Helios Solar Storm Scenario

3 November 2016

Insurance and Investment Portfolio Losses

Centre for Risk Studies

UNIVERSITY OF CAMBRIDGE
Judge Business School

Dr Andrew Coburn
Director of the Advisory Board
Cambridge Centre for Risk Studies

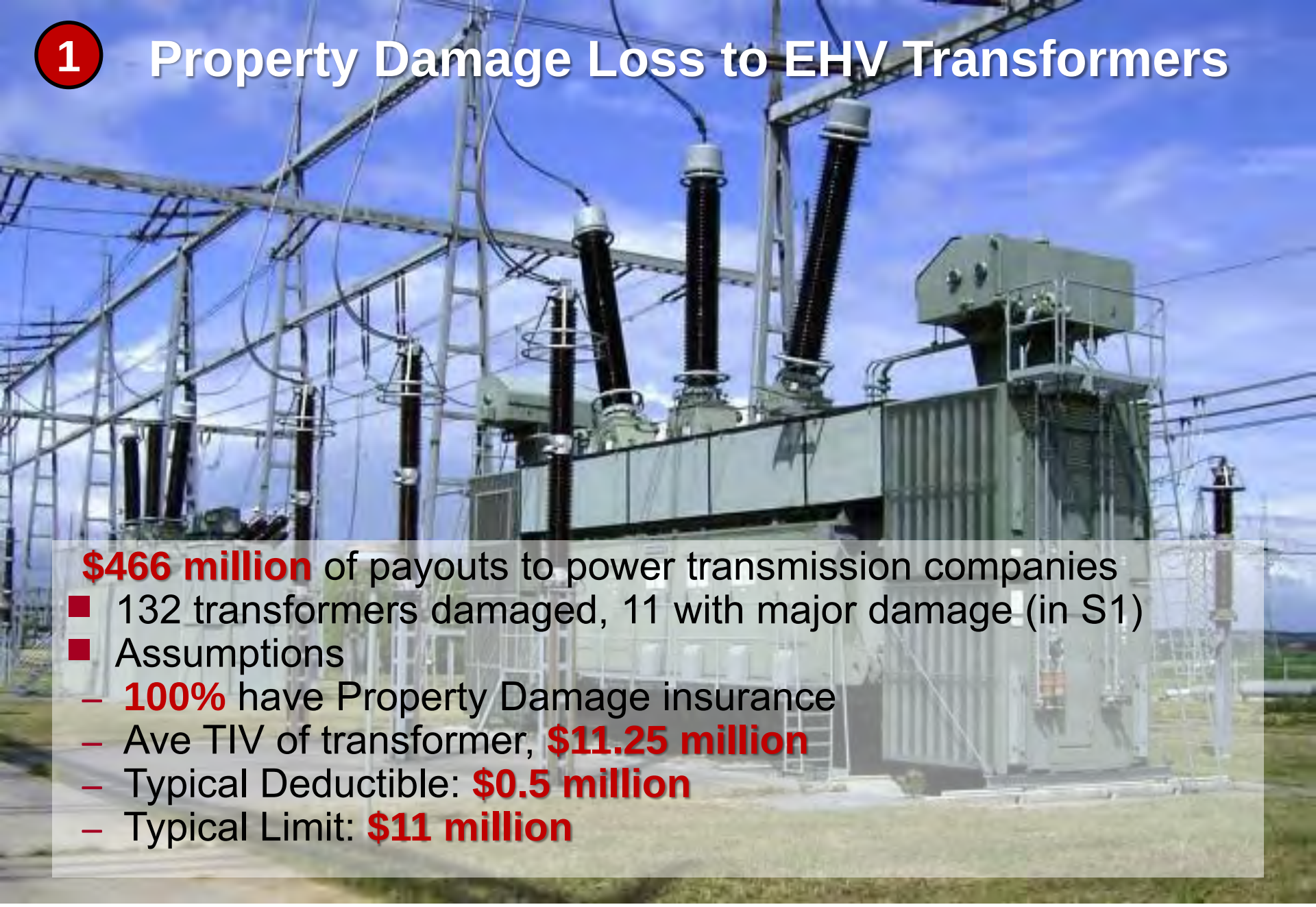
AIG

US Insurance Loss Estimate

Claimant Type		Coverage	$ millions
Power Transmission Companies	1	Property Damage (EHV transformers)	466
		Incident Response Costs	29
		Fines – FERC/NERC	4
		Directors and Officers Liability	600
Power Generation Companies		Property Damage (generator step-up transformers)	84
		Business Interruption	423
		Incident Response Costs	4
		Fines – FERC/NERC	4
		Directors and Officers Liability	95
Companies that loss power	2	Perishable contents	1,079
	3	Contingent business interruption – service interruption/utility interruption/suppliers extension	50,983
Satellite	4	Property damage (satellites)	218
Homeowners	5	Household contents	449
Speciality	6	Event cancellation	603
		Total	**$55,040**

For variant S1, $ millions

1 Property Damage Loss to EHV Transformers



$466 million of payouts to power transmission companies

- 132 transformers damaged, 11 with major damage (in S1)
- Assumptions
  - **100%** have Property Damage insurance
  - Ave TIV of transformer, **$11.25 million**
  - Typical Deductible: **$0.5 million**
  - Typical Limit: **$11 million**

2 Loss from Corporate Perishable Contents

$1.079 Billion of payouts to companies who lose temperature-sensitive contents through power loss and back-up power generation failure

- **350,000** major corporate facilities in US have perishable contents
- **95%** are insured
- **8%** of them suffer losses due to backup power failure or extended outage
- Typical Limits: **$10-25 million**

Typical facilities include

- **Supermarkets**
- **Pharmaceuticals**
- **Frozen food warehousing**
- **Cold store trucking**
- **Cargo powered containers**
- **Catering and hospitality sectors**

3 Contingent Business Interruption for Lost Power

