

Electricity
Transmission

National Grid Electricity Transmission

Resilience Stakeholder
Workshop
23 October 2018

nationalgrid



Agenda

Welcome and introduction

Resilience and the changing world

Coffee break

Physical security

Cyber security

Lunch

Extreme weather resilience

Blackstart

Exercise: society and business expectations

Coffee break

Arup – City Resilience Index and City Water Resilience Framework

Resilience measures

Wrap up and close

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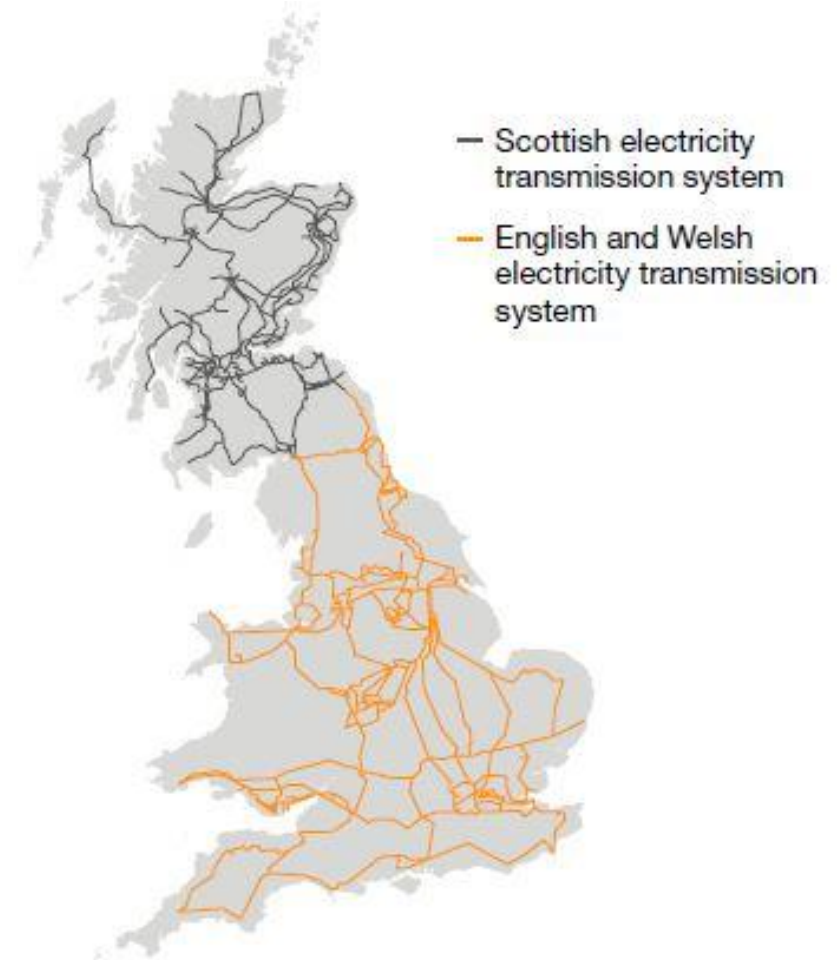
Introduction to National Grid

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National Grid: what we do

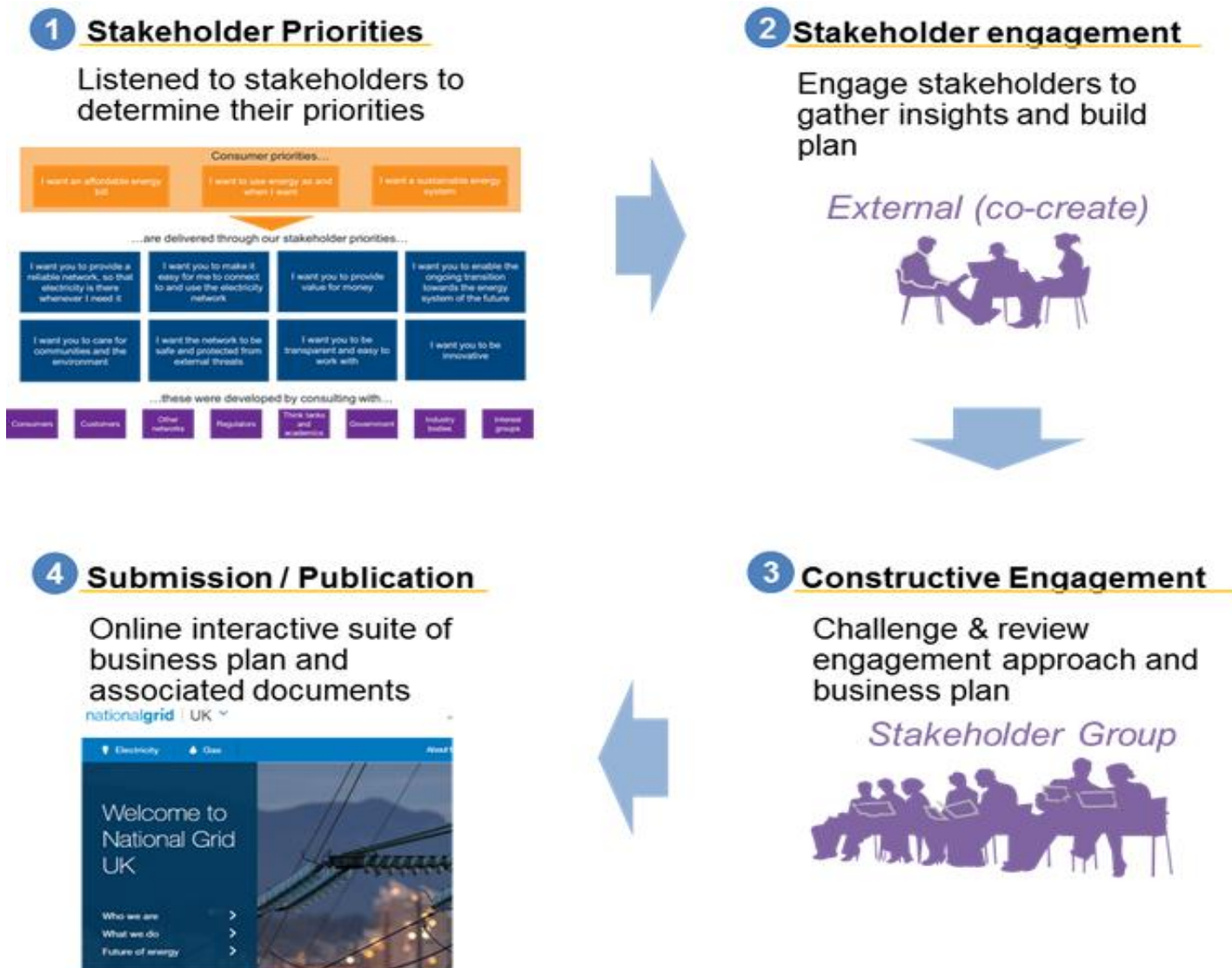
- **We are England & Wales Electricity Transmission (ET)**
 - We own, build and maintain the network
- **We are also the GB Electricity System Operator (ESO)**
 - We balance the system and ensure that voltage and frequency are kept within acceptable limits
- **Today's workshop is about Electricity Transmission**
- The ESO will have its own regulatory framework for RIIO-2 and will be engaging on this separately



