

Cambridge Judge Business School

Centre for Risk Studies 7th Risk Summit Research Showcase

Critical Infrastructure and Technology Catastrophe

Dr Edward Oughton

Research Associate, Cambridge Centre for Risk Studies

20 June 2016
Cambridge, UK

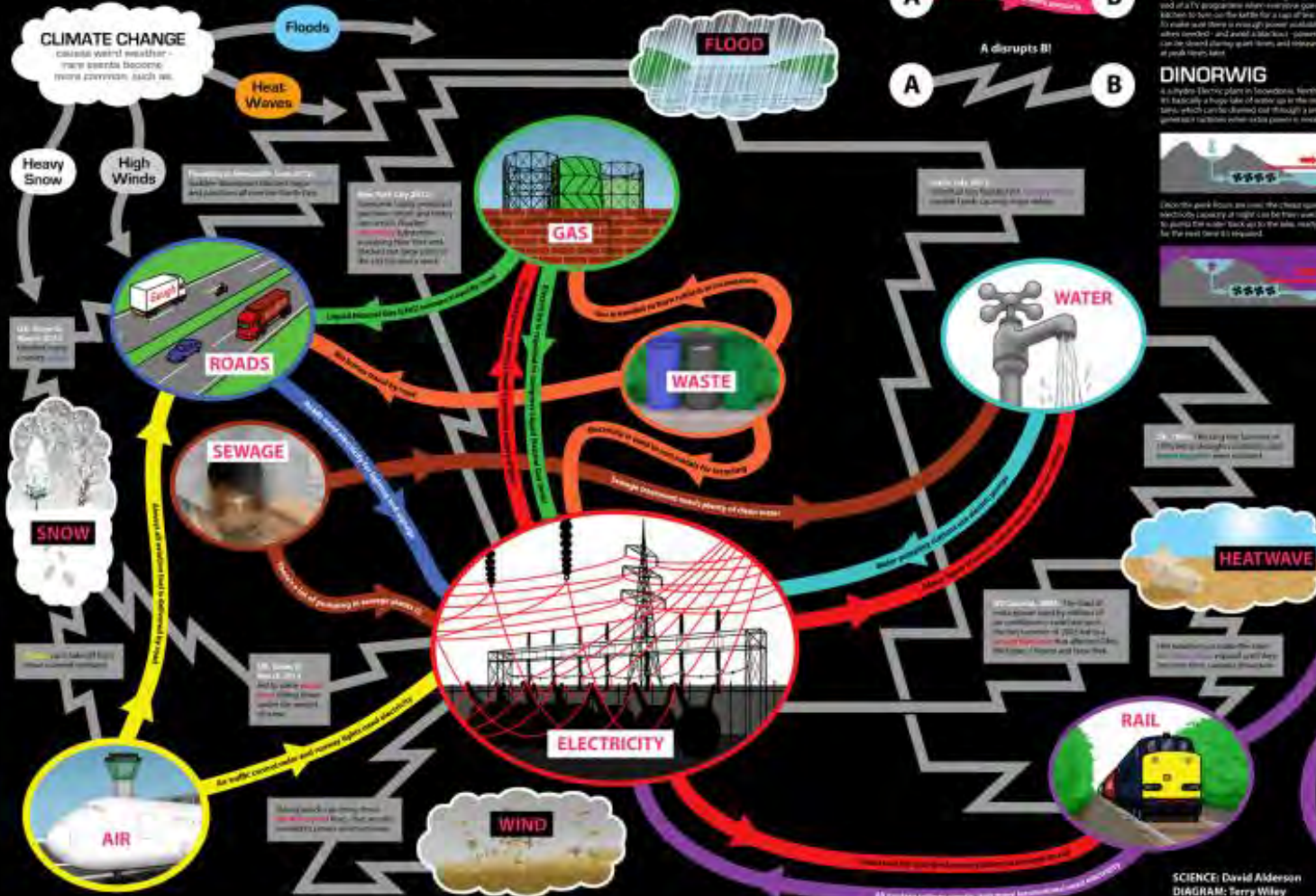
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EVERYTHING'S CONNECTED

All the different services we depend on every day also depend on each other. To keep a service running smoothly means keeping other services running smoothly too - which can be tricky...



KEEPING THE LIGHTS ON

Avoiding problems as energy use goes up and down each day

Electricity demand rises during the day, peaks in the evening, and falls at night. To ensure enough gas is available to cover peak demand, spare gas can be compressed and stored in a tank until it's needed.

DINORWIG

A nuclear power plant in Lancashire, Dinorwig is the world's largest underground pumped storage power station. It can be switched on and off in minutes to meet peak demand.



CO-LOCATION of different services

Co-location of different services can be a good idea. For example, placing a gas storage tank near a power plant can help ensure there's enough gas to cover peak demand. But there's always a chance that a disruption in the main supply will also disrupt the other services too.