$50.9 Billion payouts for companies with CBI Service Interruption cover who lose power

- Service interruption/utility interruption/suppliers extension is a component of Contingent Business Interruption commonly purchased as part of their property insurance cover on large facilities
- **1.1 million** large facilities (500+ employees) in the US
- We estimate around **19%** of them - **222,000** large facilities have Service Interruption cover on insurance
- Typical deductible: **24 hours**
- Typical sublimit: **$15 million**
- **Only those without backup power or whose backup power fails or is exhausted**
  - Using data on backup generators by sector from Energy Information Administration, 2015

Typical US Facilities with back-up generators:

- Manufacturing
- Utilities
- Mining, Quarrying, and Oil and Gas Extraction
- Educational Services
- Health Care and Social Assistance

4 Satellite Loss

$218 million for lost satellites

- 1,200 operational satellites in space (SIA, 2015)
  - 38% of satellites - 456 - are for commercial purposes
  - half are US-owned

- Low Earth Orbit (LEO)
  - Imaging, , Earth observation, data services
  - 12% of LEO satellites insured
  - Average TIV: $75 million
- Geostationary (GEO)
  - Communications, TV, Broadband
  - 56% of GEO satellites insured
  - Average TIV: $150 million
- Mid Earth Orbit (MEO)
  - GPS, Military
  - Government owned – not insured

- **18** satellites (GEO and LEO only) damaged in S1
  - 'best engineering estimate' RAE 2013
- Permanent loss of functionality, machinery breakdown
- 20% damage factor

5 Household Contents

$449 million for Household contents loss

- Over **1.1m** claims, averaging **$500** a claim
- Outage results in domestic fridges and freezers defrosting
- Over 30 million households lose power for over 24 hours
- Around 3 million have HO-3 home insurance policies
  - includes standard cover for food spoilage from fridge & freezer defrosting
  - Only half of them claim

