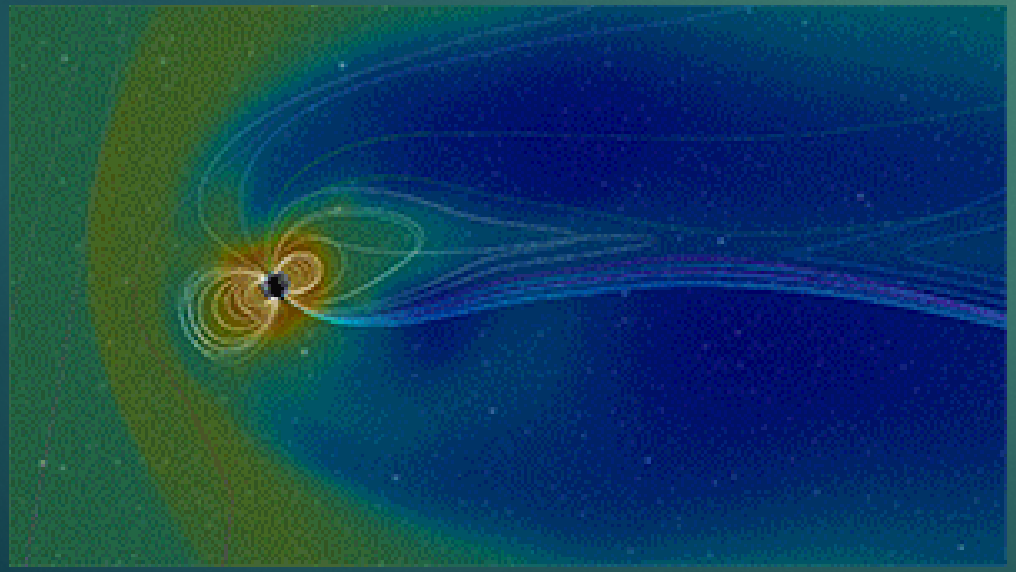
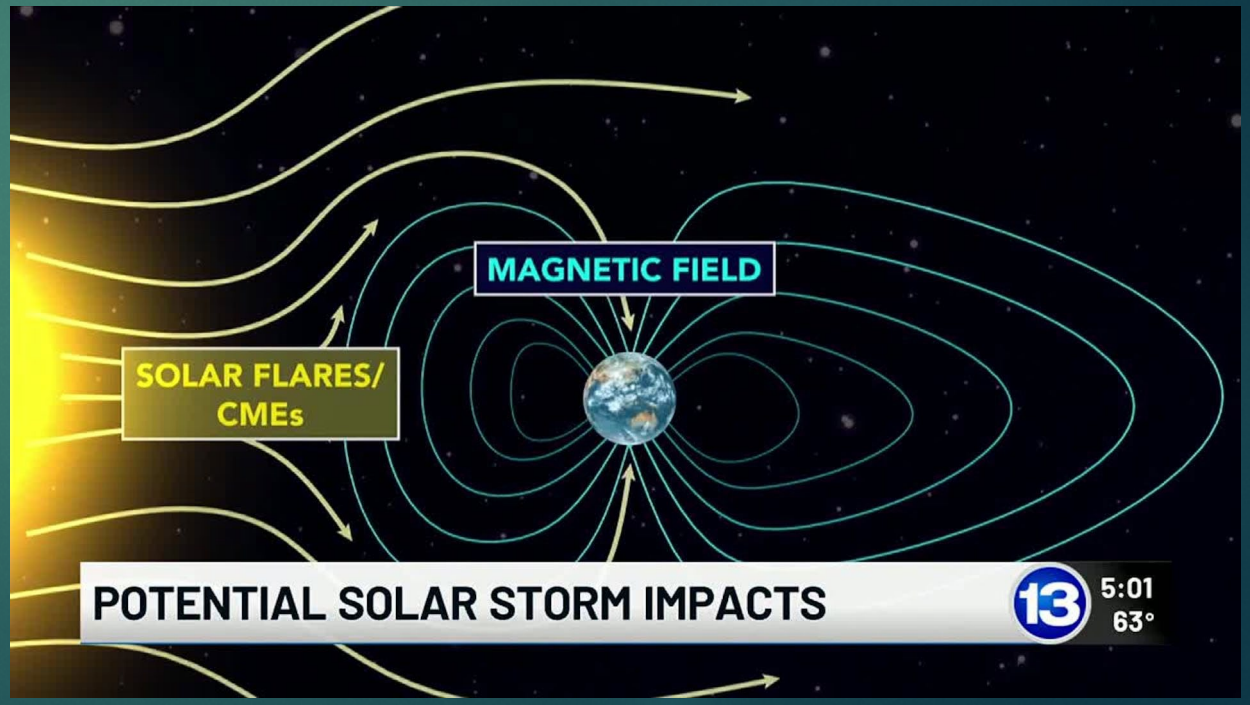
Solar Storm Preparedness

WHY EMERGENCY MANAGEMENT MUST TAKE ACTION AND PREPARE FOR THE LONG-TERM LOSS OF ELECTRICAL POWER

Hazard Identification

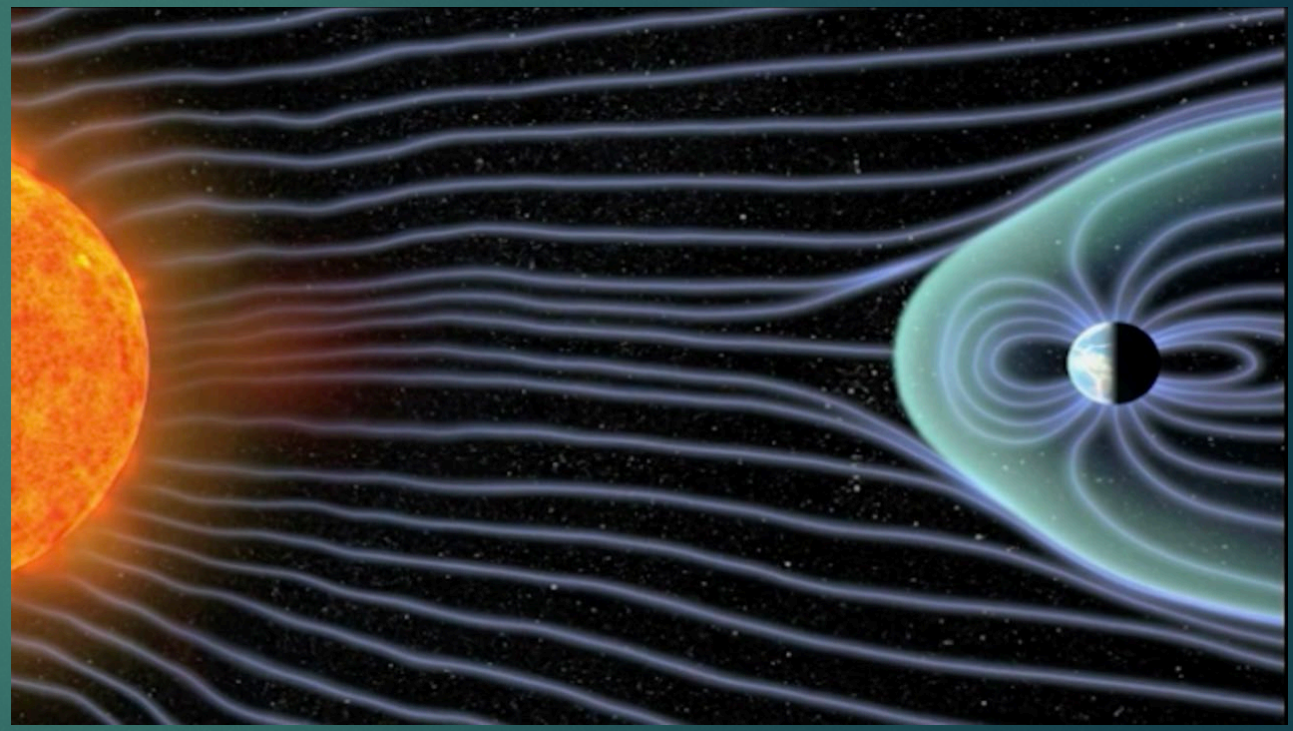
- A geomagnetic storm is a temporary disturbance of the Earth's magnetosphere caused by a solar wind shock wave and/or cloud of magnetic field that interacts with the Earth's magnetic field.