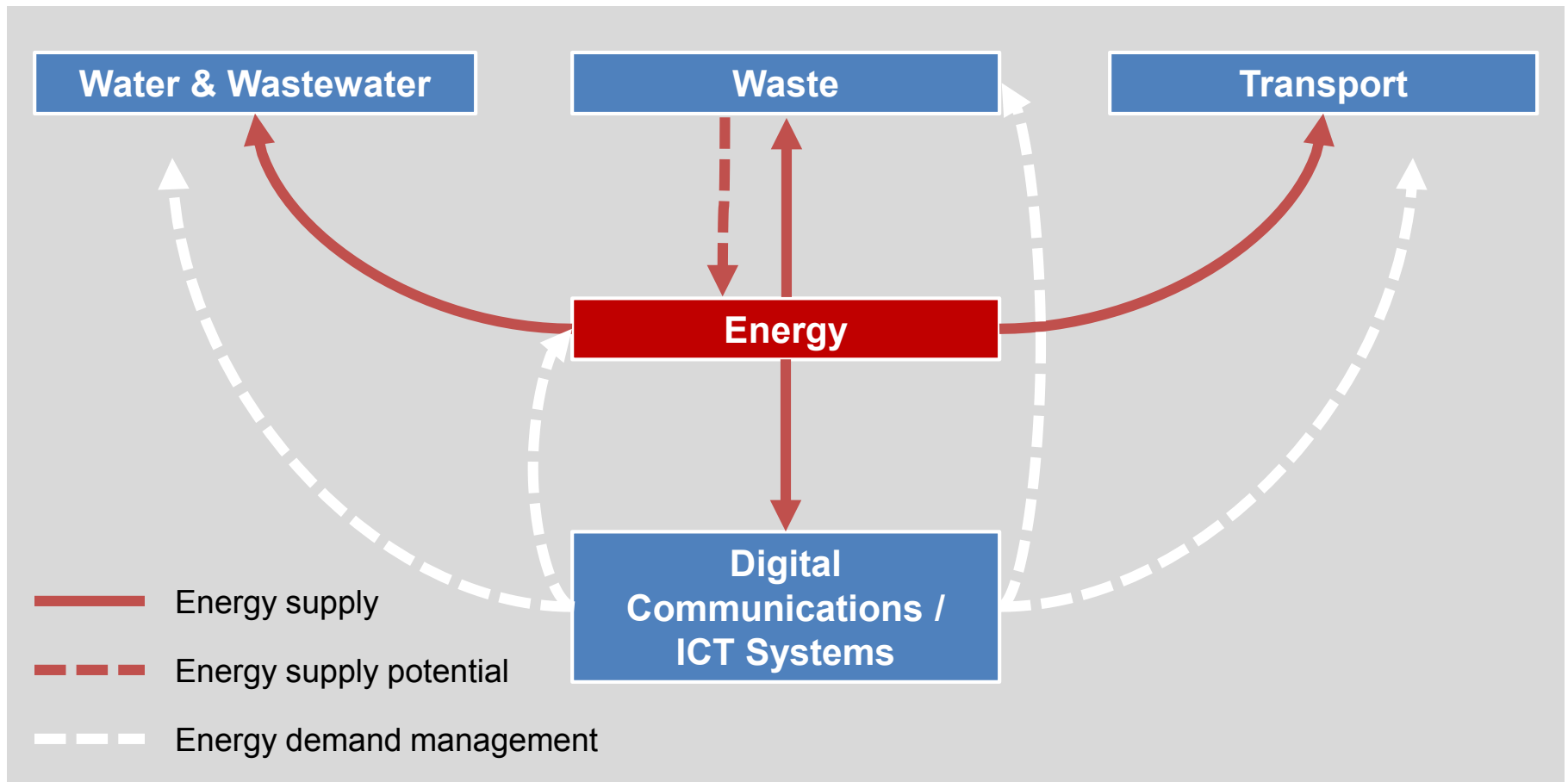


AND FINALLY

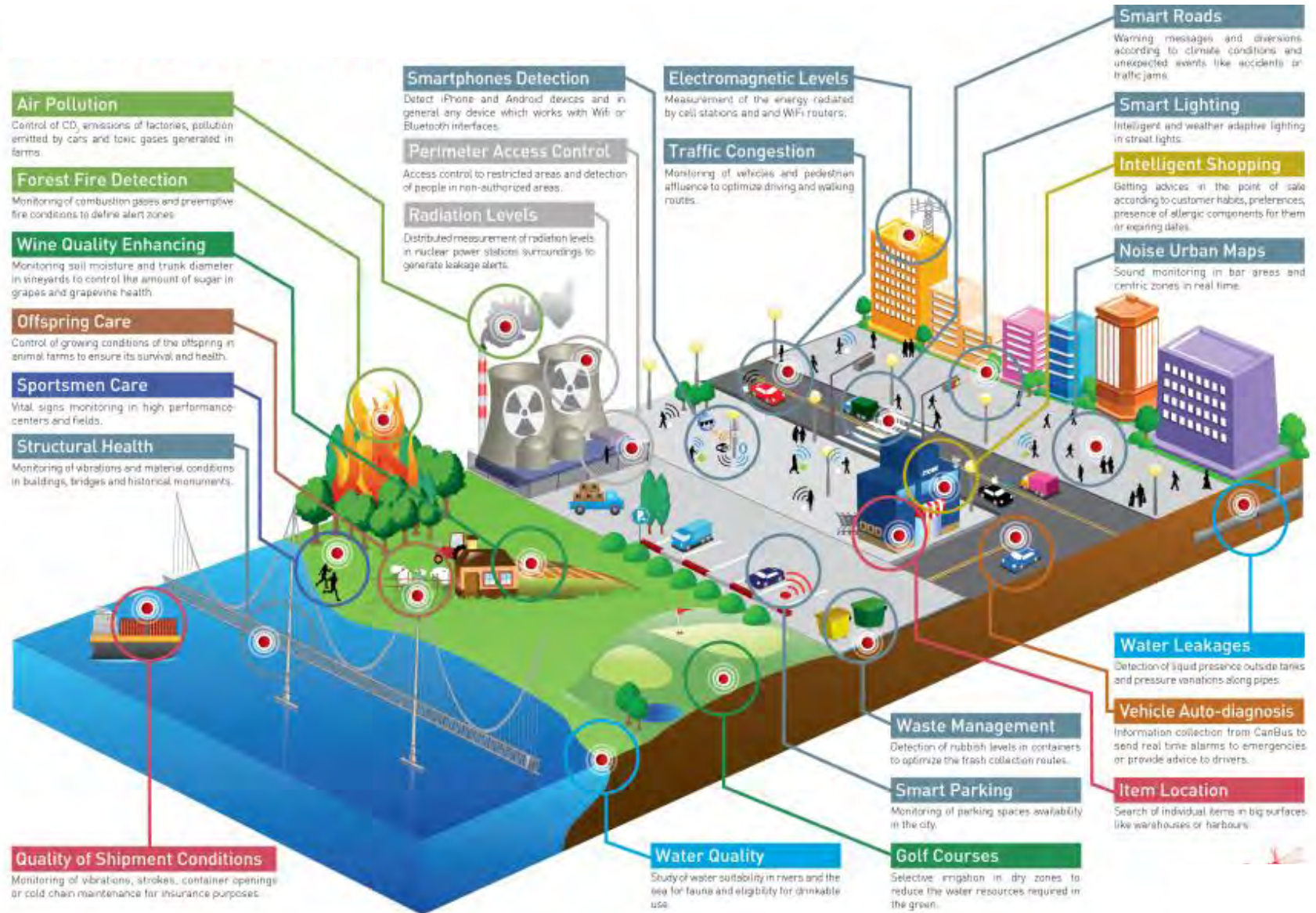


SCIENCE: David Anderson
DIAGRAM: Terry Wiley

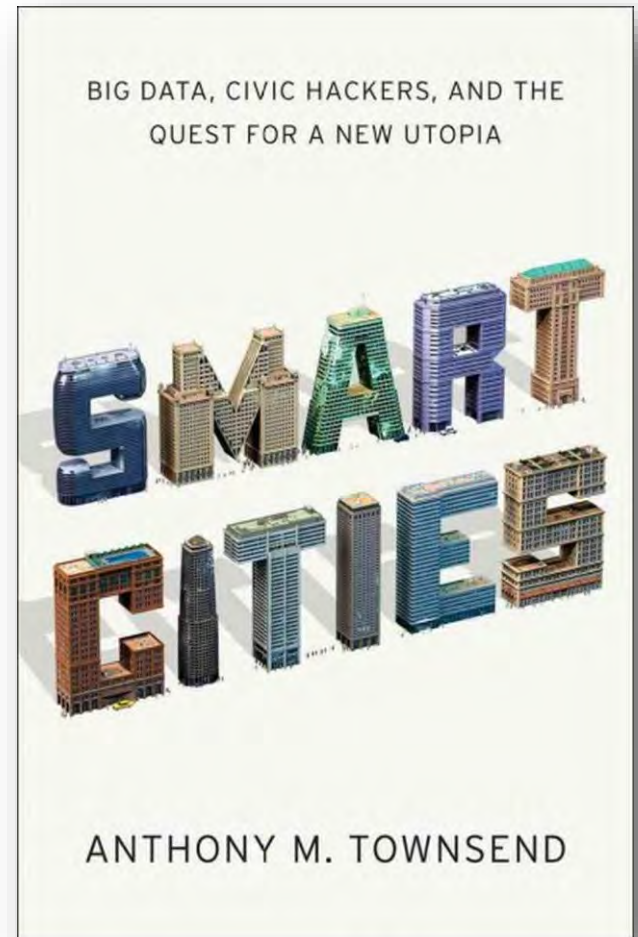
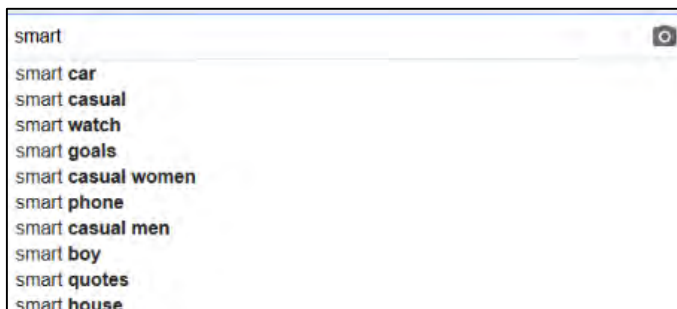
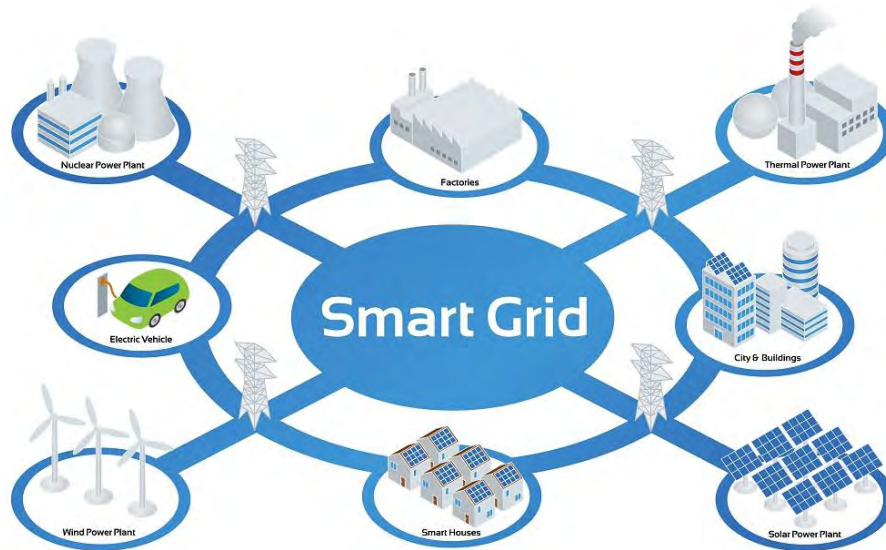
Growing Interdependency



'The Internet of Things' (IoT)



'Smart... Everything'



smart
infrastructure

UK Infrastructure Transitions Research Consortium

Modelling and Analysis of UK Infrastructure Transitions

Energy | Transport | Water | Waste | ICT

- 7 UK Universities
- 12 Government agencies & LAs
- 11 Engineering consultancies
- 10 Utility companies
- 2 Engineering societies
- 2 Research organisations & data providers
- 2 NGOs
- 1 Insurer
- 5 Contractors and sub-contractors

Consortium Leader – Professor Jim Hall

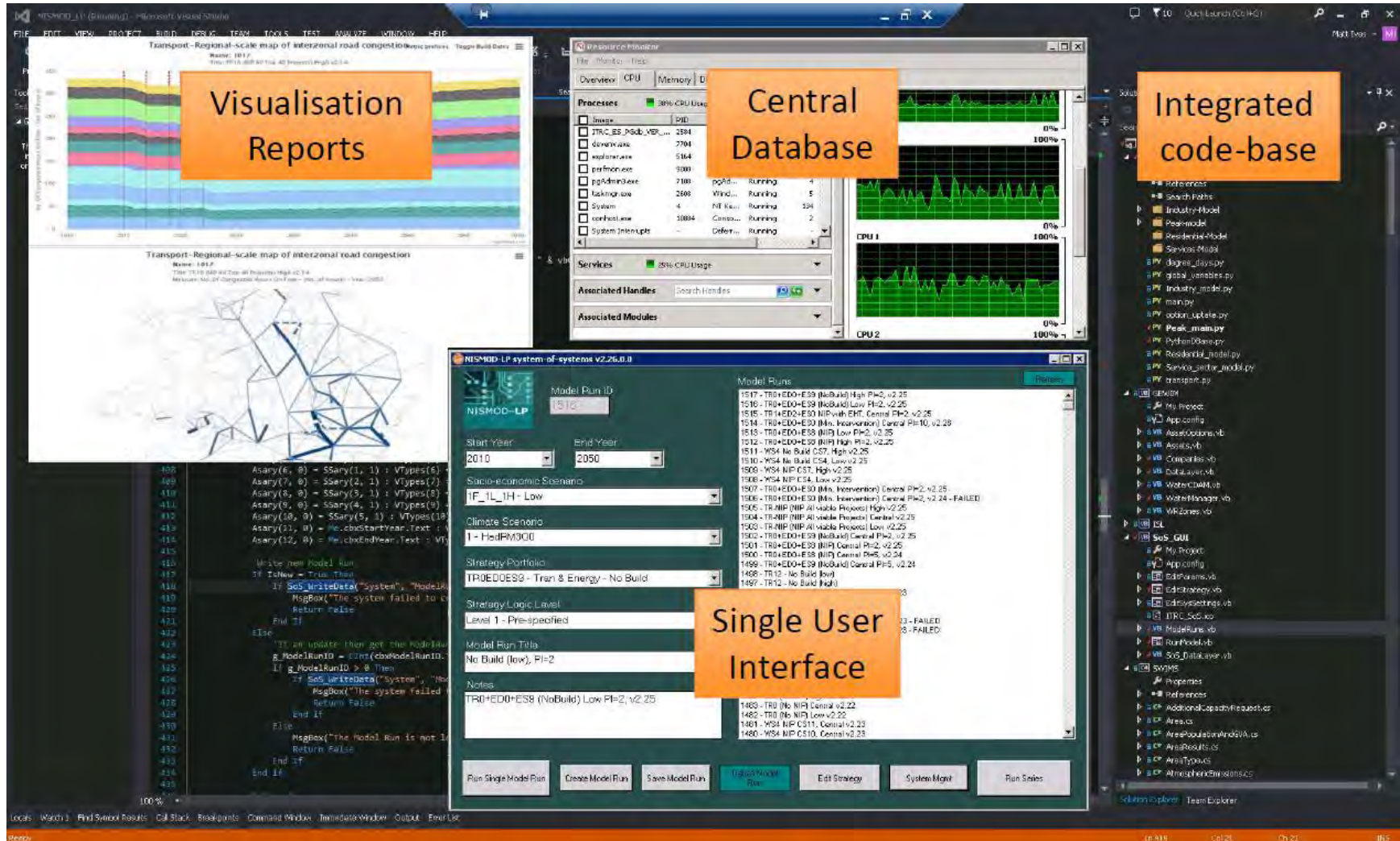
- Support from EPSRC - £4.7 million
- University contributions - £1 million
- Industry contributions £1.6 million