Credit: Daniel M. N. Turner/NPR

6 Speciality: Event Cancellation

$603 million for Events Cancellation

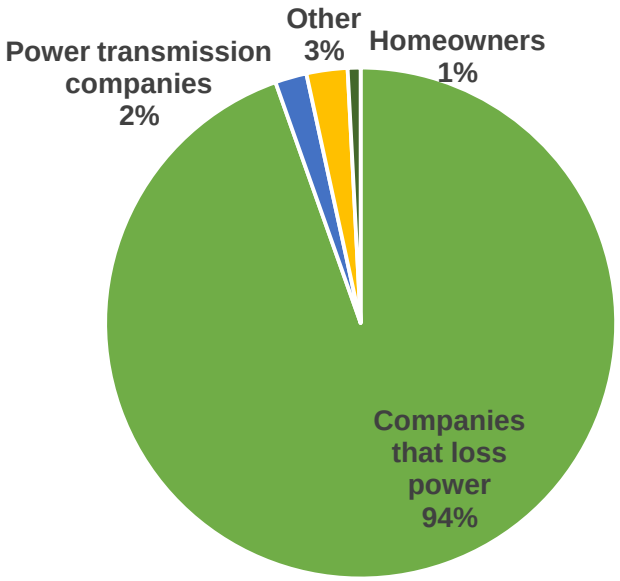
- We estimate that this scenario would impact over 600 major events in US
- Event Cancellation for major events
  - Stadiums with over 10,000+ seats
  - High ticket price events
  - Major advertising revenues, with TV coverage
- Estimated average number and average ticket price for
  - Sporting events
  - Conferences
  - Trade shows
  - Art festivals
  - Plays and musicals

2016 Events:

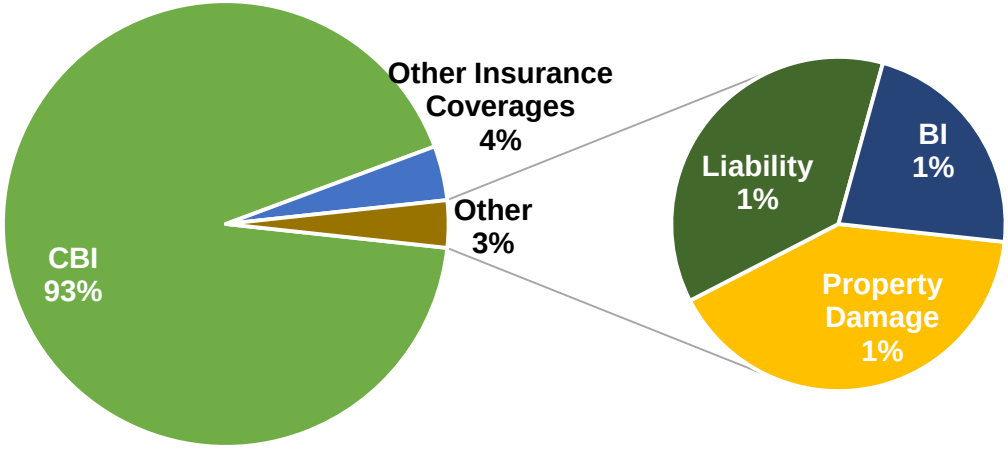
- Super Bowl Sunday
- Sundance Film Festival
- Masters Golf Tournament
- Daytona 500 Race
- Kentucky Derby
- Presidential Election
- Broadway musicals
- Music concerts (orchestra and leading artist)
- +Numerous conferences