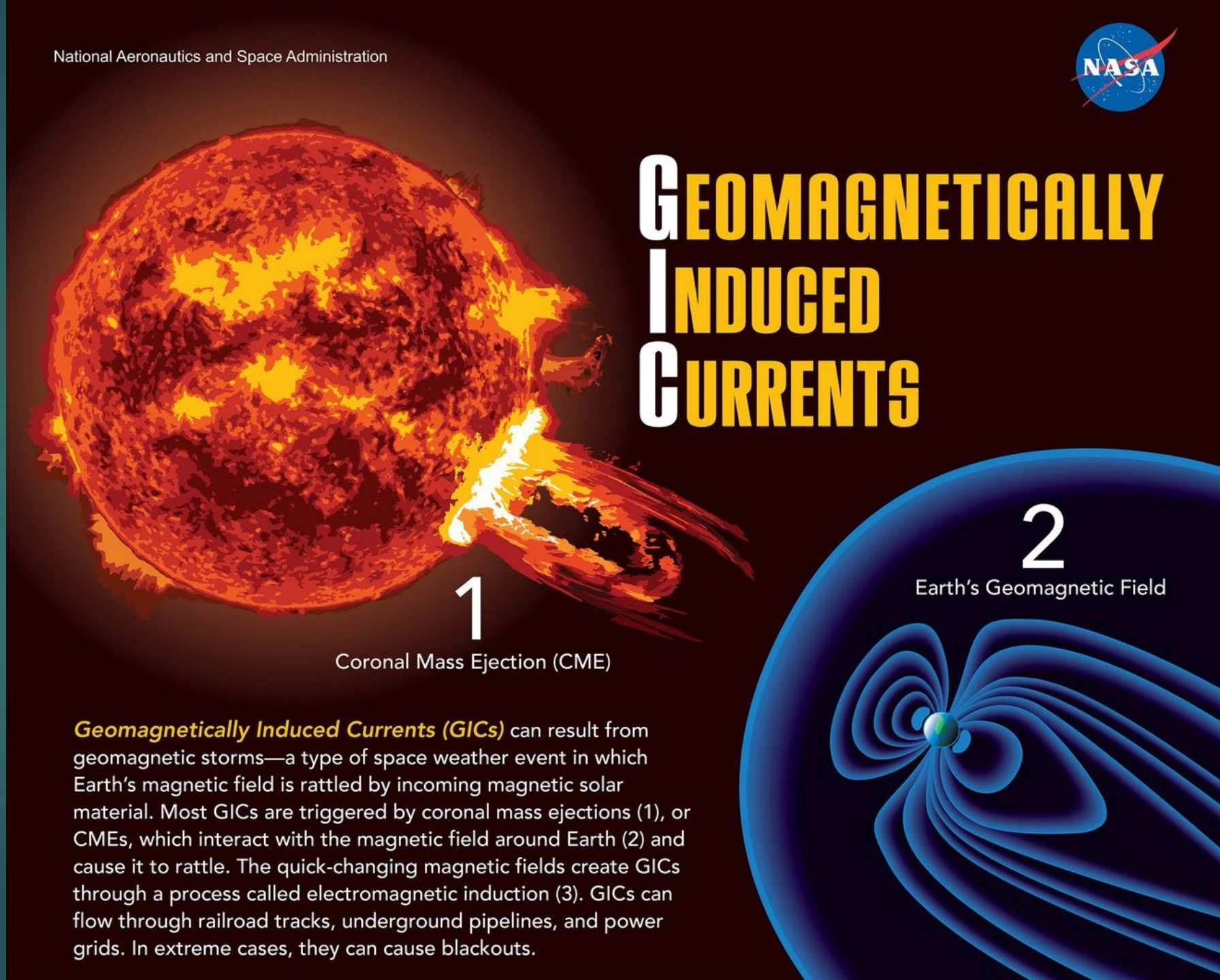
Hazard Identification

- A Coronal Mass Ejection is a giant cloud of solar plasma drenched with magnetic field lines that are blown away from the Sun during strong, long-duration solar flares and filament eruptions. A CME can cause Geomagnetic Storms at Earth



Hazard ID

- CMEs can induce extra currents in the ground that can degrade power grid operations.