Some context about today

- Today is part of a wider programme of stakeholder engagement to help us build our business plans for RIIO-2 (and this will become our business-as-usual)
- Based on what we've heard so far, we've split our plans into eight areas for engagement:
 -  The environment
 -  The future of networks
 -  Innovation
 -  Resilience
 -  Reliability
 -  Our impact on communities
 -  Connecting to and using our network
 -  Improving the way we work with you

Our stakeholder-led approach for RII0-2



Current RIIO-T1 outputs



Safety



Reliability



The environment



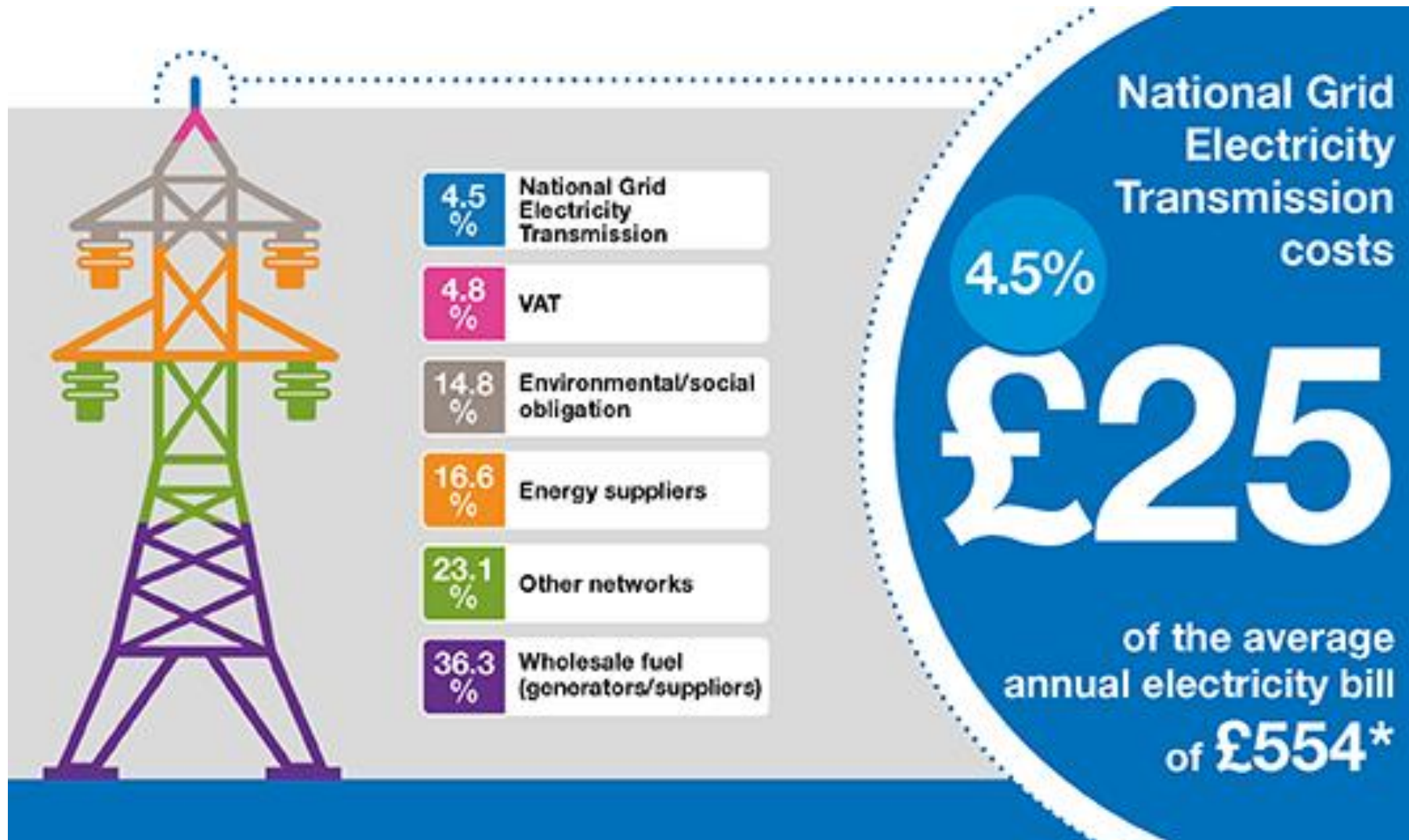
Customer connections



Customer satisfaction



Household bill impact: Electricity Transmission



Resilience-related spend will account for around 5-15% of our costs in RIIO-T2

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Why resilience?

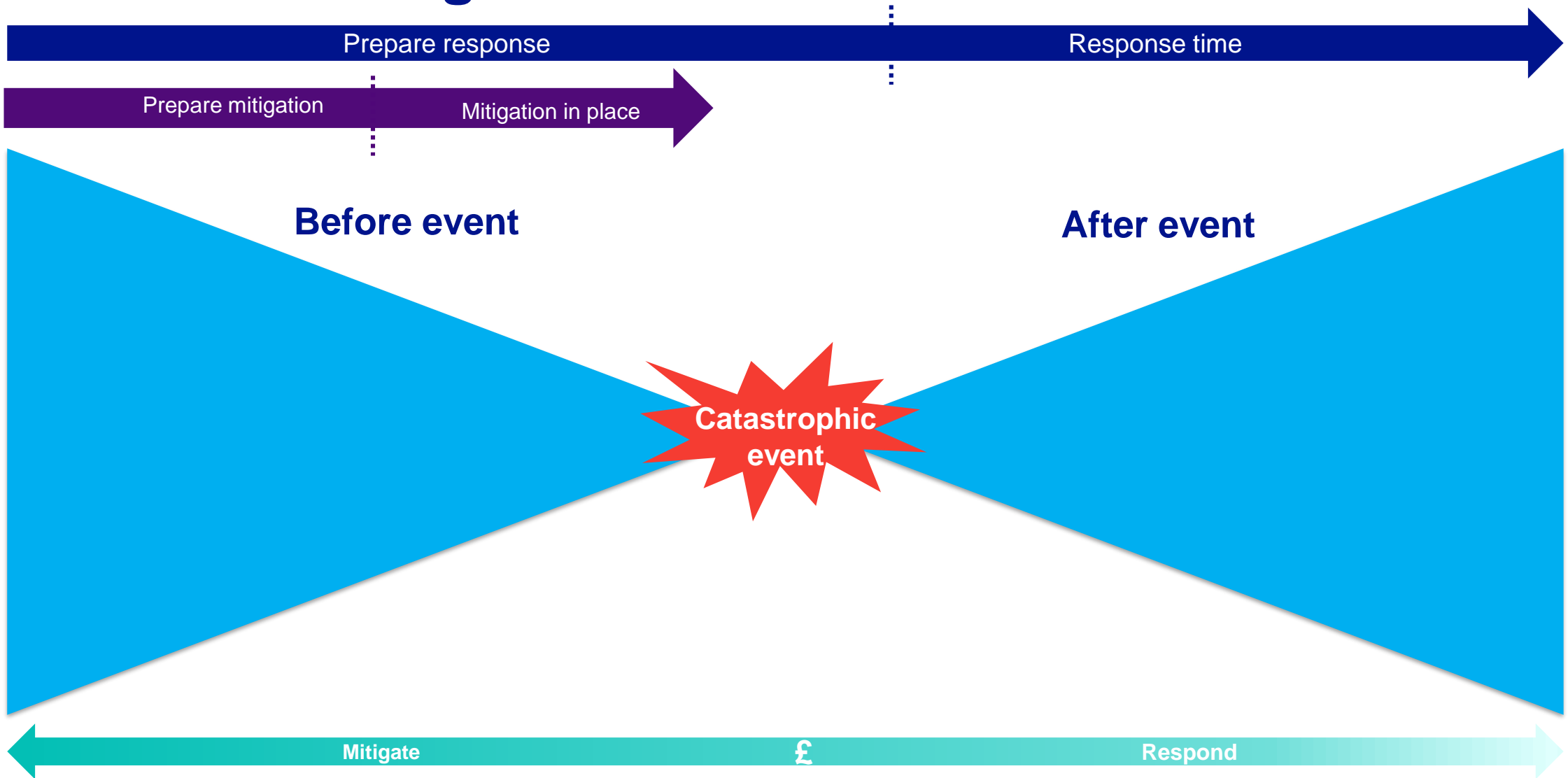
Ursula Bryan

Head of Engineering and Asset Management

nationalgrid



Bow-tie risk management



How is Resilience additional to Reliability?