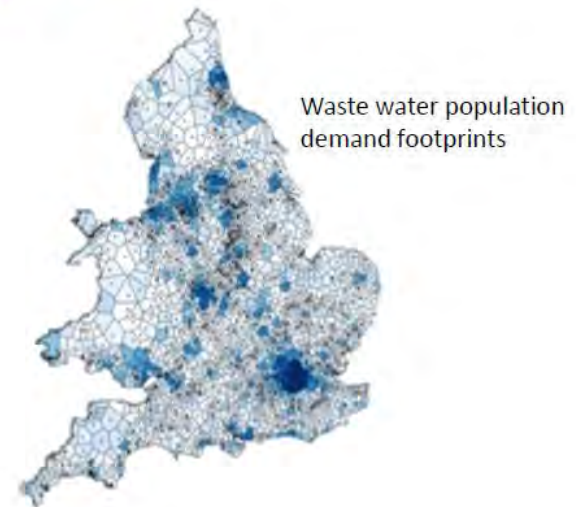
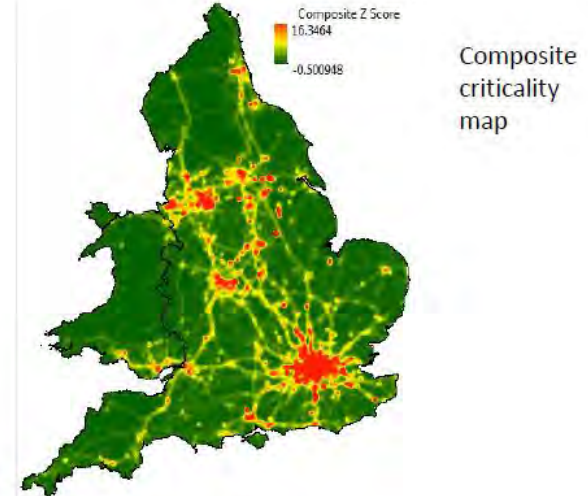
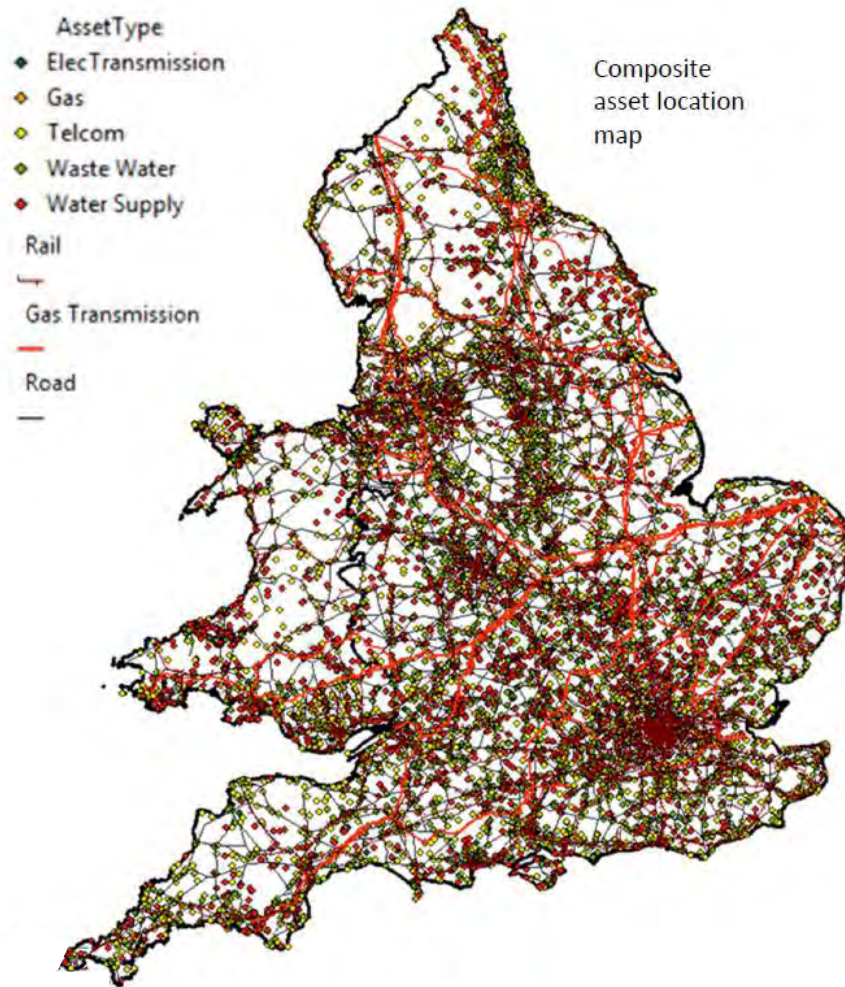
Outcomes from the ITRC – An Overview



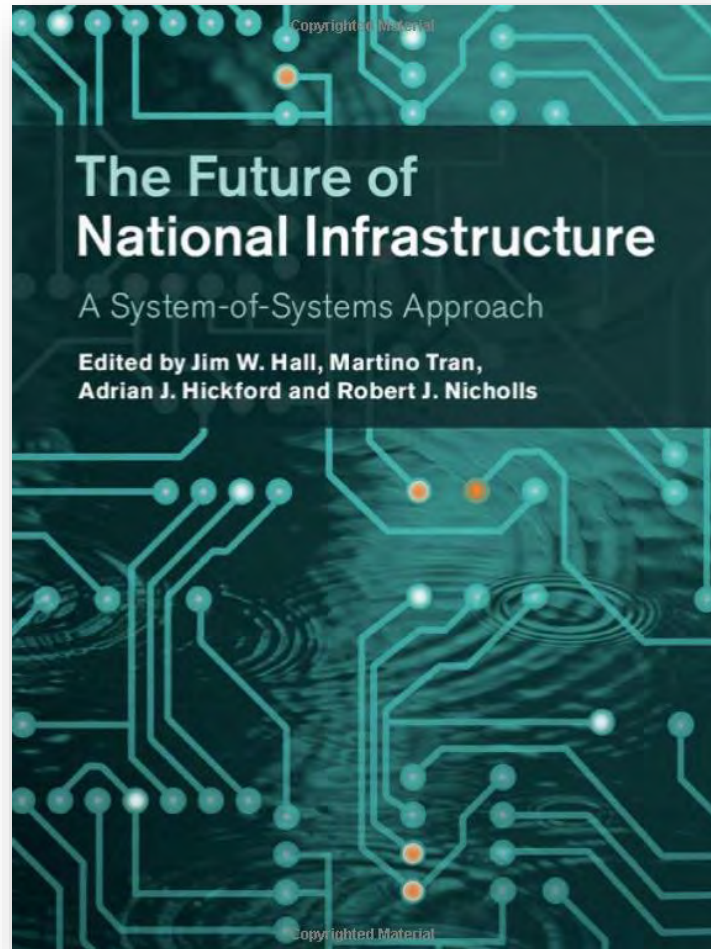
National Infrastructure Model – Long-term Planning



National Infrastructure Model – Risk & Vulnerability



The Future of National Infrastructure



MISTRAL: Multi-scale InfraSTRucture systems AnaLytics

Modelling and Analysis of UK and Global Infrastructure Transitions

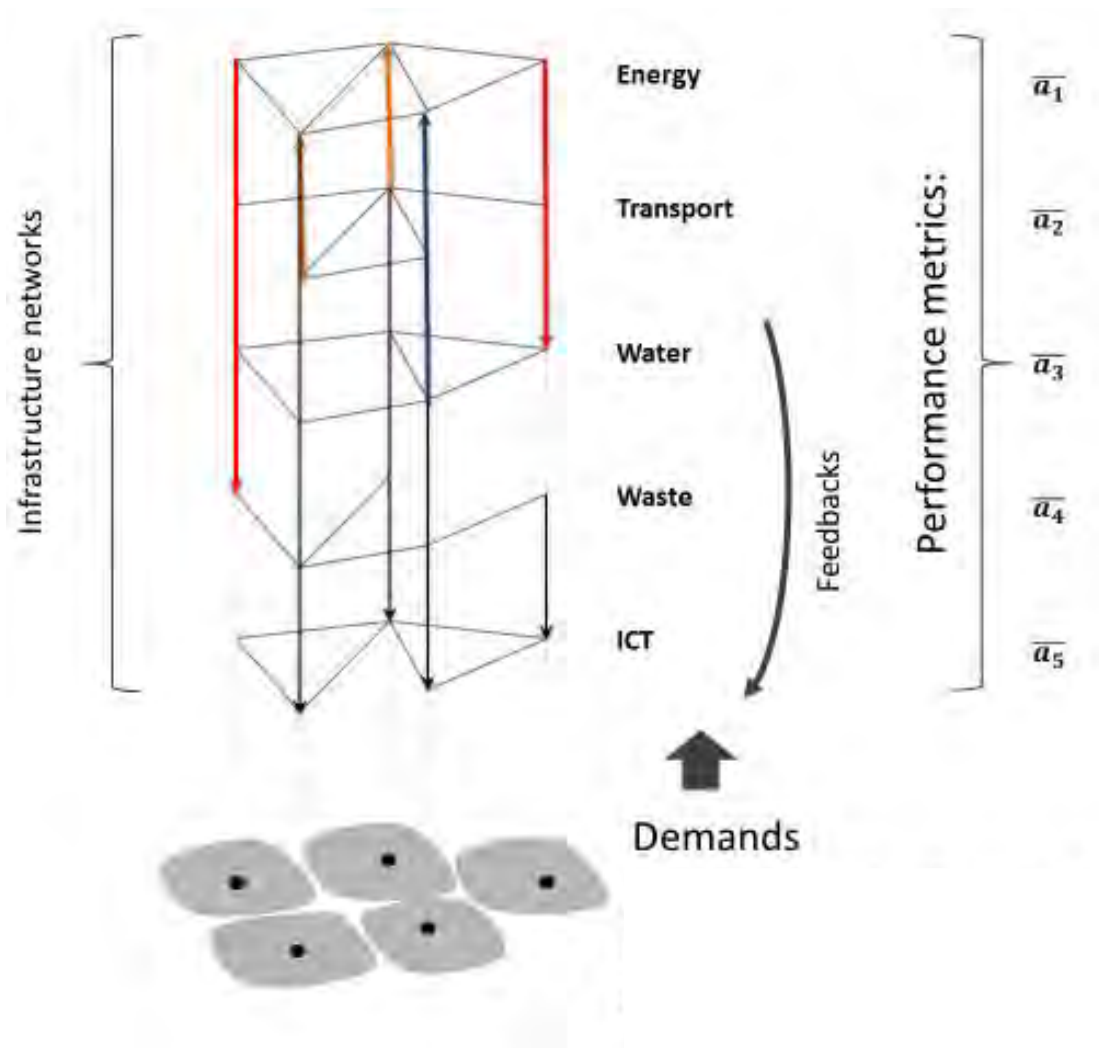
Energy | Transport | Digital Communications | Water | Waste