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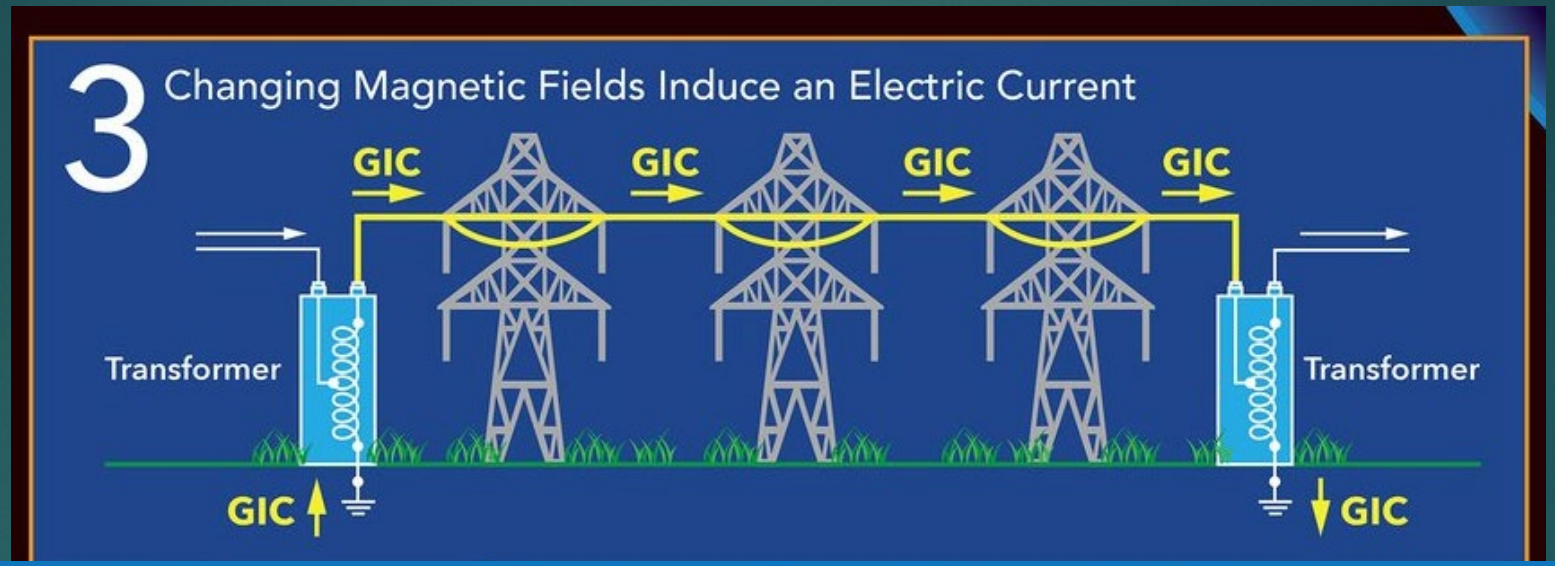
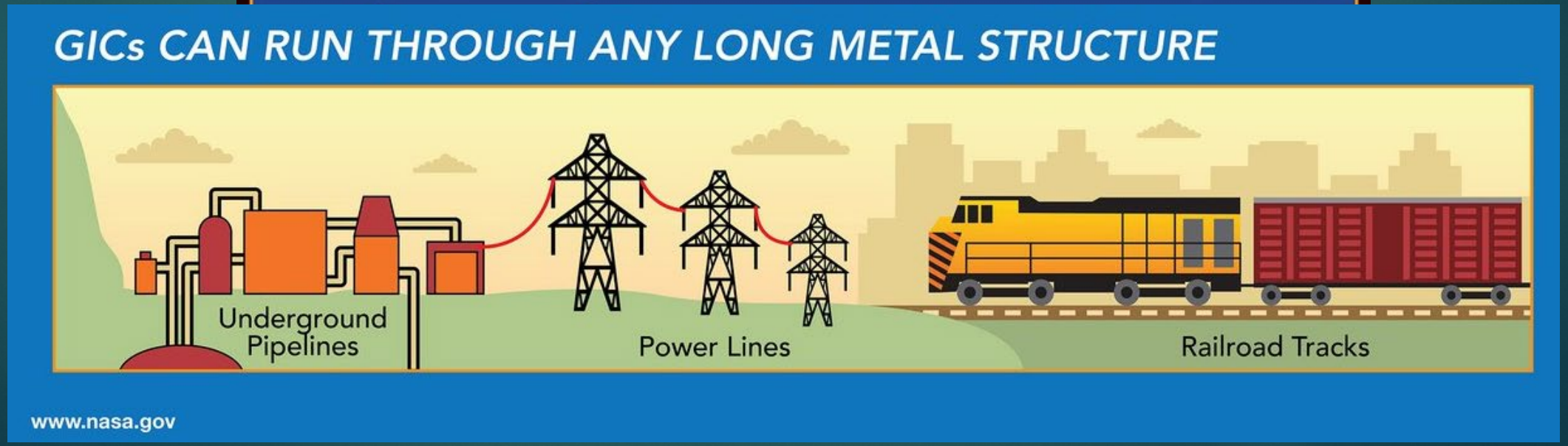


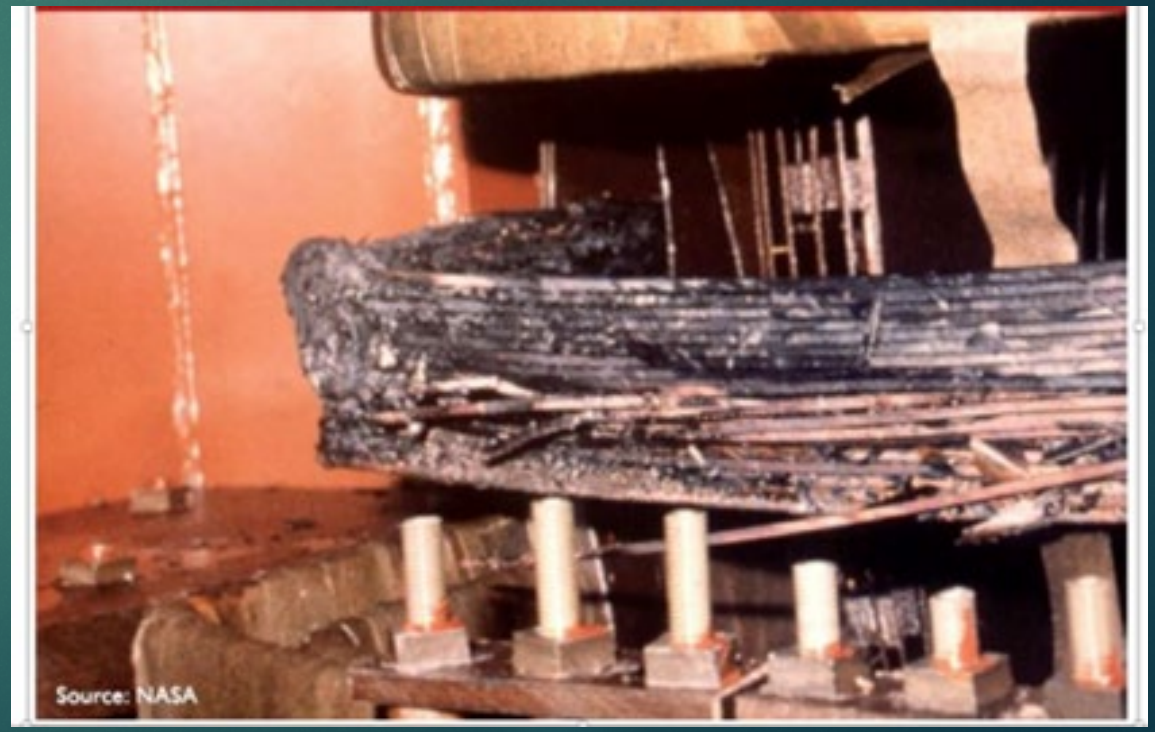


Risk Assessment - Severity

- **Aug 28 – Sept 2, 1859** – Carrington Event widely regarded as the most extreme space weather event in modern times. Induced currents on telegraph system and burned out the Transatlantic telegraph cable.
- **May 13-15, 1921** - The New York Railroad Storm, was caused by a powerful CME. The most intense geomagnetic storm of the 20th century. Caused issues with the railroad signals and switching gear.
- **Mar 13, 1989** Quebec Storm – knocked power out in Quebec Providence for 8 hours.

