



US Economic Impact Study

July 31, 2017

UN/US Workshop

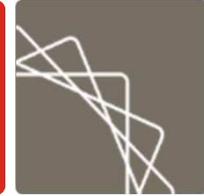
International Space
Weather Initiative

Boston, MA



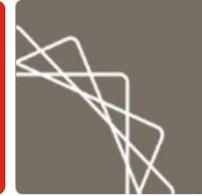
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Overview



- 1. Current Status**
- 2. Scope**
- 3. Findings**
- 4. Recommendation**

Current Status



Today



**Important
Information
Simple**

Future



**How Important
Understanding
Nuanced**

Scope



Identify

**Literature
Review**

Describe

**Stakeholder
Outreach**

Quantify

**Excel-Based
Models**

Impacts of Moderate & Extreme SWx Events



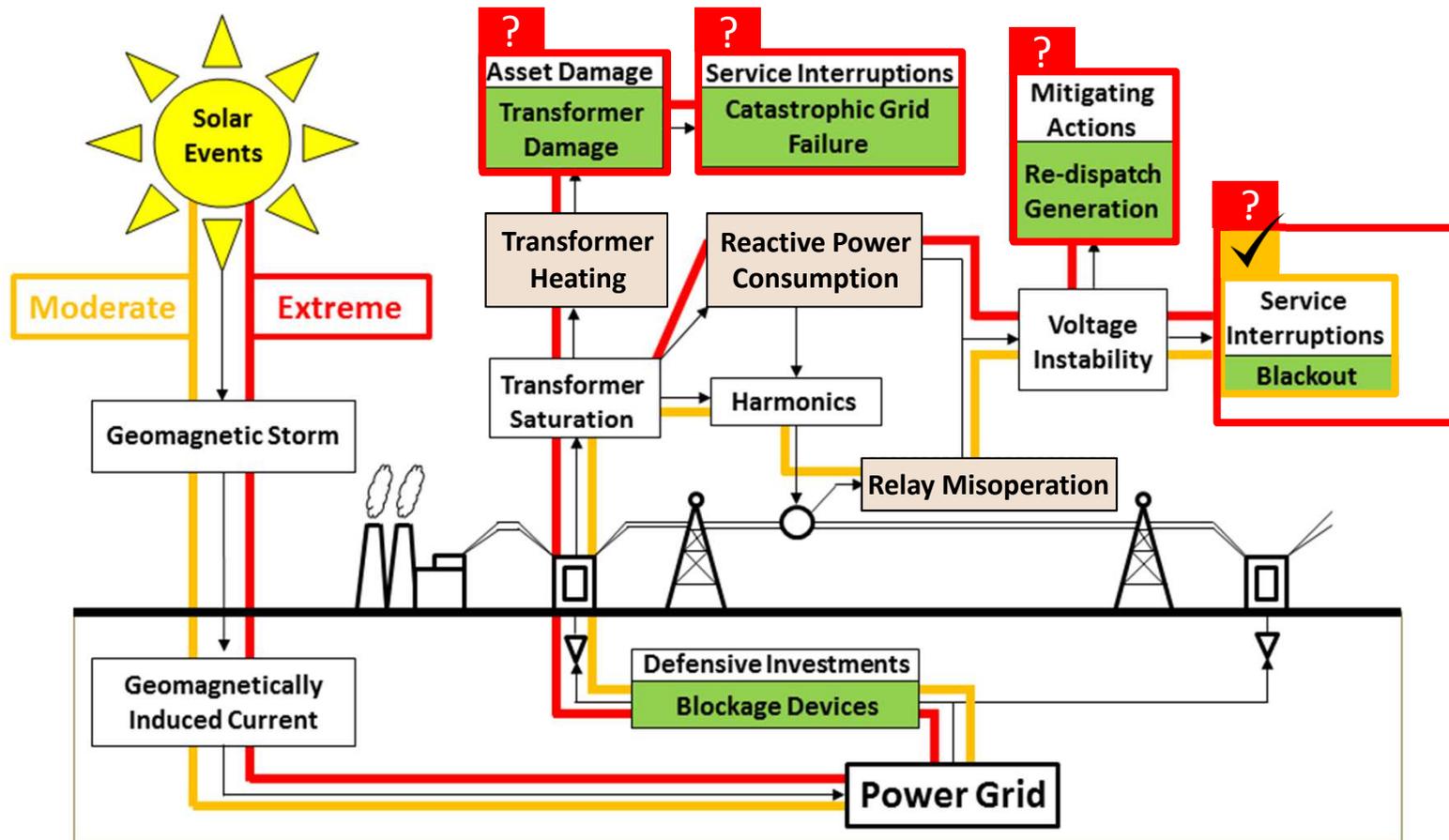
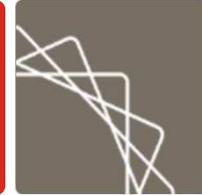
Findings