Reliability

Day-to-day challenges of running a network, within 'normal' operating conditions

Resilience

'the ability to withstand and reduce the magnitude and/or duration of disruptive events, which includes the capability to anticipate, absorb, adapt to, and/or rapidly recover from such events' (FERC, 2018)



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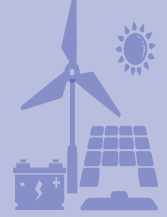
Resilient future

Neil Carter CEng MIET
Electricity Transmission
Future Strategy Manager

nationalgrid



Threats to infrastructure are changing

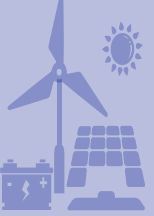


Today's electricity system is under greater threat than ever from:

- climate change
- malicious cyber attacks
- physical threats



All at a time of growing political instability across the world



We mitigate and respond today

Flooding



Physical



Cyber



Black start



Reliance on electricity is growing



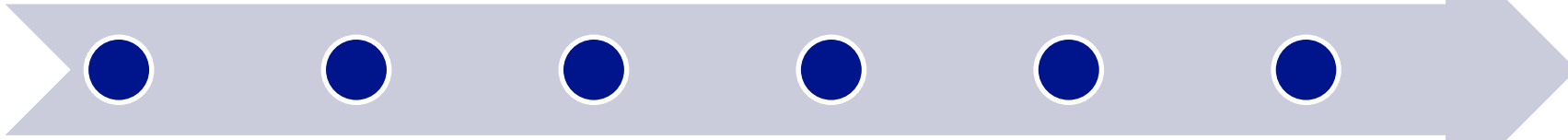
1950



1980



2010

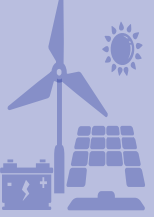


1965

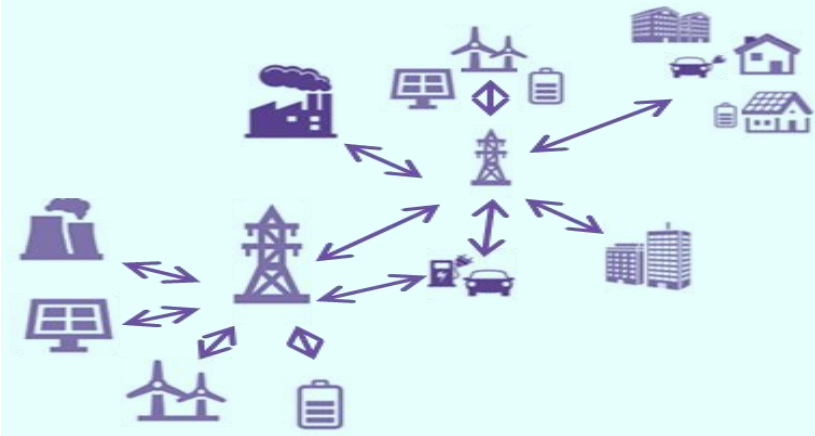


1995





Driving change in resilience needs



Changing complexity and interdependency in networks

Today's networks depend heavily on each other - electricity & communications are a common dependency for most. This places them at the heart of the resilience debate

Changing technology and networks

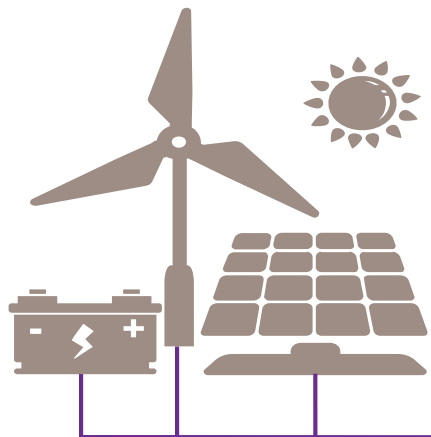
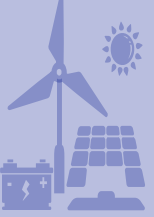
Today's society and businesses rely on availability of electricity for communication/broadband, lighting heating/cooling, cooking and power for integrated technology

Increased importance of metropolitan centres

Today's society and business are gravitating towards large metropolitan centres

These centres often contain the new high-tech, service, financial and retail industries that drive the economy

Will society and business expect and need a more resilient future?



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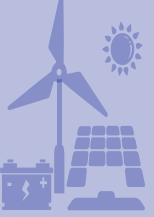


Energy Research Partnership (ERP) – Resilience Working Group

The 'Energy Research Partnership' was formed across Government, industry and academia, to provide high-level leadership for, and to enhance the coherence of, energy research and innovation activities in the UK, set within an international context.

- National Grid has been part of the ERP and wider industry group looking at future electricity resilience
- A report forming the views across Government, industry and academia is due to be released imminently
- Adding extra emphasis and gravitas to the importance of electricity resilience within the UK





Resilience and the changing world



How do you think the resilience of the electricity transmission system could impact the operations of your business and/or personal life?



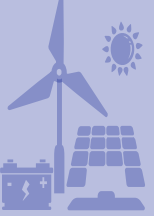
What are the threats that we should be resilient against in the future?



Which of these are the most important/where should we focus future investment?



How do you see the influence of electricity changing in the next 20 years?



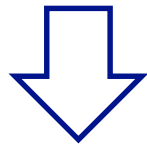
Resilience and the changing world



Relative to today, what do you think the future need for a resilient electricity network will be?