Risk Assessment - Severity

- A storm of the strength of the Carrington Event or 1921 Railroad event is expected to damage a number of Extra High Voltage Transformers, which could take months or years to replace.
- Although the 1989 storm was 1/10 as intense as the 1859 storm, it still burned out this transformer.



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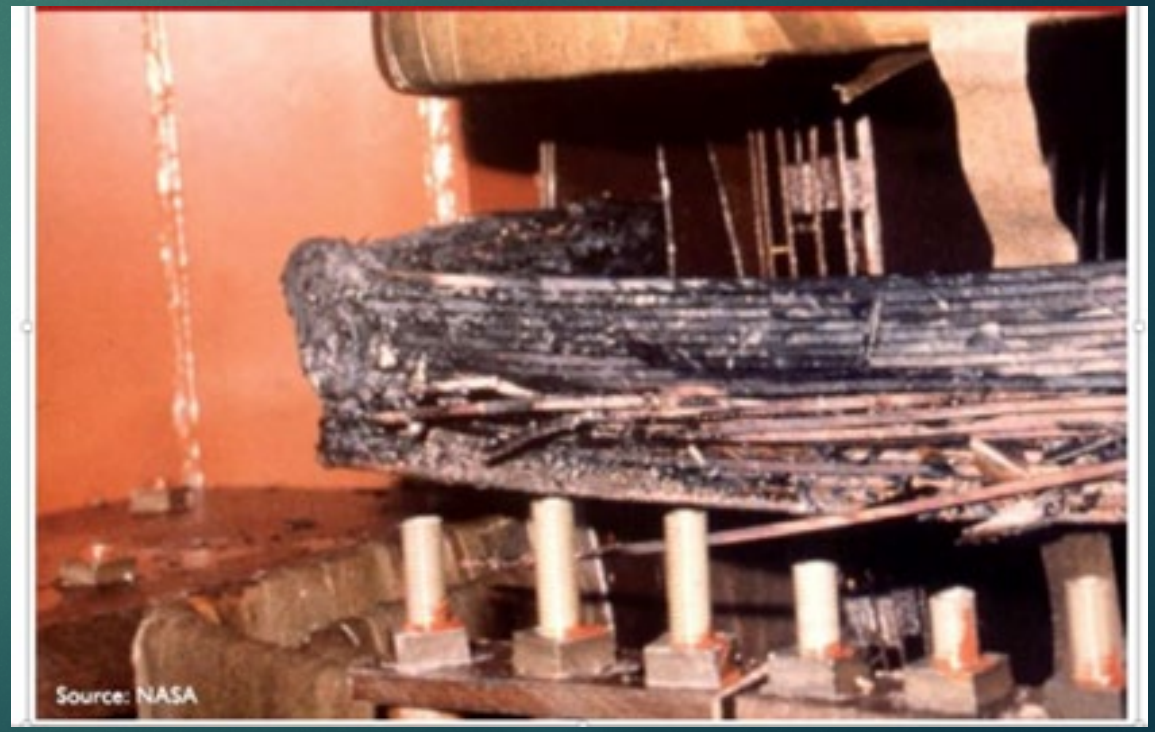
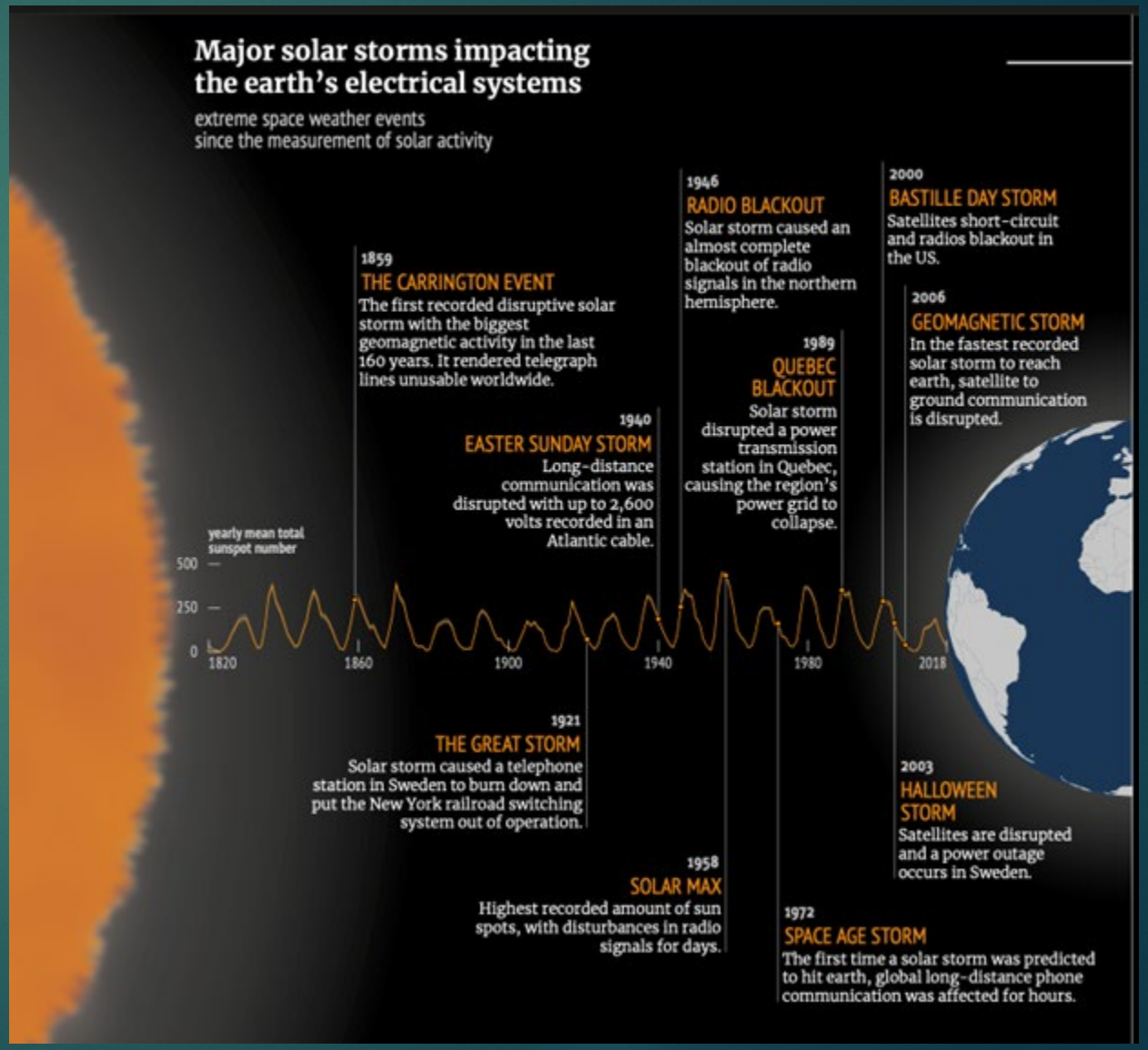