Breakdown of Loss

Claimant Type



Line of Business/Coverage

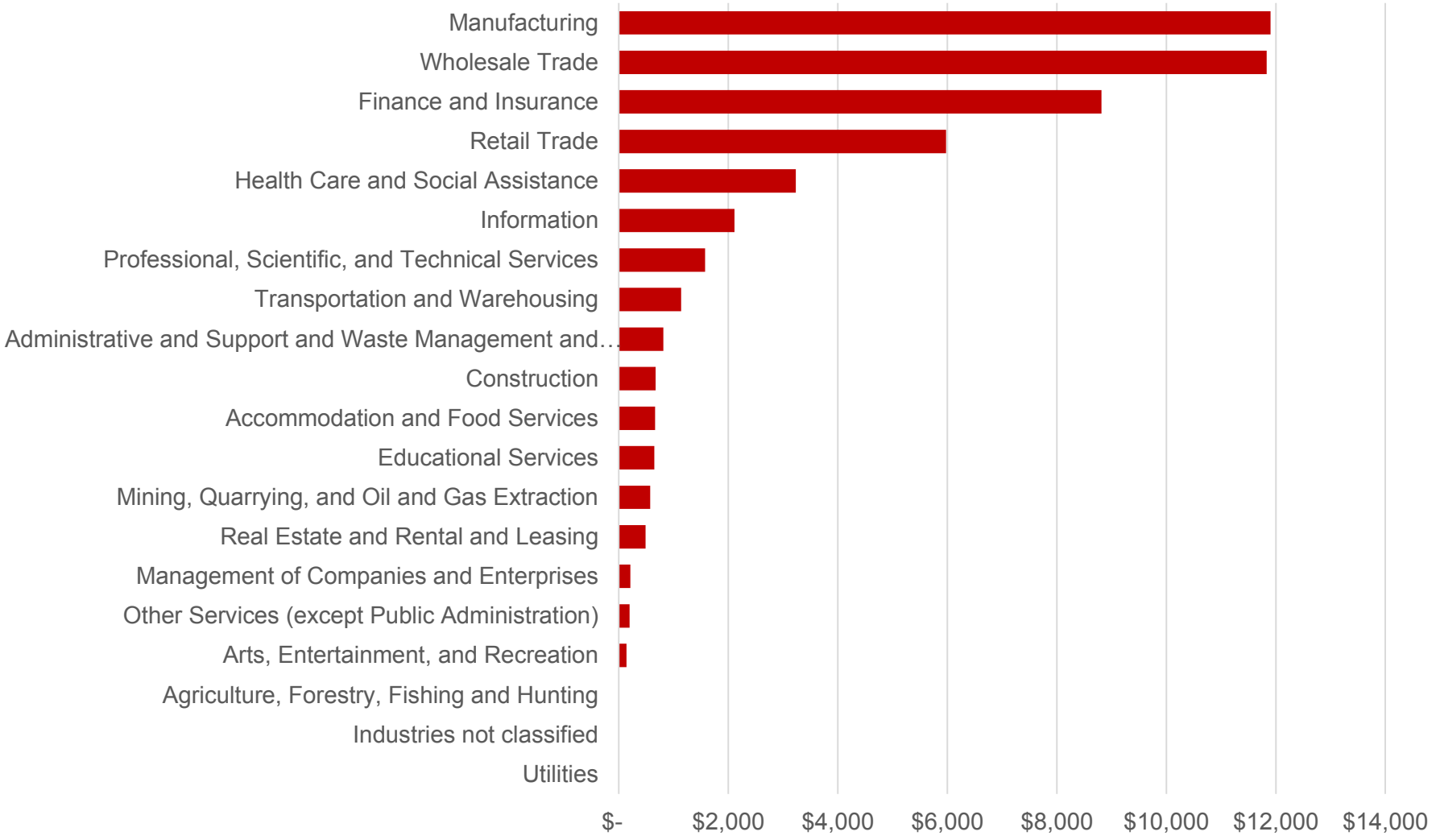


Share of $55 Billion

Insurance Loss Estimate

S1 Variant Solar Storm Scenario

Insurance Loss by Sector



Sectoral share of $50 Billion of Contingent Business Interruption Losses from Service Interruption cover S1 variant only

Insurance Industry Loss Estimates for Solar Storm Scenario

Scenario Variant	Outage Duration	Total Direct and Indirect, US only, $ Bn	US Insurance Industry Loss Estimate, $ Bn	Insurance Loss as a % of economic loss
S1	6 months	$474	$55	13%
S2	8 months	$1,532	$173	13%
X1	12 months	$2,693	$334	14%

For context:

- Total insurance catastrophe losses 2015: $85 Bn
- Hurricane Katrina 2005: $80 Bn
- Tohoku Earthquake Japan 2011: $38 Bn
- Superstorm Sandy 2012: $37 Bn
- Hurricane Andrew 1992: $28 Bn
- 9/11 WTC 2001: $26 Bn