Significantly less need for a resilient electricity network

Today



Significantly greater need for a resilient electricity network

-5	-4	-3	-2	-1	0	1	2	3	4	5



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Physical security

Lee Warren

Asset Policy Engineer

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NGET and Critical National Infrastructure (CNI)

- We regularly liaise with the Government to identify both Electricity and Gas Transmission sites that require designation as CNI
- The Government sets out the criteria for deciding which sites should be hardened
- Working with us, the Government then decides which sites should be enhanced in terms of physical security
- At these sites, the Government then agrees with us what measures are required to 'harden' their physical security, broadly using a '**defence-in-depth**' strategy
- We have established the Physical Security Upgrade Programme (PSUP) to deliver these works and request funding from OFGEM



Department for
Business, Energy
& Industrial Strategy

CPNI®

Centre for the Protection
of National Infrastructure

ofgem

Physical security: our current approach

We have invested significant capital and operational expenditure during the RIIO-T1 period (circa **£350m**) to ensure physical security resilience is provided at key Electricity Transmission sites across England and Wales.

Our investment during RIIO-T1 has ensured our physical security resilience is at a suitable level to defend against and respond to credible physical threats.

We have already identified the physical security requirements for RIIO-T2 based on our current approach and the forecast costs are around **£90m**

This equates to **around 6p per year** on the average annual household electricity bill

Discussion questions

- What are your views on whether our current approach goes far enough?
- What other aspects do we need to be considering in our approach?

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Cyber security

Jason Bewley

Technology Application Engineer

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There is a growing cyber threat: this has happened

“The cyber operation was highly synchronized and the adversary was willing to maliciously operate a SCADA system to cause **power outages**, followed by **destructive attacks** to disable SCADA and communications to the field. The destructive element is the first time the world has seen this type of attack against OT systems in a **nation’s critical infrastructure.**”

E-ISAC | Analysis of the Cyber Attack on the Ukrainian Power Grid | March 18, 2016

We need to be ahead of the threat

The cyber security industry has to keep pace with a constantly evolving threat, and the security of our **operational technologies** needs to be ahead.

- 20 year asset lifecycle for control of the transmission system
- Security threats change much more rapidly
- We are responding to the changing threats by investing in RIIIO-T1
- Government has responded with strategy and legislation



The Network and Information Systems Regulations 2018

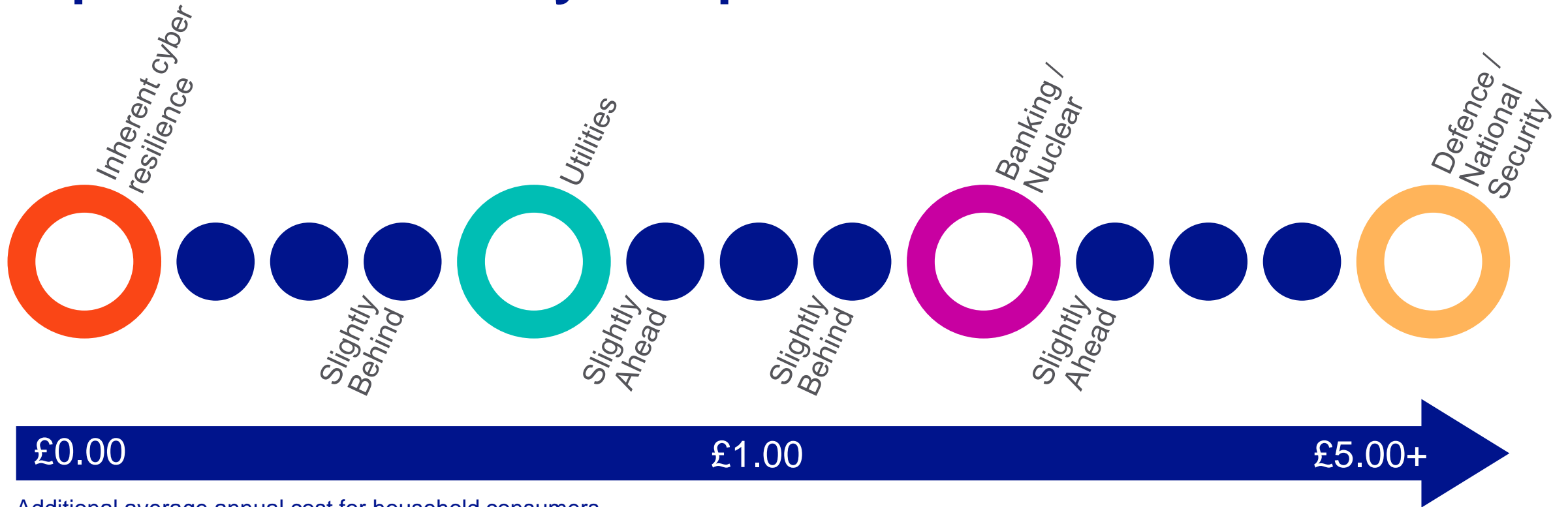
Introduced in May 2018 to improve the security of network and information systems (NIS) across the UK, with a particular focus on essential services

Top level objectives:

- A: Managing security risk
- B: Protecting against cyber attack
- C: Detecting cyber security events
- D: Minimising the impact of cyber security incidents



Options for RII0-2 cyber specific investment



Additional average annual cost for household consumers

- Where do you think National Grid's ambitions should lie in comparison with other industries?
- What role should National Grid Electricity Transmission play in supporting industry/other sectors' cyber security plans?