Consortium Leader – Professor Jim Hall (Oxford)

- Support from EPSRC ~ £5 million
- University contributions ~ £1 million
- Industry contributions ~ £2 million



MISTRAL: Multi-scale InfraSTRUCTure systems AnaLytics



Multi-scale Infrastructure Systems Analytics (MISTRAL)

Cambridge Group



Dr David Cleevely CBE FREng



Dr Edward Oughton



Professor Peter Tyler

National Needs Assessment



Sir John Armitt
President of the ICE

National Infrastructure Commission



Chancellor of the
Exchequer



HM Treasury



Led by Lord
Adonis



National Infrastructure
Commission

Infrastructure Commissioners:

- Lord Heseltine
- Sir John Armitt
- Professor Tim Besley
- Dr Demis Hassabis
- Sadie Morgan
- Bridget Rosewell
- Sir Paul Ruddock



Integrated Infrastructure: Cyber Resiliency in Society

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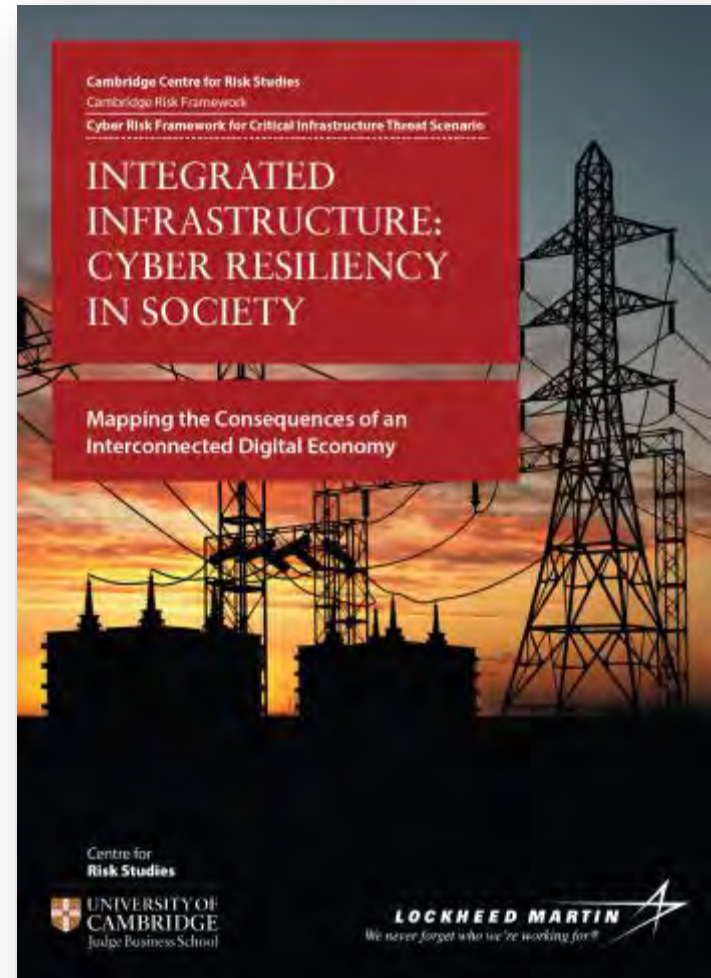
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*Insight into Systemic
Technological Risk*



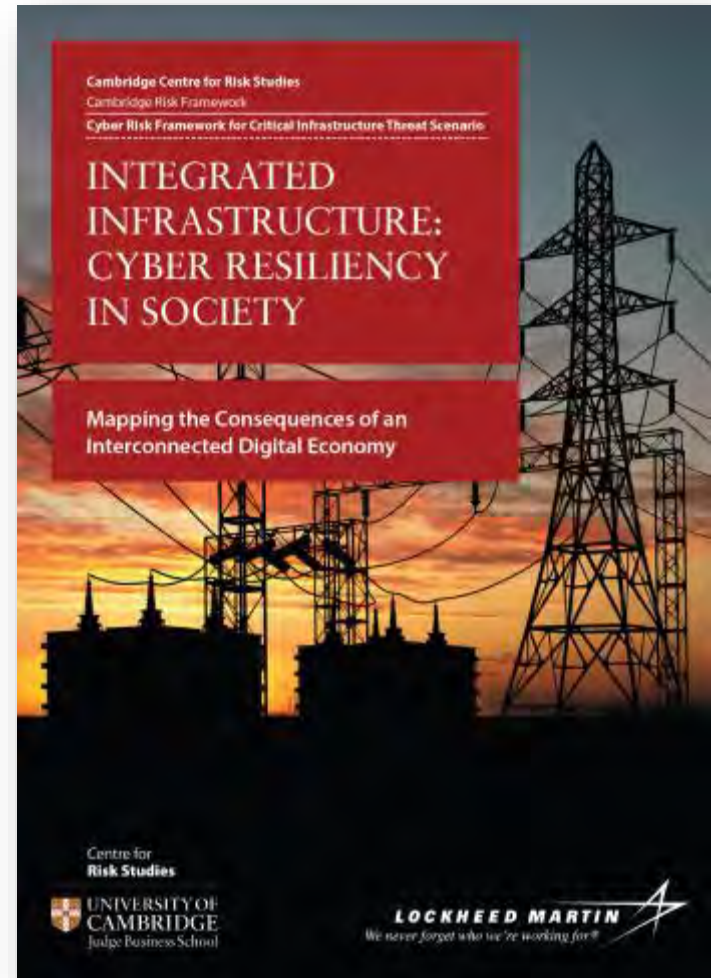
Examples of CRS Recent Work

- Estimating the direct impact on industrial production systems



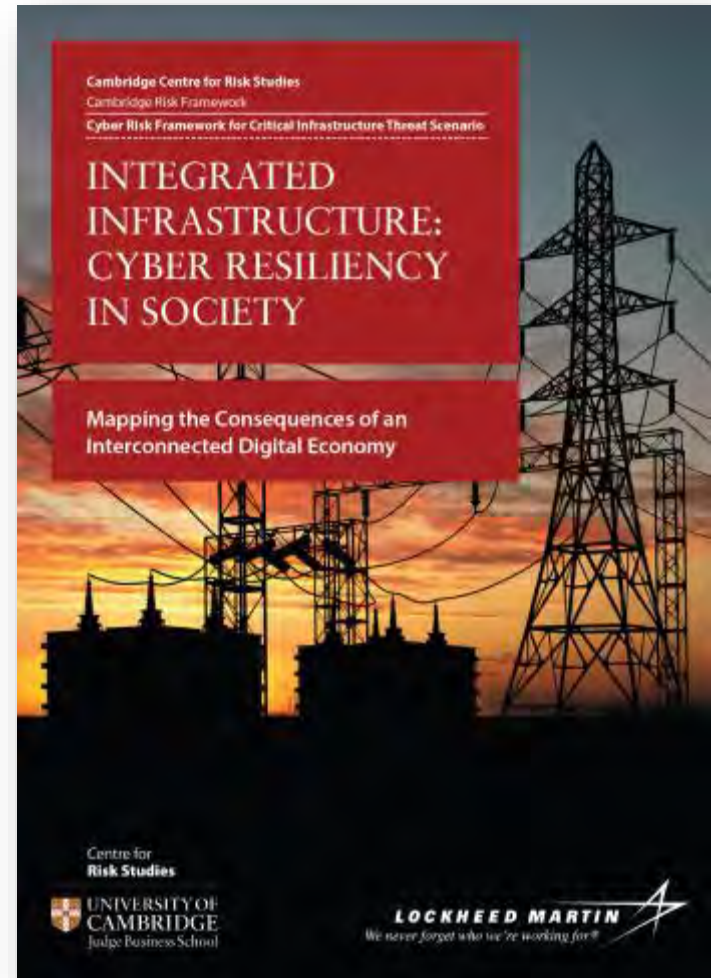
Examples of CRS Recent Work

- Estimating the direct impact on industrial production systems
- Quantifying the indirect impact on supply chains



Examples of CRS Recent Work

- Estimating the direct impact on industrial production systems
- Quantifying the indirect impact on supply chains
- Valuing the total cost to the UK economy



Ukraine – 23rd December 2015



Scenario Modelling Process

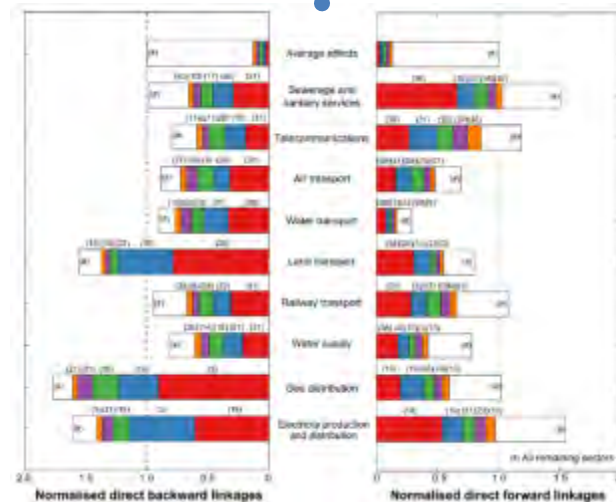
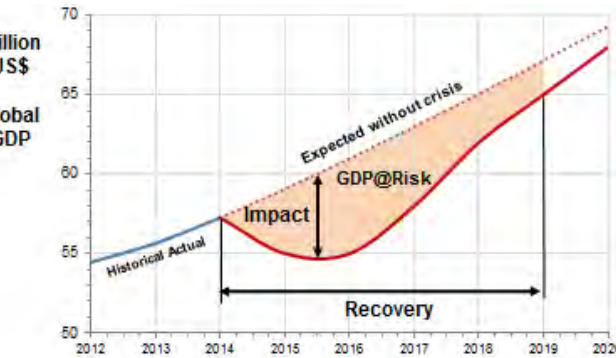