Risk Assessment - Severity

- "If the Carrington Event happened today, it would have even more severe impacts, such as widespread electrical disruptions, persistent blackouts, and interruptions to global communications. Such technological chaos could cripple economies and endanger the safety and livelihoods of people worldwide." - NASA

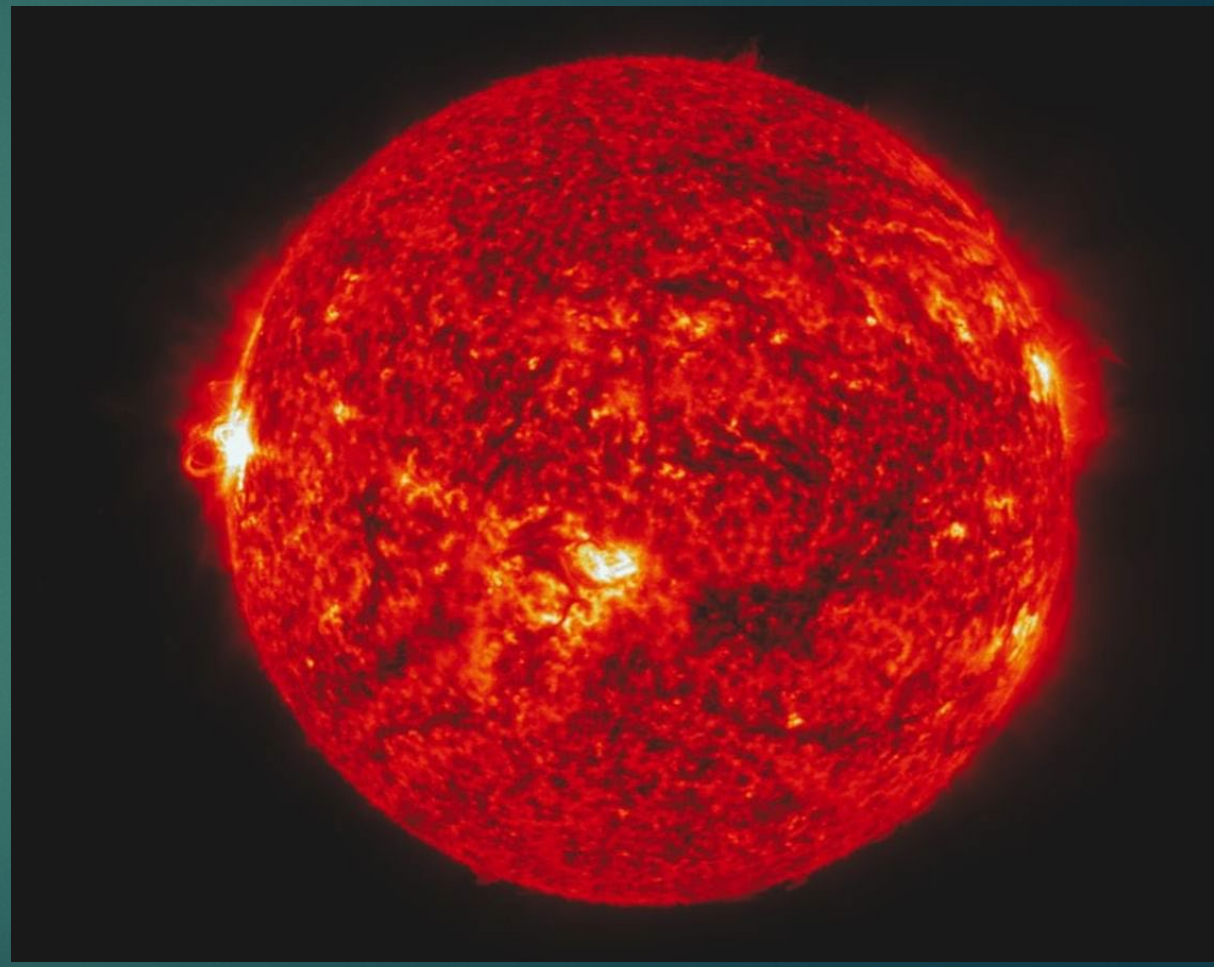
Risk Assessment - Probability

- There have been a several studies to estimate the probability of a Carrington level event.
- Most estimate 0.7 to 1.5% in any given year. This is much like a 100-year flood – 1% chance in any given year.



Risk Assessment - Probability

- The highest chances for solar storm activity are during a solar maximum – the 11-year cycle for solar sunspot activity.
- Solar Cycle 25 is expected to peak late 2024 to early 2025.



Solar Cycle 25

- "May 2024 has already proven to be a particularly stormy month for our Sun. During the first full week of May, a barrage of large solar flares and coronal mass ejections (CMEs) launched clouds of charged particles and magnetic fields toward Earth, creating the strongest solar storm to reach Earth in two decades — and possibly one of the strongest displays of auroras on record in the past 500 years." – NASA

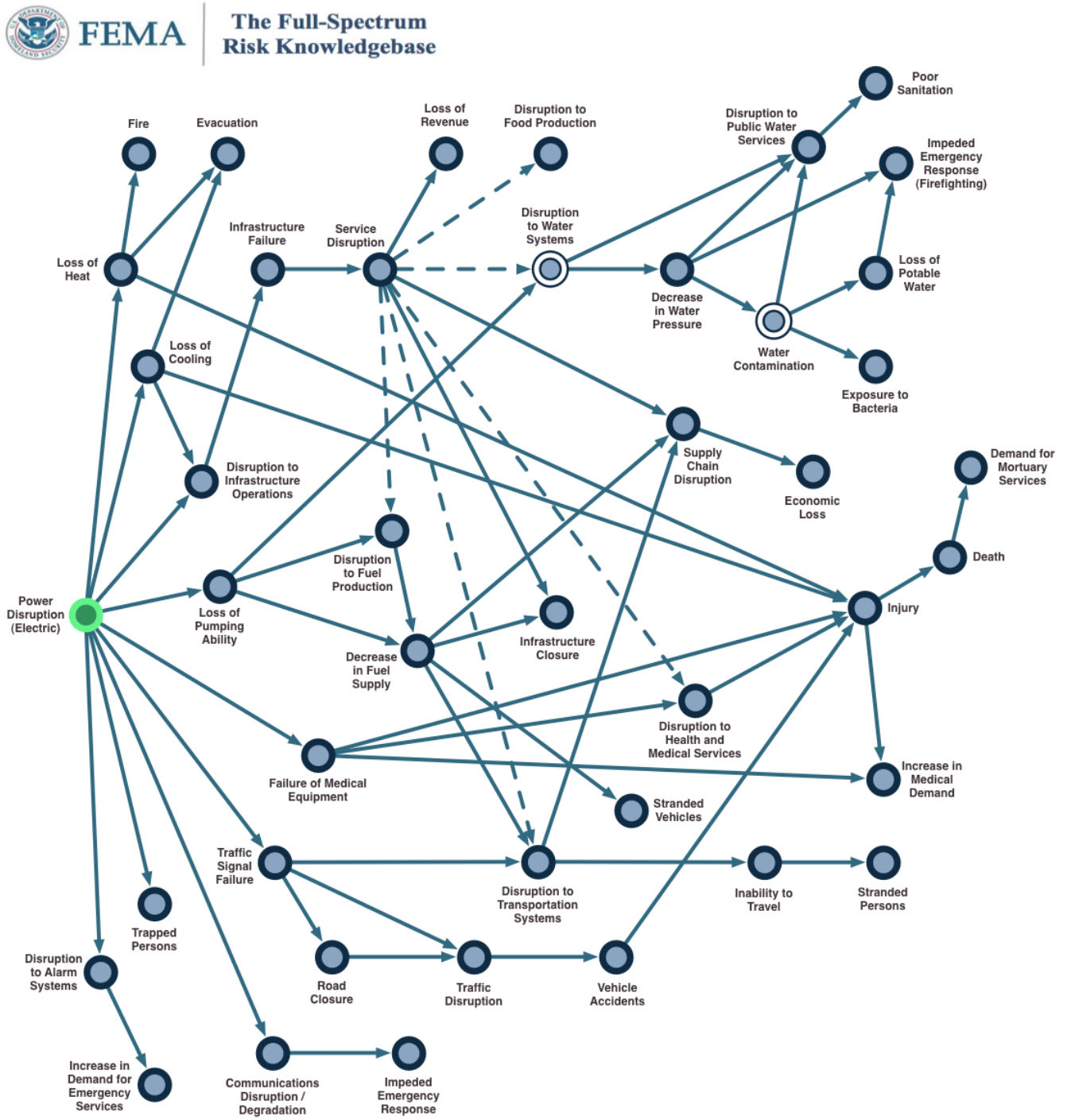
- …. and we haven't reached solar maxim yet.