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Extreme weather resilience

Doug Dodds
Environmental Engineering

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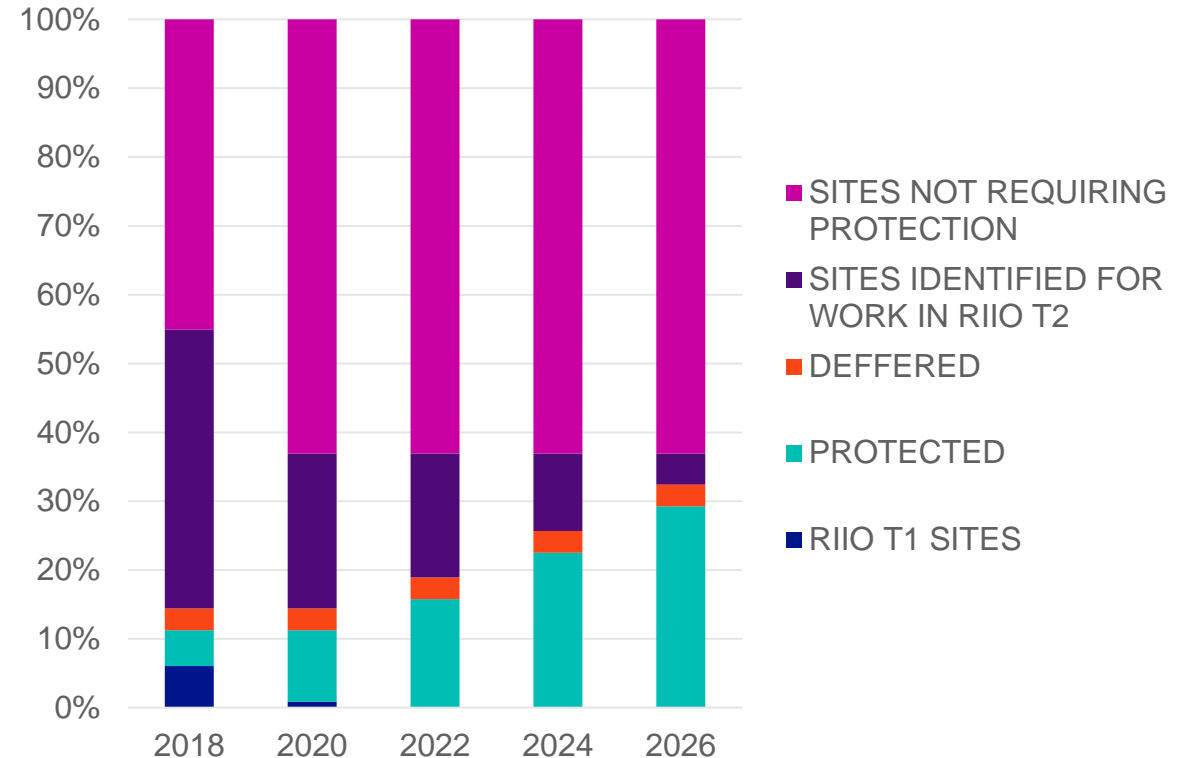


Flooding and associated resilience: then and now

Coordinated industry response with our energy partners

- 1 in 1000 target recognised by the National Flood Resilience Review (NFRR 2016) as demonstrating best practice
- 32 sites of 50 either protected or works in progress on site (RIIO-T1 spend £120m)
- We plan to invest a further £50m to protect a further 100+ sites from surface water risks in RIIO T2
- This equates to around 3p per year on the average annual household electricity bill

Site Flood Risk Reduction

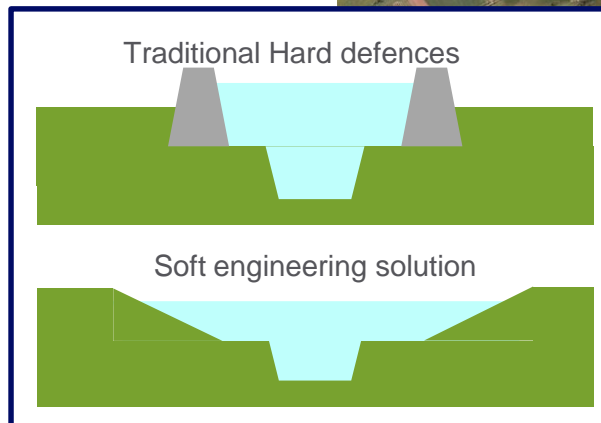


Flooding and associated hazards: next steps

The current updated version of ETR138 tasks the energy industry to ensure resilience of supply of critical local infrastructure to 1 in 1000 levels from all sources of flooding to all sites which supply 10,000 customers

- Greater scope for utilising soft and green solutions protecting sites from surface water risks
- We will coordinate resilience works with routine cable maintenance outages delivering incremental resilience
- All our sites and assets have been assessed against flooding risks and likely linked or amplified geo-hazards, we plan to include this into our routine inspections and assessments