DNO cyber attack scenarios

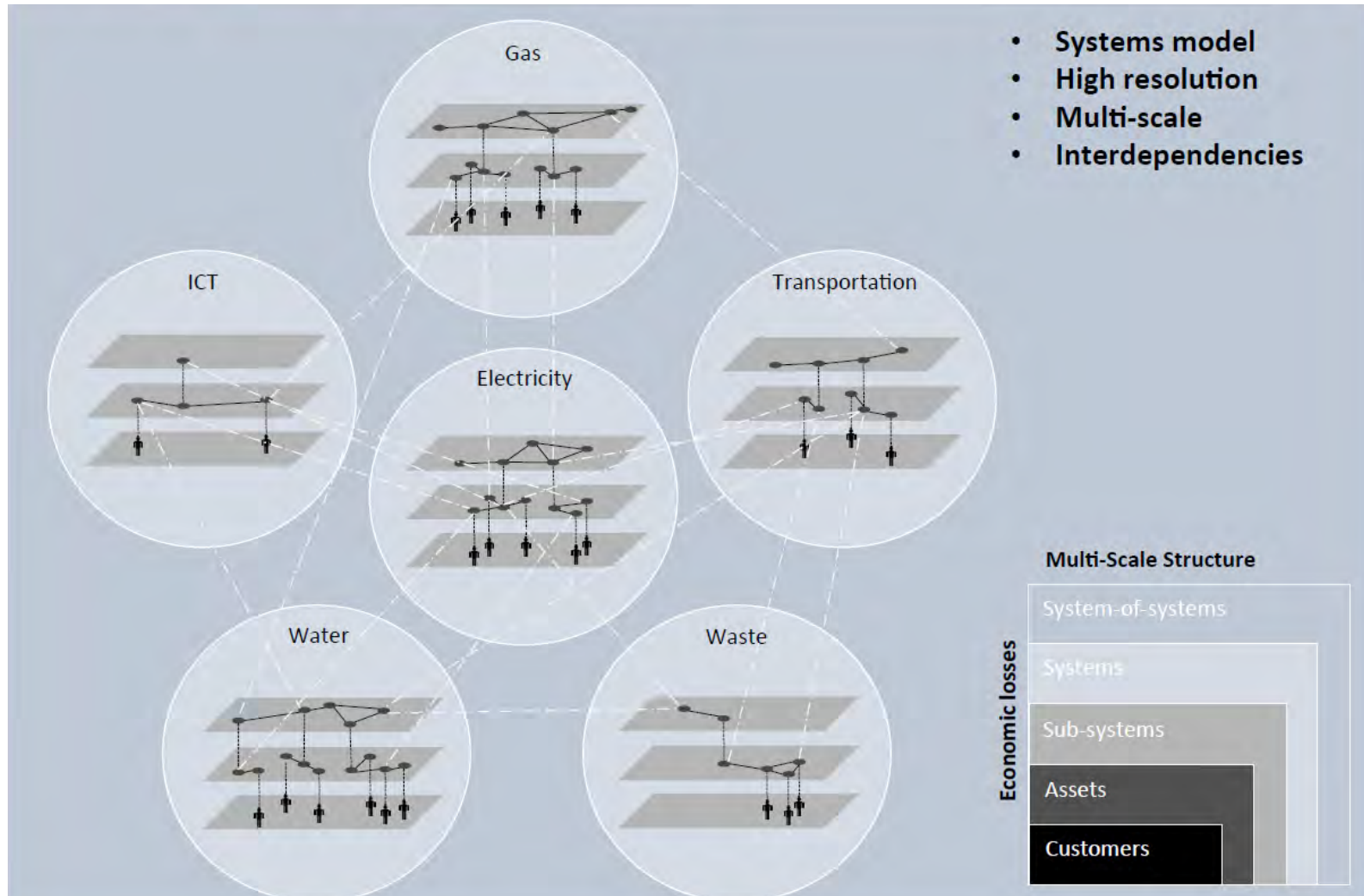
Run Infrastructure Network Vulnerability Assessment Model:
Estimate customers disruptions

Shock UK IO model:
Estimate direct and indirect economic losses by industry

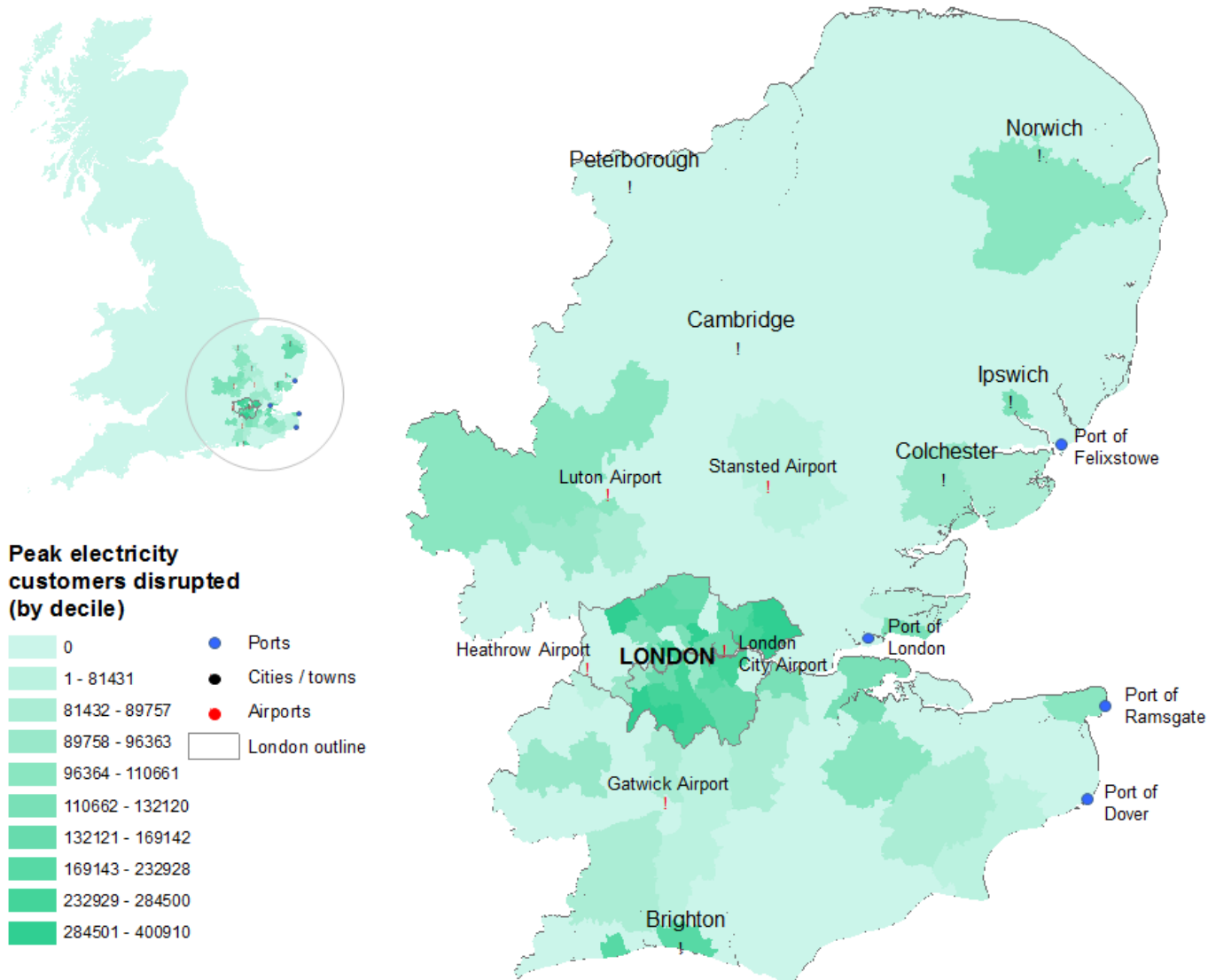
Produce simulations using OEM model: Estimate 5 year GDP@RISK



A System-of-Systems Approach to Infrastructure Interdependencies

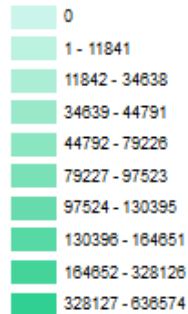


Electricity Customers Disrupted

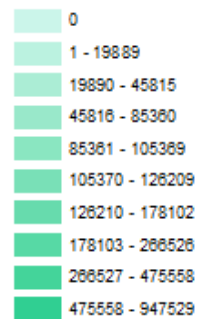


Critical Infrastructure Customers Disrupted

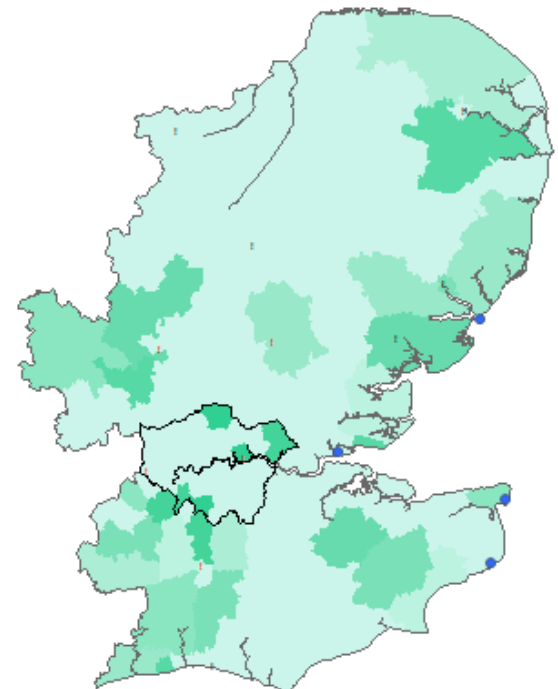
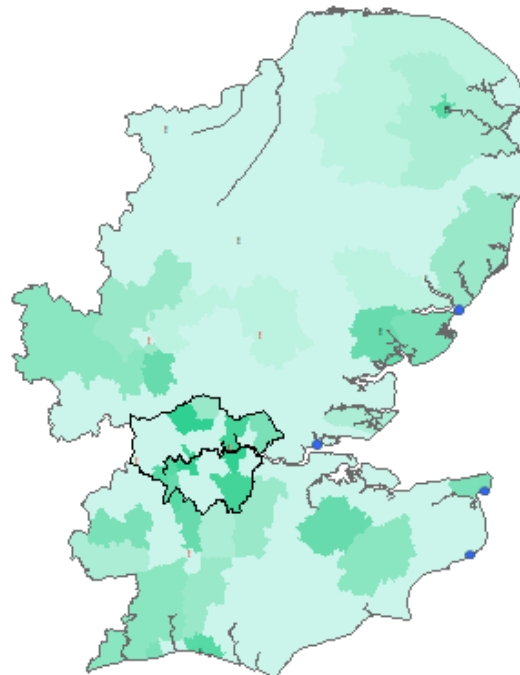
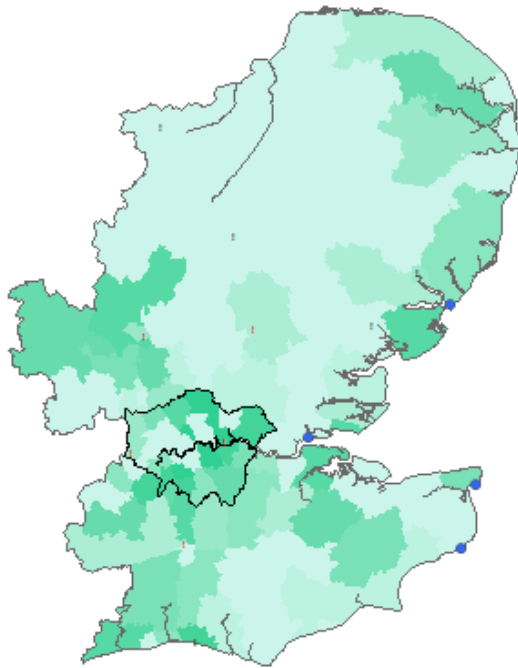
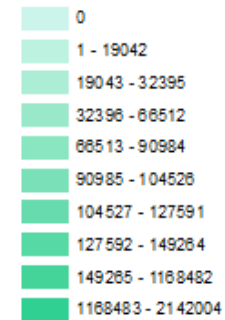
Peak digital communications
customers disrupted
(by decile)