[2016 $ value]

Modelled insurance industry loss from

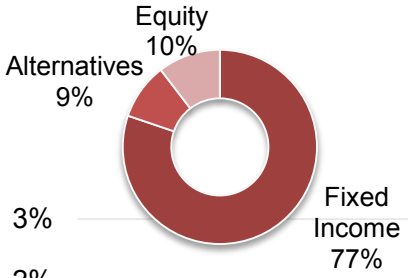
- Erebos Lloyd's Business Blackout: $21-$71 Bn
  - (Hypothetical cyber attack on power grid causing power outage in US Northeast)

We Have Not Estimated Insurance Losses From

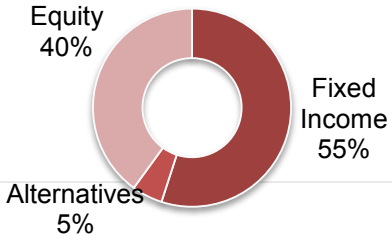
- Transformer manufacturers
- Telecommunications and GPS/GNSS failure
- Rail transportation
  - Step-down transformers used by rail companies could be damaged
- Goods in transit
- Auto
- Aviation
- Travel
- Industrial accidents/environmental liability
- Deaths and injury
- Riot and civil commotion

Market Risk: Impact on an Investment Portfolio

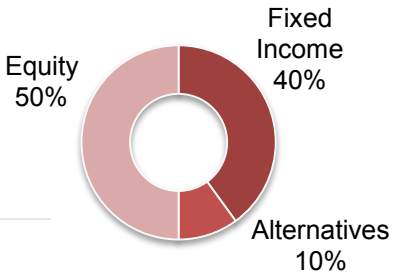
High Fixed Income



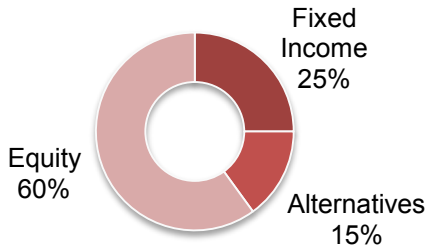
Conservative

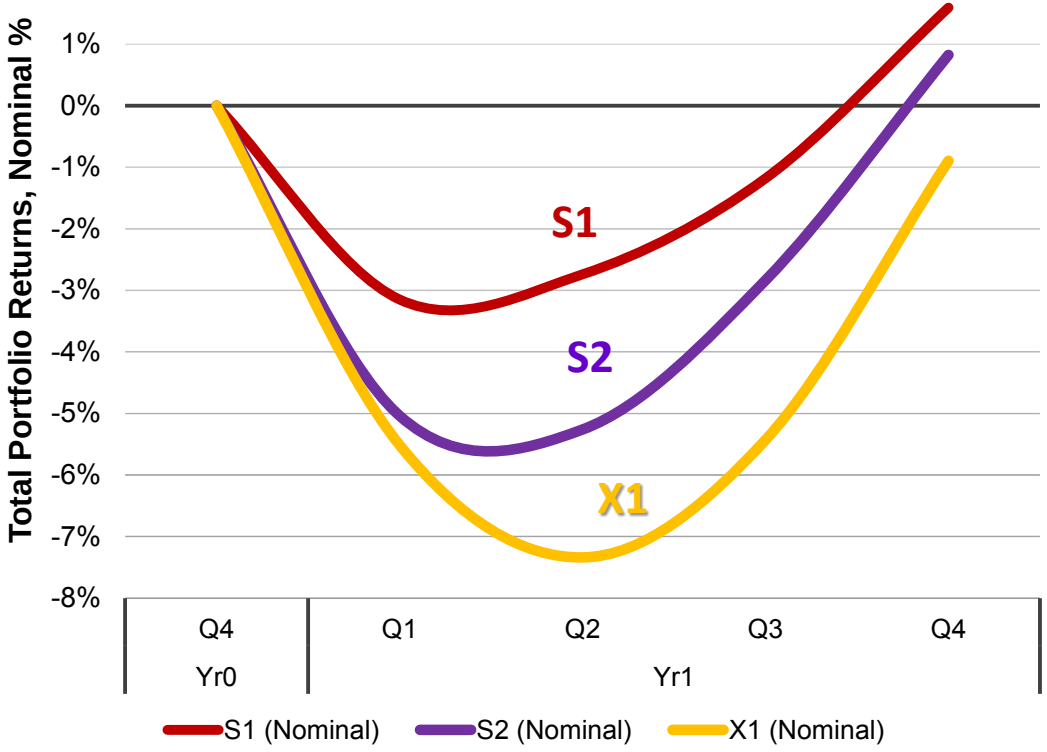


Balanced



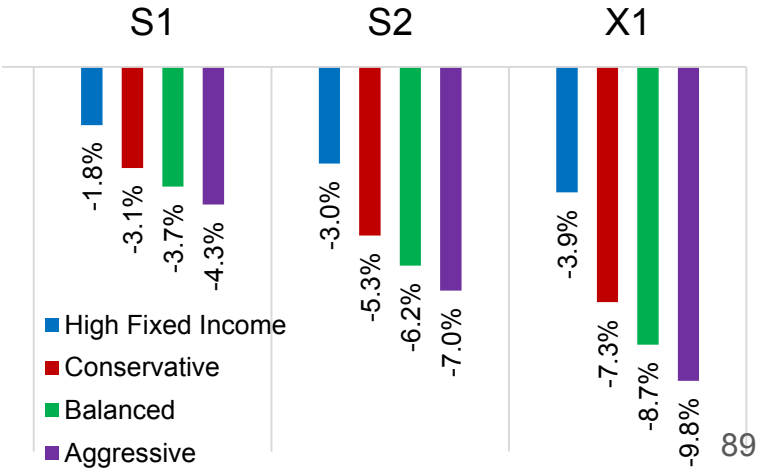
Aggressive





Max Downturn (Nominal %)

Portfolio Structure	S1	S2	X1
High Fixed Income	-1.8%	-3.0%	-3.9%
Conservative	-3.1%	-5.3%	-7.3%
Balanced	-3.7%	-6.2%	-8.7%
Aggressive	-4.3%	-7.0%	-9.8%



How Can We Manage This Threat?

- Better early warning systems
  - Increase spinning reserve and reactive power
  - Reduce or remove the load on key transformers
  - Isolate parts of the system
- More resilient power grid infrastructure
  - Hardening the engineering transmission equipment to prevent GICs from flowing through it
  - Invest in more resistive transformers
  - Smarter grid technologies such as automatic voltage stabilisation and other automatic protective measures
- Each individual business can be better prepared and protected for potential outages and over-reliance on power continuity
- How are we doing?


UK: replacing about 10 transformers a year with 50% more resistive ones


US: NERC is still reviewing engineering/ thermal assessments requirement


Australia: has recently done solar storm studies of its electricity system


Nordic Countries: well prepared and well used to the phenomenon


Japan: just starting to look into engineering improvements, but very concerned of the threat


China: just took first geomagnetic measurements this year

Conclusions

- Solar Storm events on this scale are real and emergent
  - The available science now confirms this as a real threat
  - There is however a lot more still science still needed to understand likelihoods and severities
- These are rare but potentially catastrophic events
- The lack of a historical catalogue of catastrophic events is because the systems they damage are a recent artefact
  - This causes a clear awareness problem
  - It may take a major catastrophic event before the threat is fully recognized
- Solar Storms are potentially more disruptive today than ever before
  - We are rapidly growing our power infrastructure
  - We have an increasing reliance on power continuity for our economy
- Collectively we can manage the risk, mitigate it through investments in engineering and space observation, and improve our preparedness
- Insurers, financial services companies, and businesses need appropriate scenarios to explore their risk management
- We offer this study as a key step in building the awareness and tools needed to manage this risk