on Other Parts of Bulk Electric System:**
  - May trip protective equipment
  - Could trip generators
  - Could result in grid imbalances
  - Interferes with precision timing devices

Potential Impacts on the Electric Grid from an Extreme Storm

- **Voltage Collapse is Biggest Concern Due to:**
  - Increase in Absorption of Reactive Power
  - Tripping of Generators and Other Equipment
- **Damage to Transformers from Heat and/or Vibrations**
- **Wear and/or Damage to Other Equipment**
  - Fuses and Breakers May Open
  - Bearings
- **Voltage Instability Can Lead to Power Quality Issues**
  - Lights Flickering
  - Damage to Customer Equipment?

Mitigation Current Systems

- **Adjust Protective Equipment to Reduce False Trips**
- **Have Ample VAR Compensation Available**
- **Reduce Load on Vulnerable Transformers**
- **Cool Transformers Prior to Arrival of GICs**
- **Reconfigure Grid to Reduce or Eliminate Movement of Electricity on Long Distance Transmission Lines**

Mitigation Future Options

- **Deploy new transformers with lower susceptibility to adverse impacts from GI**
- **Rely more on distributed energy resources**
- **Consider factors that affect strength of GICs when siting new substations:**
  - Latitude
  - Geology
  - Large Bodies of Water
  - Orientation of Transmission Lines
  - Adjust Protective Equipment to Reduce Trips

Current Protection and Cost to Enhance

- **Current Protection**
  - GIC blockers on transformer neutrals
  - Series compensation on transmission lines
  - Transformers with high GIC withstands
  - Protective device settings to prevent premature trips

- **Potential Protection Measures**
  - Transformers with higher GIC withstands
  - Configuring and building systems with less reliance on high voltage equipment and/or long distance power lines
  - Neutral resistive device
  - Low capacitance neutral blocker
  - Sacrificial MOV (surge arrestor) as a ground

Situational Awareness and Response

- **Situational Awareness**
  - Monitoring and Reporting Prior to, During, and After an Extreme GMD
- **Response**
  - Activation
  - Coordination with Partners
  - Damage Assessments
  - ESF-12 Roles and Responsibilities
  - DOE Responsibilities and Authorities

DOE Future Actions

- **Support National Space Weather Strategy and Action Plan**
  - DOE has a number of actions and deliverables
- **Develop and Implement CE-SMART**
  - Started in FY 2019
  - Center for EMP/GMD Simulation, Modeling, Analysis, Research and Testing
- **Mitigation and Protection**
  - Implement pilot program to field deploy mitigation or protection devices on grid

Questions?

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