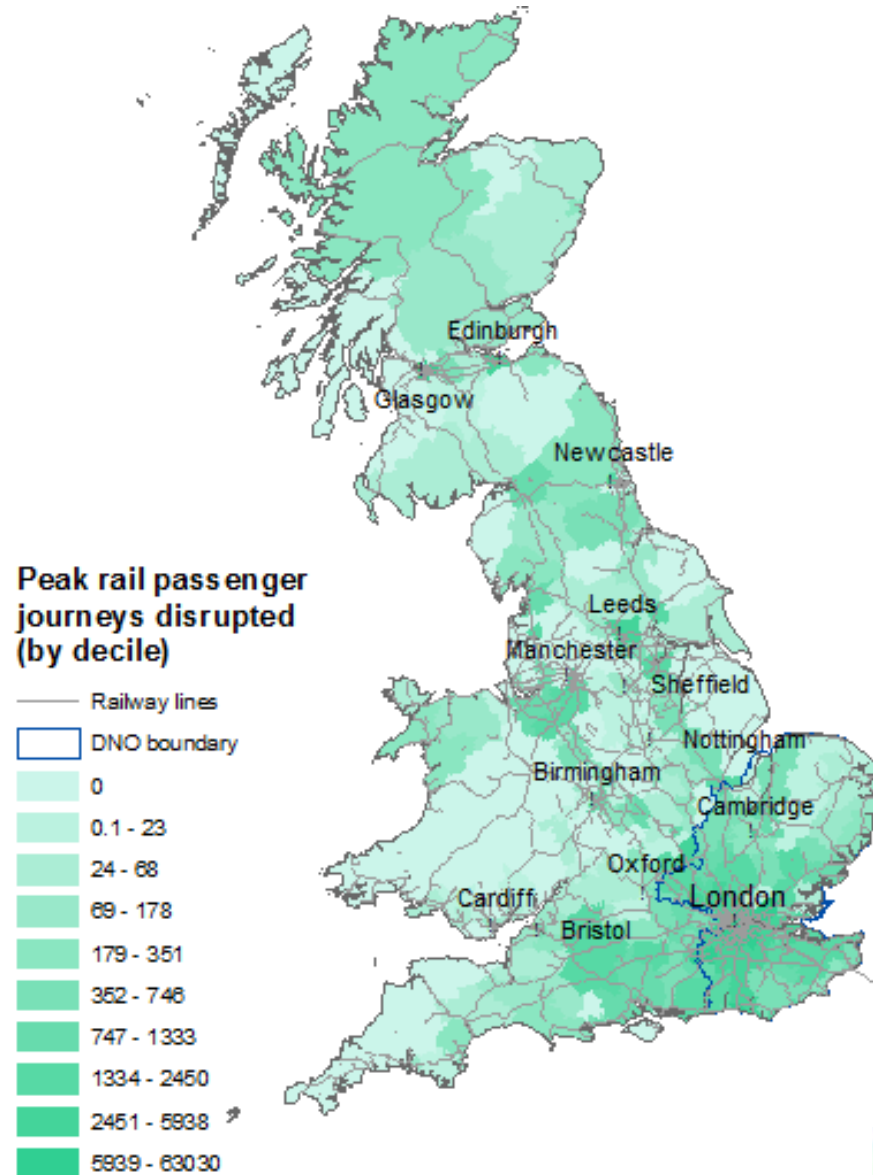
Peak fresh water
customers disrupted
(by decile)



Peak waste water
customers disrupted
(by decile)



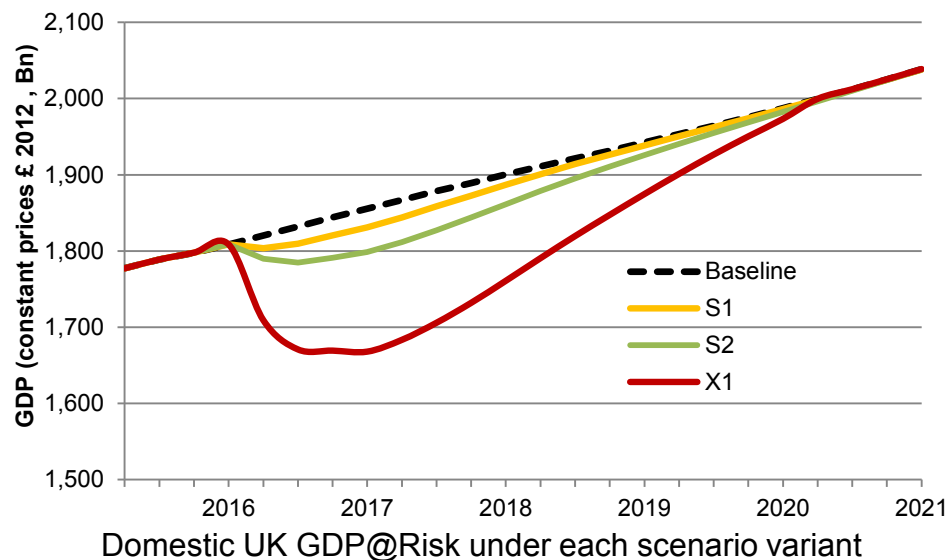
Railway Customers Disrupted



Direct and Indirect Economic Losses by Industry

	S1		S2		X1	
	Direct	Indirect	Direct	Indirect	Direct	Indirect
Financial Services	897	419	2,175	1,039	5,325	2,870
Wholesale and Retail trade	770	505	1,950	1,263	6,126	3,710
Real Estate Activities	820	388	2,063	956	6,295	2,601
Professional Services	700	335	1,736	834	4,857	2,369
Construction	428	406	1,088	1,020	3,574	3,123
Manufacturing	354	379	922	953	3,442	2,922
Health	402	255	1,013	638	3,101	1,900
Administrative Services	362	211	902	524	2,613	1,489
Transportation	304	252	762	628	2,317	1,822
Education	441	114	1,113	286	3,451	859
Information Technologies	440	96	1,085	239	2,776	672
Government And Emergency Services	318	206	797	515	2,407	1,511
Other Services Activities	361	42	900	104	2,550	296
Accommodation and Food Service Activities	205	135	511	338	1,473	1,006
Communications	82	139	205	345	578	983
Food	63	135	162	341	589	1,079
Arts, Entertainment and Recreation	120	64	300	159	901	457
Water Supply and Waste Management	62	54	160	135	529	402
Energy (Oil and Gas)	12	74	30	184	80	529
Electricity	17	64	44	160	133	467
Defence Manufacturing	22	55	57	139	186	412
Agriculture, Forestry and Fishing	28	37	75	94	318	294
Mining	2	9	6	23	21	68