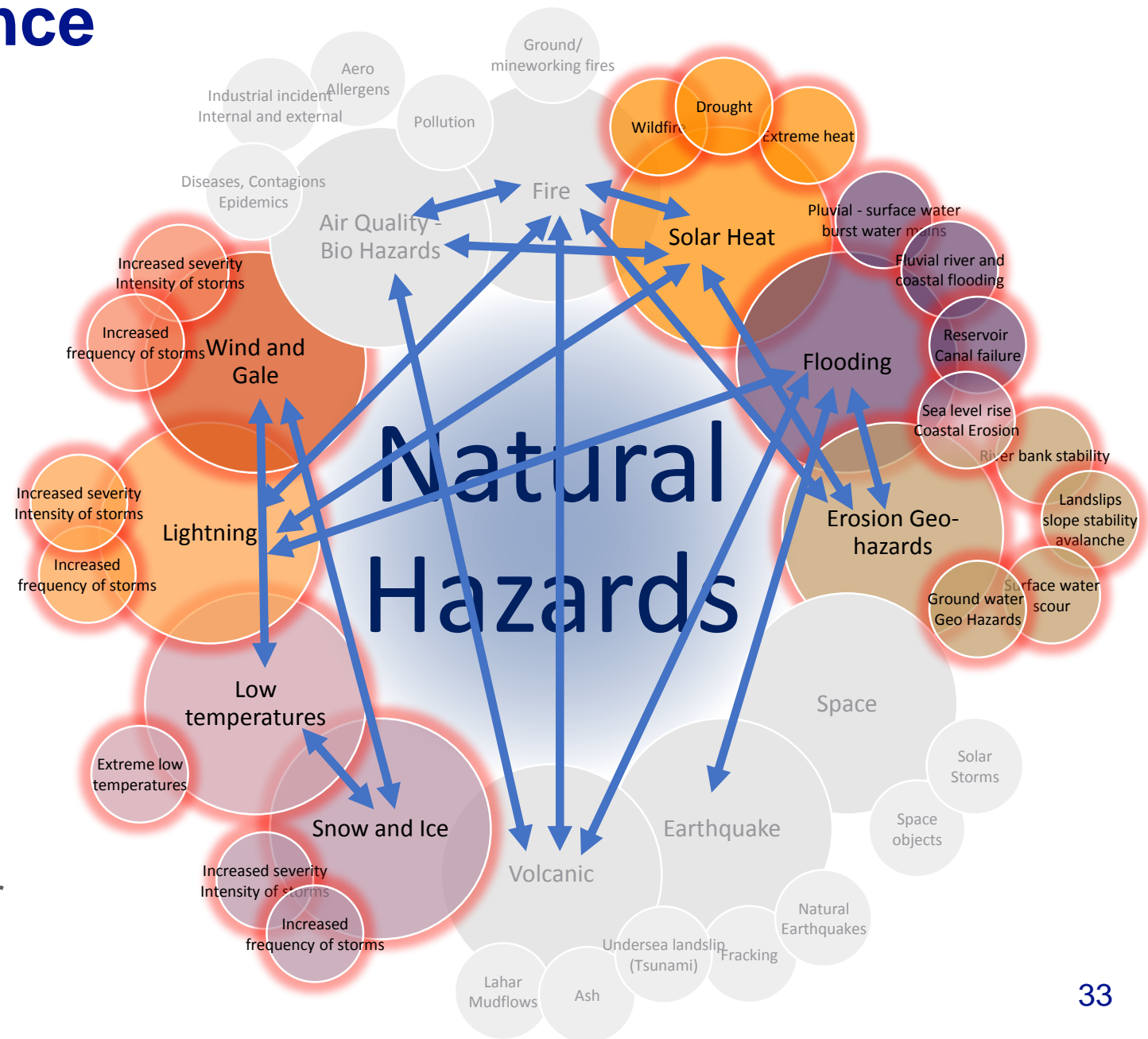
- A further £8m for scheme development, assessments and research into erosion and other flood related Natural Hazards risks to our assets (around 1p per year on the average annual household electricity bill)



Extreme weather resilience

Weather related natural hazards associated and amplified risks

- Flooding gets all the press but it's not the only risk we deal with
- Majority of risks are controlled through national and international design standards
- Climate change presents future challenges where design standards may need to change
- Approximately £3.2m in developing and managing climate change/natural hazard risks (less than 1p per year per household)



Discussion questions

- **Is this the right approach, or should we be considering a different one?**
- **What areas have we missed?**
- **What hazards or combined hazards could we coordinate with you on to find solutions?**

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Black start: our role

Richard Earp
Site Management Policy Assurance Manager

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What and why

‘Black Start’ is the condition where the electricity system has shut down

Our network is de-energised, and there is therefore no ‘mains’ electricity to end consumers

Black start could be nationwide (all of GB), or regional following a ‘system split’

What and why

What could cause it?

- Random coincident faults, beyond normal security standards
- Weather-related damage (or sabotage) to *multiple* sites/circuits
- ‘Normal’ faults coincident with other operational failures, e.g. failure to manage transmission constraints
- Sudden large scale generation losses beyond the scope of low frequency protection arrangements
- Complete and prolonged loss of (all) control centres and/or (all) their IT systems

All these are low probability events, requiring failure of multiple redundant and/or backup systems

Can it *really* happen?