Consequence Analysis

- Grid Failure
  - **Damage to EHV Transformers could knock out power in large areas of the country for months or years.**
  - **Loss of telephone and internet systems**
- HF Radio disruption
- GPS Signal distortion
- Pipeline corrosion damage
- Low Earth Orbit Satellites degradation

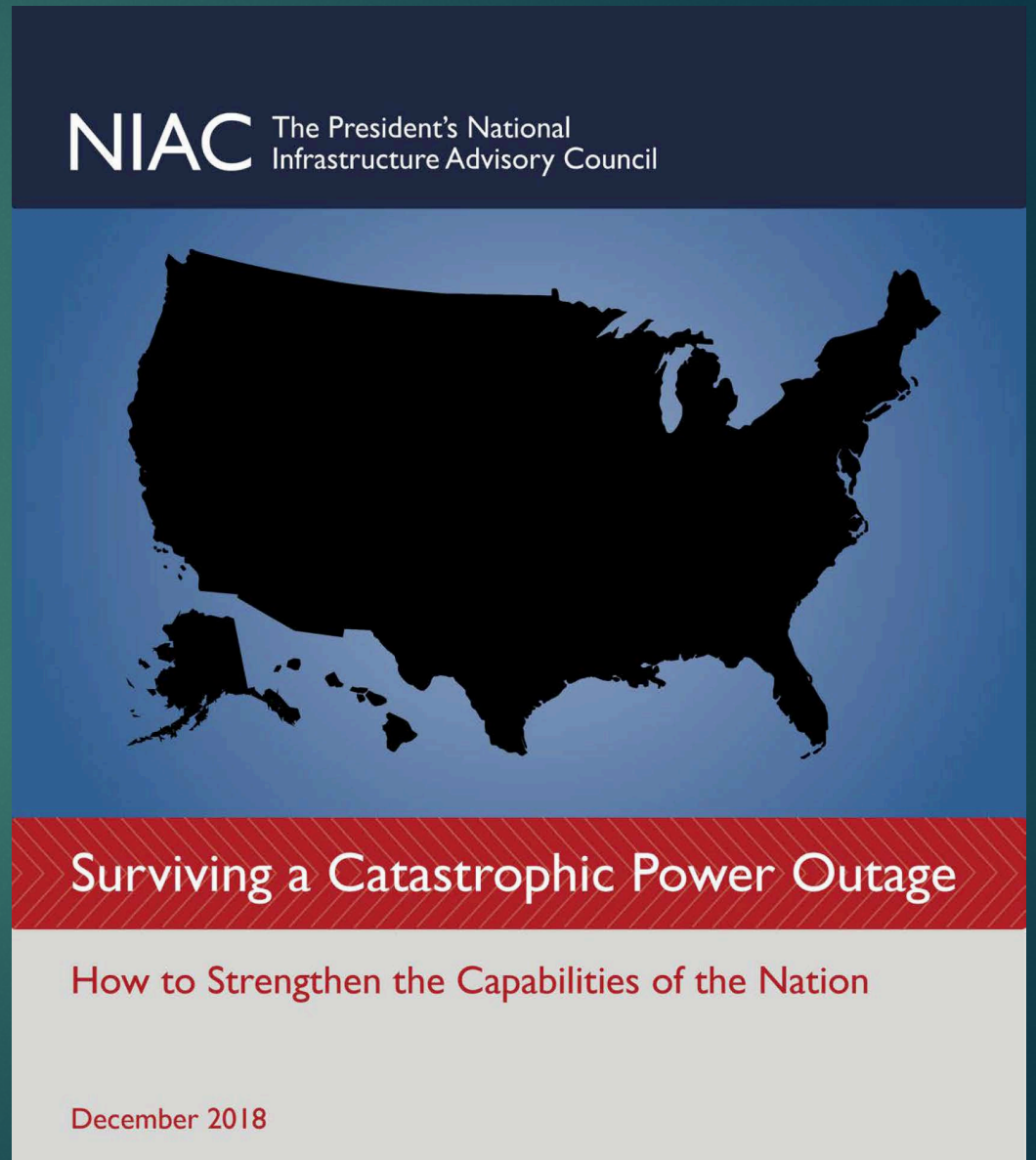
Grid Failure Consequences

- No fuel supply
- No food supply
- No water supply
- No heat or cooling
- No transportation
- No communications
- No safety and security
- No medical