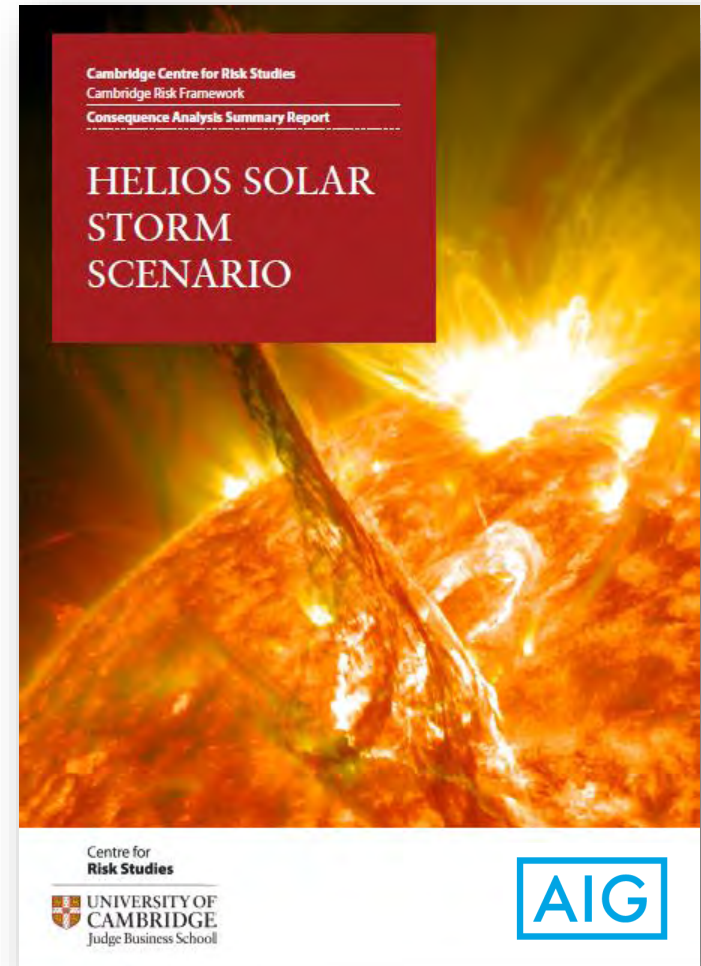
Estimation of Economic Loss



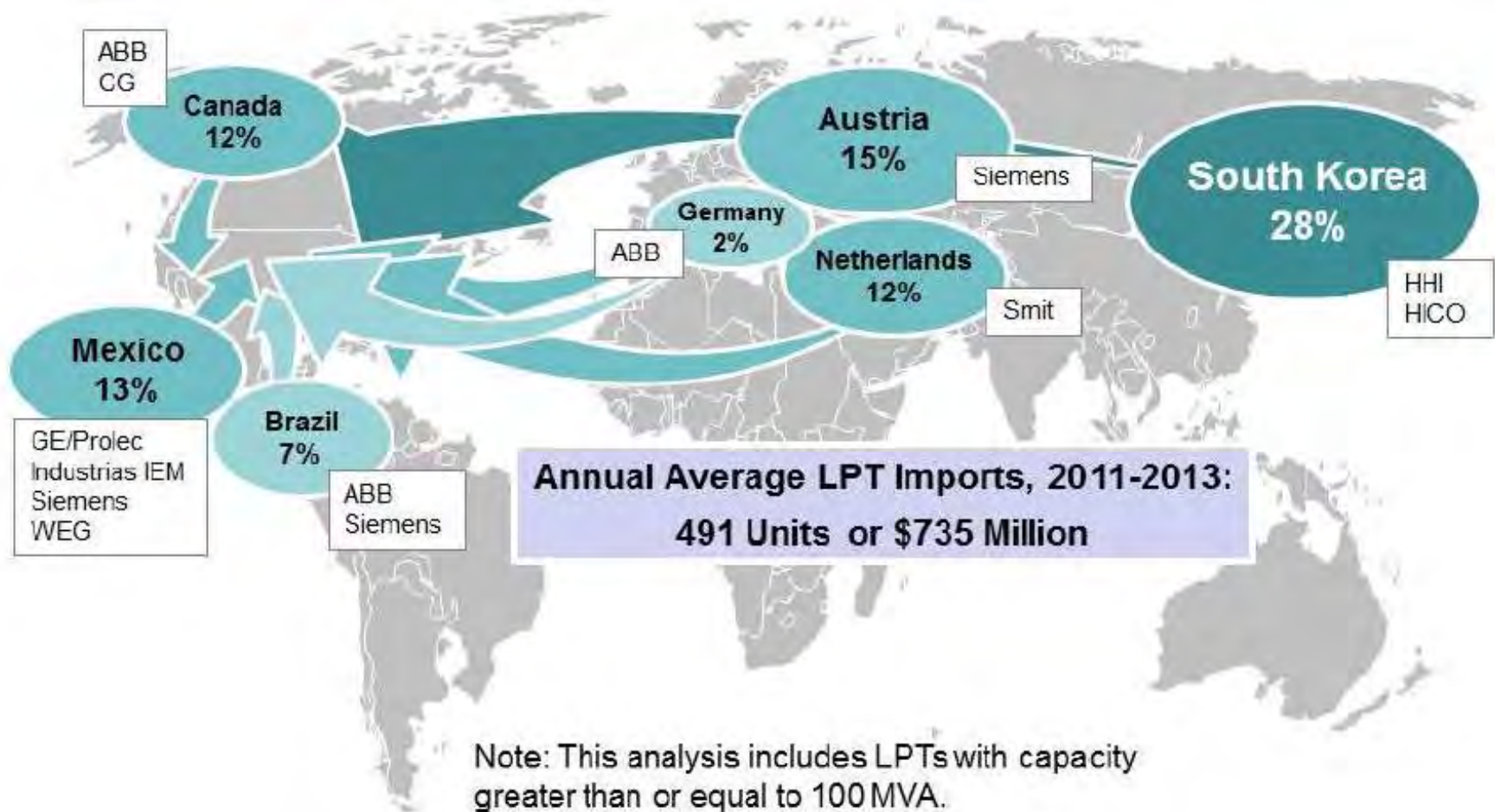
Scenario Variants	Lost Power (TWh)	Direct Industrial Production Losses (1 Yr) £ billion (from IO modelling)	Indirect Losses to Supply Chains (1 Yr) £ billion (from IO modelling)	GDP@Risk (5 Yr) £ billion (from macroeconomic modelling)
S1	10.3	7.2	4.4	49
S2	19.8	18.0	10.9	129
X1	39.6	53.6	31.8	442

Helios Solar Storm Scenario

- Explores the potential economic impact of extreme space weather.
- Develops an open-source risk matrix.
- Undertakes sectoral analysis of global supply chain linkages and total macroeconomic losses.
- Estimates insurance portfolio losses.

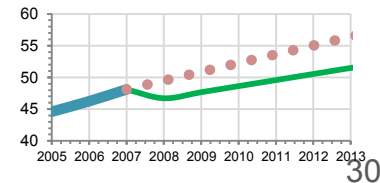
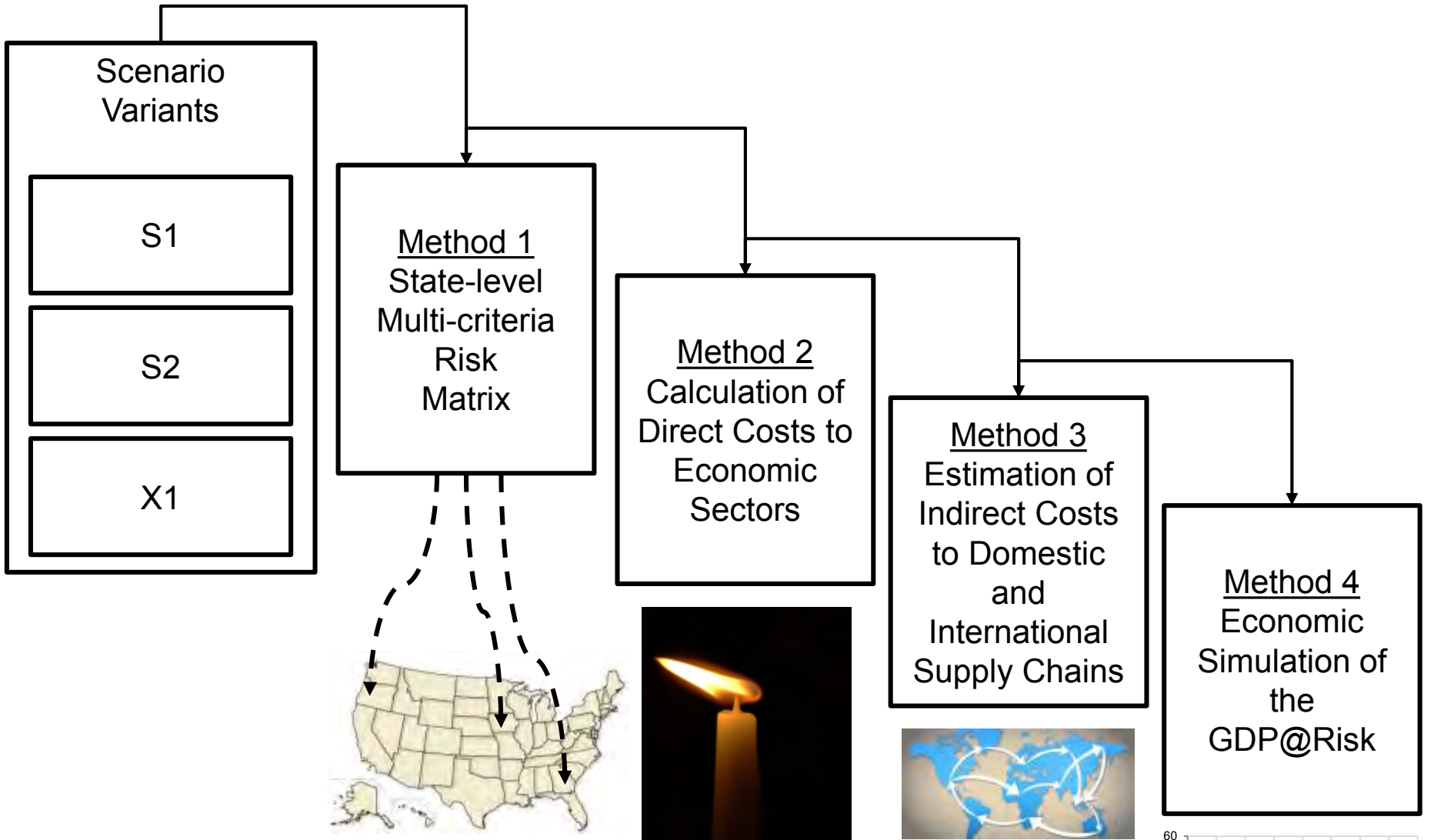