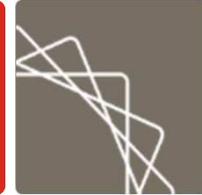
Impact Categories

Sector	Physical Effects	Impact Categories				
		Defensive Investments	Mitigating Actions	Asset Damages	Service Interruptions	Health Effects
Power Grid	Reactive Power Loss	●	●		●	
	Transformer Heating	●	●	●	●	
	Relay Misoperation	●	●		●	
	Power Imbalances		●		●	
	Generator Tripping	●	●		●	
	Precision Timing	●	●		○	
Aviation	Communication	●	●	○	●	
	Navigation	●	●	○	●	○
	Human Exposure		●		○	○
	Avionic Upsets	●	○	○	○	○
Satellites	Cumulative Dose	●		○	○	
	Anomalies	●	●	●	●	
	Link Disruptions	●	●		●	
	Loss of Orientation	●	●	●	●	
	Loss of Altitude	●	●	●	○	
GNSS Users	Loss of Lock	●	○		●	
	Ranging Errors	●	○		●	

Findings



Findings



Impact Categories

Sector	Physical Effects	Impact Categories				
		Defensive Investments	Mitigating Actions	Asset Damages	Service Interruptions	Health Effects
Satellites	Cumulative Dose	●		○	○	
	Anomalies	●	●	●	●	
	Link Disruptions	●	●		●	
	Loss of Orientation	●	●	●	●	
	Loss of Altitude	●	●	●	○	

Event Date ¹	Satellite ¹	Orbit ¹	Cause ¹	Satellite Type	Asset Value ²	Age at Failure ³
01/11/97	Telstar 401	GEO	Anomaly	Communications	\$200-250m	4 yrs
05/19/98	Galaxy IV	GEO	Anomaly ³	Communications	\$200-250m	5 yrs
07/15/00	Astro-D	LEO	Altitude Loss	Scientific	\$500-750m	8 yrs
10/24/03	MIDORI 2	LEO	Anomaly	Scientific	\$500-750m	7 yrs
01/14/05	Intelsat 804	GEO	Anomaly	Communications	\$200-250m	8 yrs

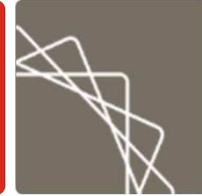
¹Information reported by Cannon et al. 2013

²Cost estimates based on Stakeholder Conversations

³Comparison of loss versus launch dates, where launch dates are from <http://space.skyrocket.de/>

⁴Further investigations by Bodeau 2007 suggests that this loss was not attributable to space weather.

Recommendation



Today

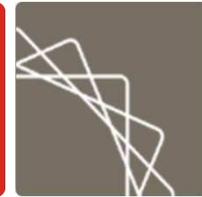


Future



- Iterative, multidisciplinary effort
- Hand in hand with industry
- At different scales

Thank You



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