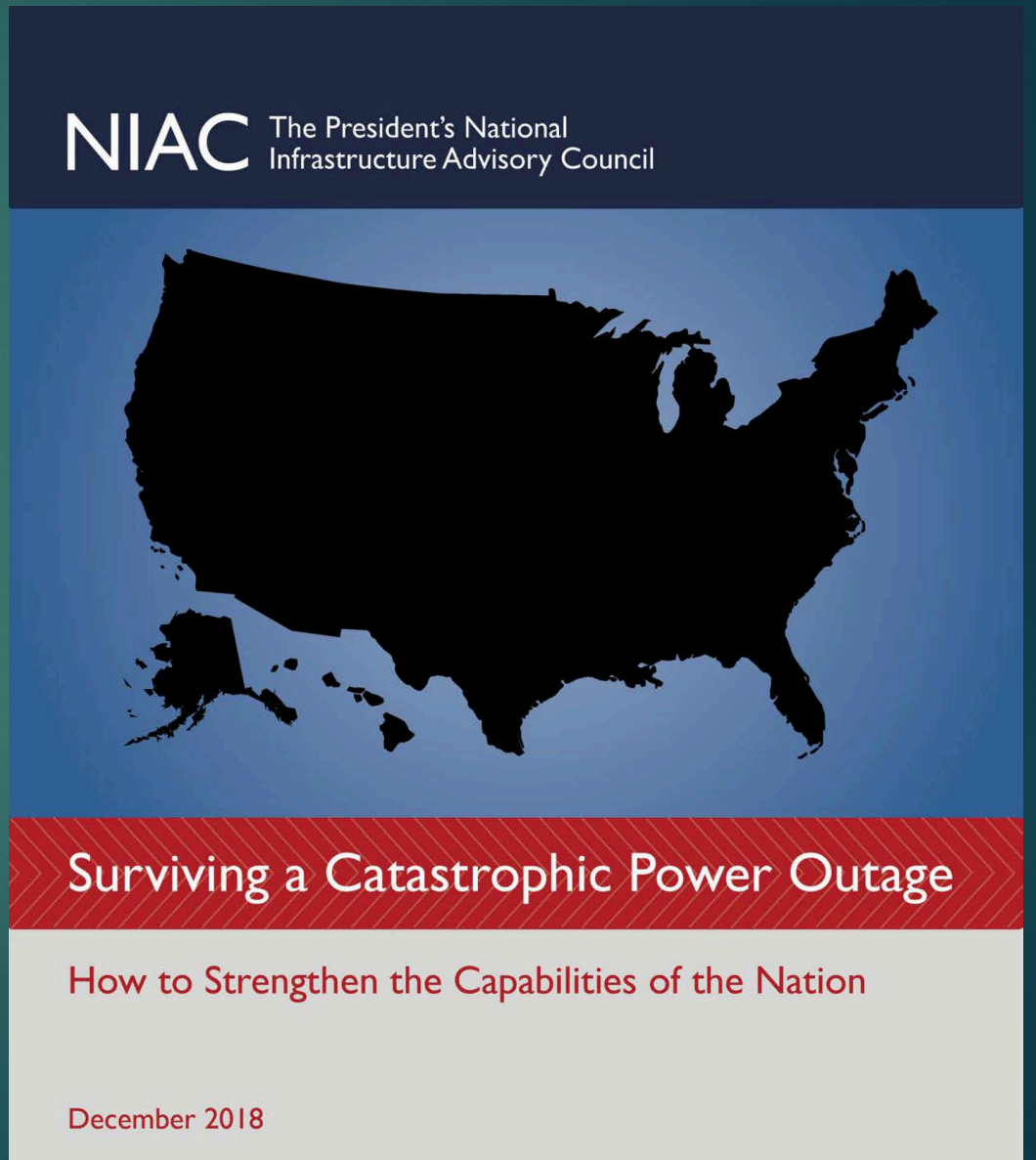
Does the Fed Gov believe that this is possible?

- "After interviews with dozens of senior leaders and experts and an extensive review of studies and statutes, we found that existing national plans, response resources, and coordination strategies would be outmatched by a catastrophic power outage. **This profound risk requires a new national focus.** Significant public and private action is needed to prepare for and recover from a catastrophic outage that could leave the large parts of the nation without power for weeks or months, and cause service failures in other sectors—including water and wastewater, communications, transportation, healthcare, and financial services—that are critical to public health and safety and our national and economic security." – page 3.



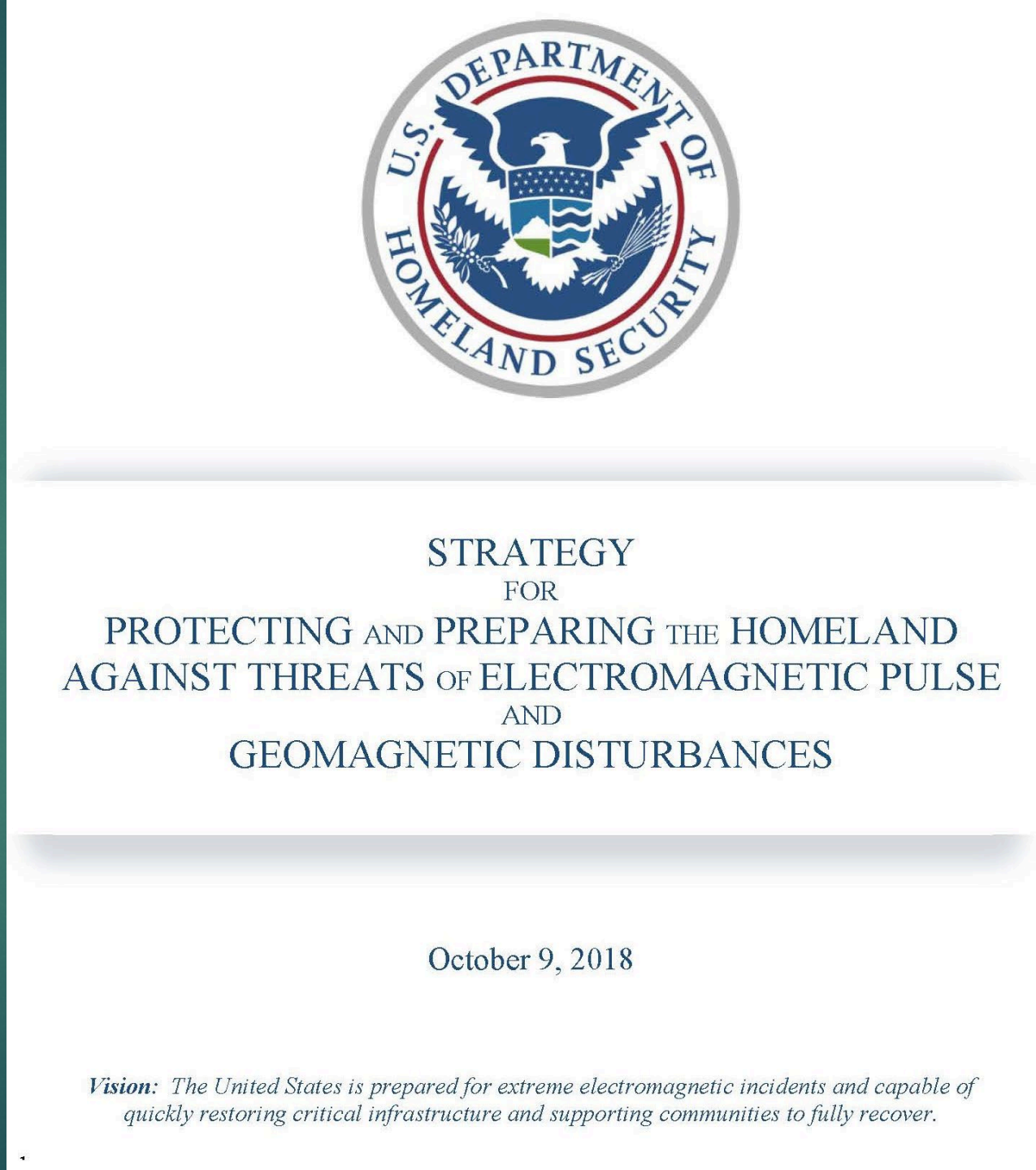
What is a Catastrophic Power Outage?