US Dependent on Global Supply Chain

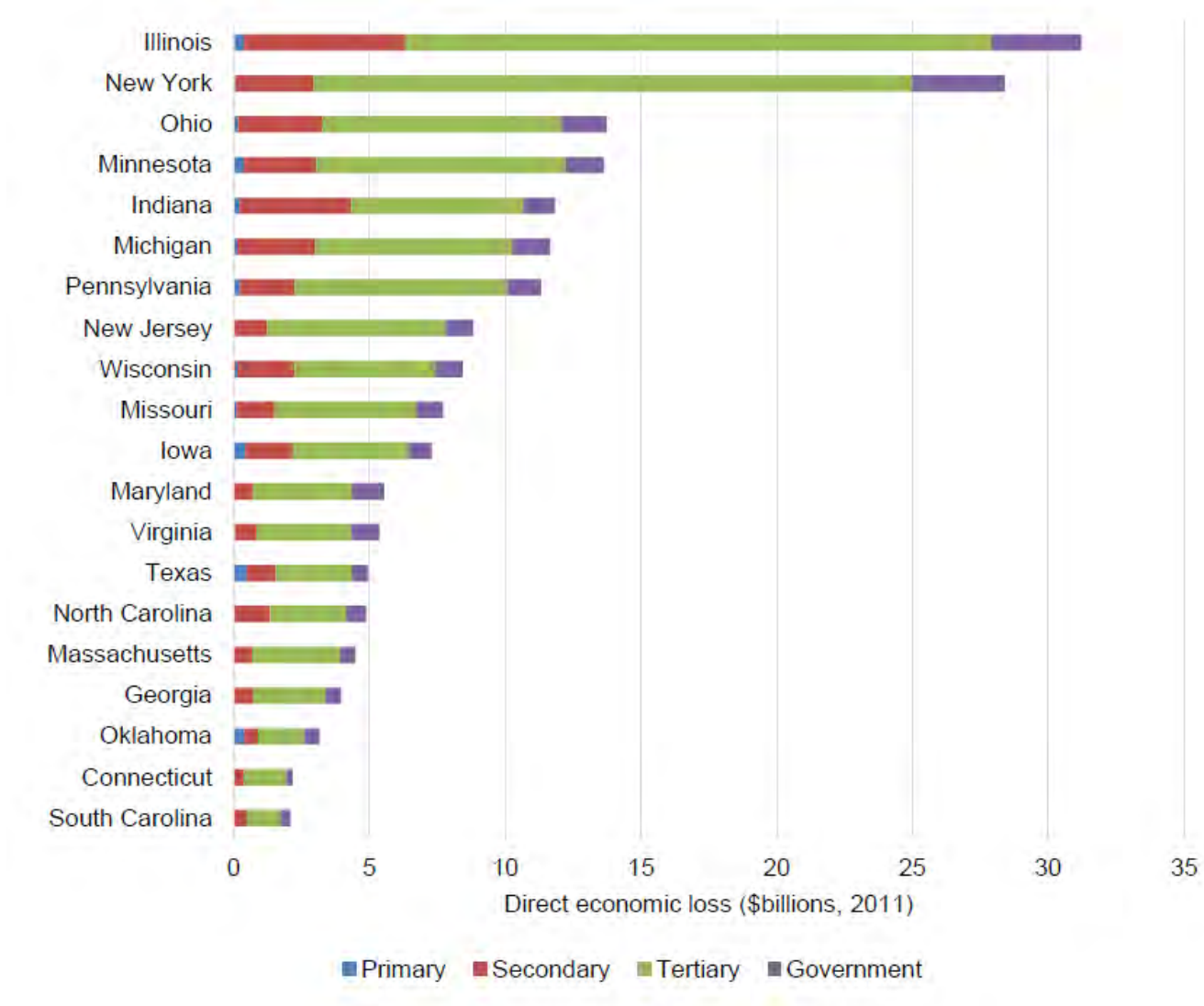


(DOE, 2014)

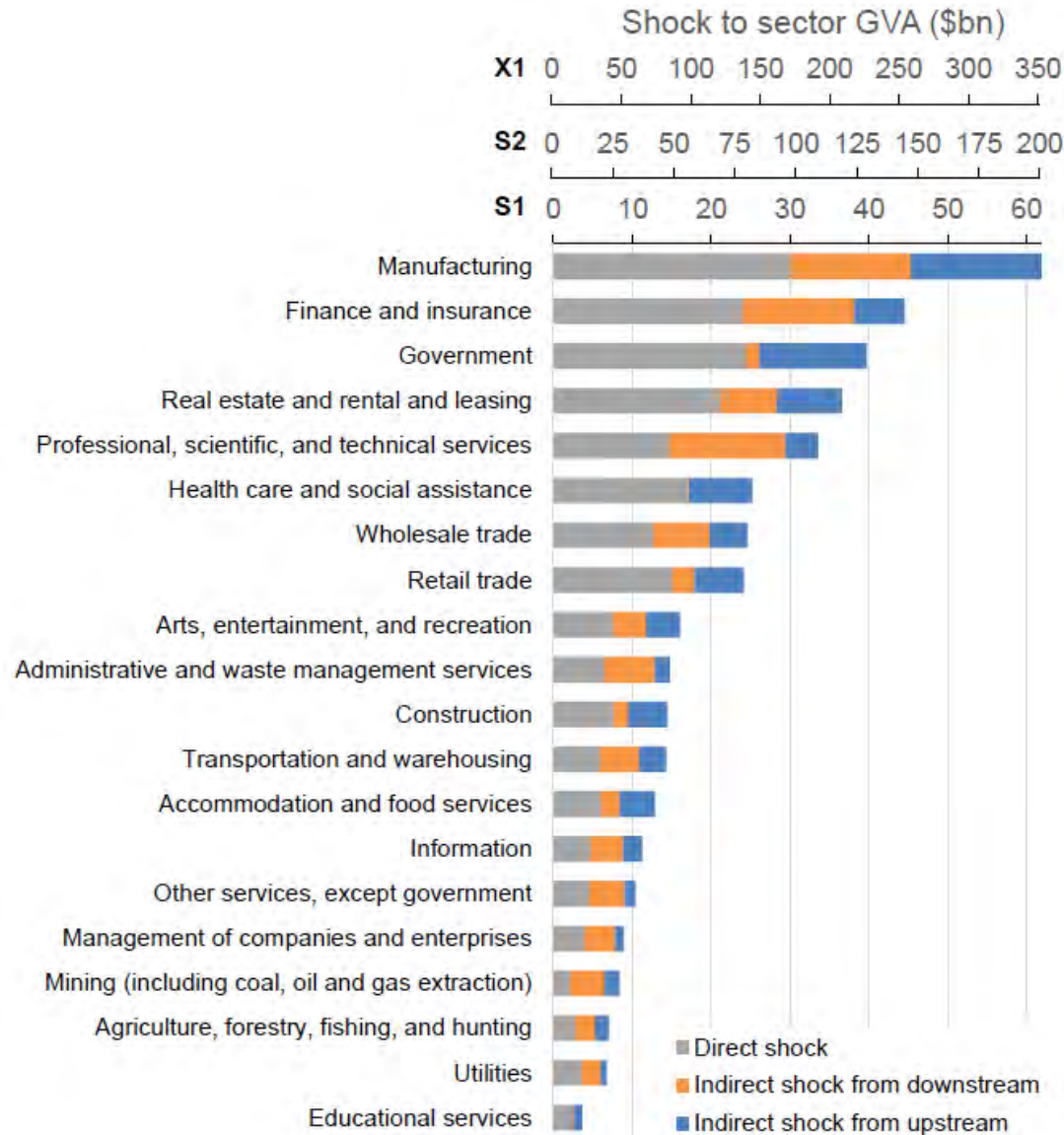
Methodology



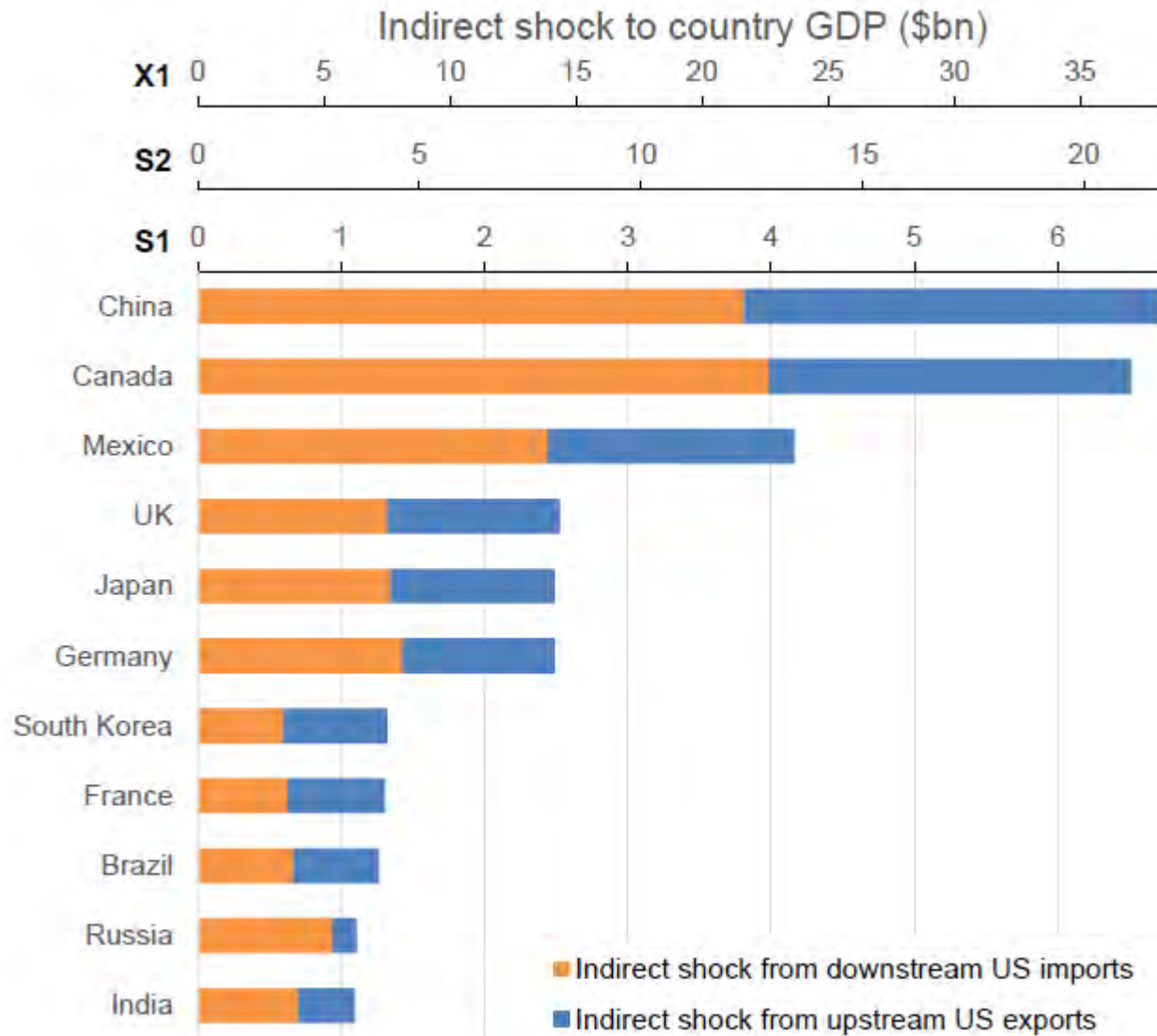
Direct Economic Impacts by Industrial Sector



US Sectoral Supply Chain Impacts



International Supply Chain Impacts



In Summary

- Critical infrastructure and technological catastrophe:
 - In context
 - Expertise
 - Recent achievements
 - Ongoing real world impact
- Research highlights:
 - Integrated Infrastructure
 - Helios Solar Storm

Conclusion

- Infrastructure systems are becoming more and more interconnected:
 - Proliferation of digital technologies in a rapidly changing environment;
 - Ramifications for risk, vulnerability and resilience;
- New models needed to understand technological risks in order to provide genuine insight for industry and government:
 - Uniquely placed to do this thanks to our methodological expertise;
 - Our perspective recognises the complexity of the international business landscape.

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