- Events beyond modern experience that exhaust or exceed mutual aid capabilities
- **Long duration, lasting several weeks to months** due to physical infrastructure damage
- **Affects a broad geographic area, covering multiple states or regions** and affecting tens of millions of people
- Causes severe cascading impacts that force critical sectors—drinking water and wastewater systems, communications, transportation, healthcare, and financial services—to operate in a degraded state



U.S. DHS Strategy

- "Extreme electromagnetic incidents caused by an intentional electromagnetic pulse (EMP) attack or a naturally occurring geomagnetic disturbance (GMD, also referred to as "space weather") could damage significant portions of the Nation's critical infrastructure, including the electrical grid, communications equipment, water and wastewater systems, and transportation modes." – pg 3



STRATEGY
FOR
PROTECTING AND PREPARING THE HOMELAND
AGAINST THREATS OF ELECTROMAGNETIC PULSE
AND
GEOMAGNETIC DISTURBANCES

October 9, 2018

Vision: *The United States is prepared for extreme electromagnetic incidents and capable of quickly restoring critical infrastructure and supporting communities to fully recover.*

U.S. DHS Strategy

- "The potential severity of both the direct and indirect impacts of an EMP or GMD incident compels our national attention." – pg 3
- The 2017 National Defense Authorization Act directs DHS to provide a strategy that provides guidance and identifies key actions we must take as a Nation to protect and prepare the homeland against EMP attacks and naturally occurring GMD caused by solar activity. – pg 4

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Executive Order 13865

- "An electromagnetic pulse (EMP) has the potential to disrupt, degrade, and damage technology and critical infrastructure systems. Human-made or naturally occurring EMPs can affect large geographic areas, disrupting elements critical to the Nation's security and economic prosperity, and could adversely affect global commerce and stability. The Federal Government must foster sustainable, efficient, and cost-effective approaches to improving the Nation's resilience to the effects of EMPs."

FEMA Planning

- "Electricity is essential for daily life. Basic functions, including communication, transportation, food, housing, water, and healthcare, are dependent upon it. As reliance on electricity continues to grow, a significant disruption to the electric grid may put lives, the economy, and the environment in danger." – pg 1

Power Outage Incident Annex to the Response and Recovery Federal Interagency Operational Plans

Managing the Cascading Impacts from a Long-Term Power Outage

Final - June 2017

Homeland Security

FEMA Planning

- "A long-term outage that results in businesses, critical infrastructure, and thousands of people without power for weeks or months could leave the population in need of life saving and life-sustaining efforts." – pg 2
- "A power outage of this magnitude may be the result of a natural disaster, space weather, large near-earth object, accident, terrorist act such as an electromagnetic pulse (EMP), or significant cyber incident." – pg 7

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Homeland Security

Fed Gov entities planning for Grid Failure

- President of the United States
- President's National Infrastructure Advisory Council
- Department of Defense
- Department of Energy
- Department of Commerce
- Department of Homeland Security
- Federal Emergency Management Agency

Are You?

Maine Assessment

- In 2013, the Legislature passed LD131, requiring the Maine Public Utilities Commission to "examine the vulnerabilities of the State's transmission infrastructure to the potential negative impacts of a geomagnetic disturbance or electromagnetic pulse capable of disabling, disrupting or destroying a transmission and distribution system and identify potential mitigation measures. – pg 9

2014 Maine GMD/EMP Impacts Assessment

A Report Developed for the Maine Public Utilities Commission

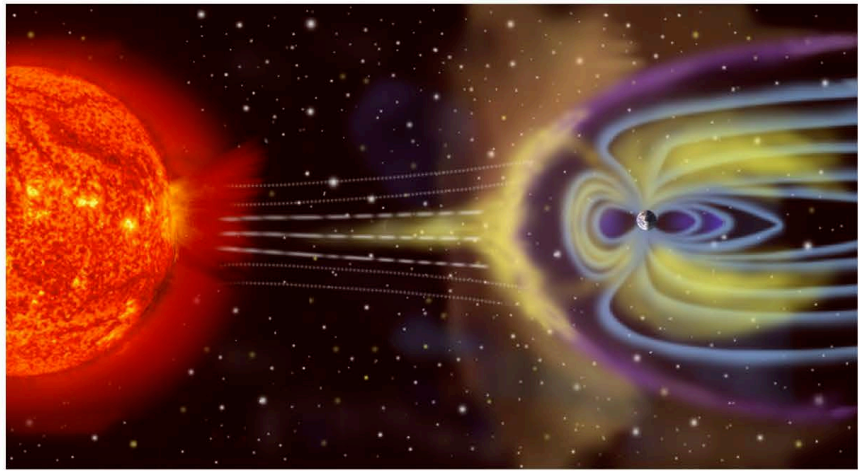

Image source: http://upload.wikimedia.org/wikipedia/commons/f/f3/Magnetosphere_rendition.jpg

Prepared By: Justin Michlig, PE – Central Maine Power Co.

Contributions From: EMPRIMUS, MPUC

Maine Assessment

- "The two studies conducted on the Maine transmission system show that GMD events can cause concern above a 14 V/km geoelectric field strength. Using current study techniques, transformer heating and voltage with the loss of capacitor bank functionality show the highest level of risk to power system performance in the State of Maine." – pg 39
- A 100-year event could result in a 20 V/km field. This study showed a concern for a field over 14 V/km.

GMD Event Geoelectric Field	4.53 V/km	14 V/km	20 V/km	23.5 V/km	29 V/km
	NERC 1 in 100 year Benchmark	Study team assumed 1 in 50 year event	Study team assumed 1 in 100 year event	Study team assumed 1 in 200 year event	Study team assumed 1 in 500 year event and EMP-E3 level

So what do we do about it?

- Long Term Power Outage (LTPO) Planning @ State and Local
  - New Hazard Identification, Risk Assessment, Vulnerability Analysis
  - Preparedness and Mitigation plans
  - Continuity of Operations & Government (COOP/COG) plans
  - Emergency Operations Plan annex
  - Grid Failure Recovery Plans
- Purchases of LTPO Equipment and Supplies with HSGP
- Training and Exercising Program on par with 2005 NIMS rollout
- Major Public Awareness and Education Campaign
- Statutory updates
- Thinking outside the box on Disaster Recovery staffing

Preparedness Resources

- Space Weather Prediction Center (SWPC) - Alerts
- SWPC Geoelectric Fields
- FEMA Power Outage Annex
- CISA Catastrophic Power Outage
- Electric Infrastructure Security (EIS) Council
- Space Weather.com
- Secure the Grid Coalition
- Grid Down, Power up