BBC NEWS LIVE LIV BBC NEWS CHANNEL

Last Updated: Sunday, 28 September, 2003, 10:22 GMT 11:22 UK
E-mail this to a friend Printable version

Huge blackout cripples Italy

Italy has been hit by a massive power cut - and many parts remain without electricity hours after the



The New York Times Late Edition
NEW YORK, FRIDAY, AUGUST 15, 2003 ONE DOLLAR

POWER SURGE BLACKS OUT NORTHEAST, HITTING CITIES IN CANADA AND 8 STATES; MIDDAY SHUTDOWNS DISRUPT MILLIONS

OVERLOADED GRID

Buildings Are Evacuated and Hospitals Fill — Bush Plans Review


JAMES BARROD
A surge of electricity to western New York and Canada touched off a series of power failures and forced blackouts yesterday that left parts of at least eight states in the Northeast and the Midwest without electricity. The widespread failures provoked the evacuation of office buildings, stranded thousands of commuters and flooded some hospitals with people suffering in the stifling heat. In an incident that one utility official called "a blink-of-the-eye second" shortly after 4 p.m., the grid that distributes electricity in the eastern United States became overloaded. That tripped circuit breakers and other protective devices at one

BBC NEWS Find local news

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South Australia storms leave state without power

28 September 2018 Australia



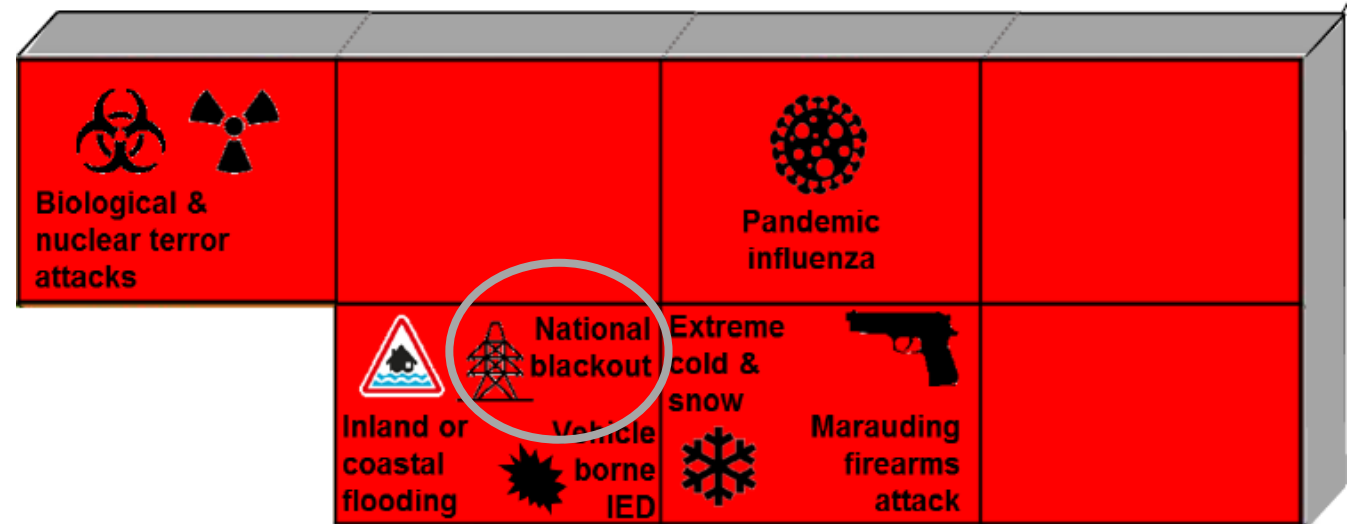
Historically, there is one black start event in a developed country somewhere in the world every two years. **However, the probability of black start in Great Britain is very small.**

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Consequences: Government's perspective

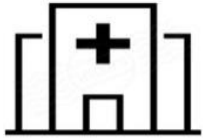
BEIS have shared this with Civil Contingencies authorities:

- A **national power outage** would be caused by the total failure of the National Electricity Transmission System
- This risk is one of the highest rated risks in the National Risk Register – societal and economic impacts to GB would be significant



Their concern stems more from the *consequences* for society than any judgement of likelihood of occurrence

Impacts: a Government view



Influx of patients and vulnerable people from the community to hospitals

Only critical care provided. All elective activity postponed

Hospital, blood, transplant, medicine, and device supply chains disrupted



Failure of rail and airport networks

Many commuters, unable to return home, require shelter

Lighting and signal failures cause difficult road conditions.

Petrol forecourts close - Fuel supply & distribution network disrupted



Core fixed telecoms network expected to be resilient for up to 5 days

Minimal continuity of digital & mobile phone services & broadband networks.

Normal TV and radio broadcasts disrupted.



Loss of domestic lighting, heating, and cooking ability

Failure of mains water supply. Sewerage network disrupted

Inability of public to communicate / receive information

Food spoils as fridges and freezers defrost



Severe staff absence due to transport disruption and schools closure

Electronic payment systems and financial services disrupted.

Staff unable to work in office buildings due to health and safety concerns



Potential public disorder as supplies run low, increasing demand on police

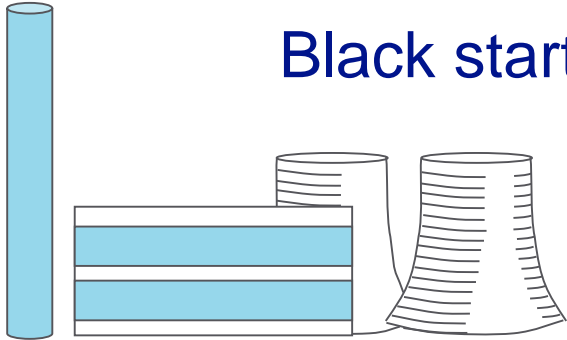
CJS (prisons, courts, probation) faces severe disruption

People trapped in buildings and underground require rescue

Airwave system is resilient to a loss of telecoms, - batteries need recharging.

System restoration: overview

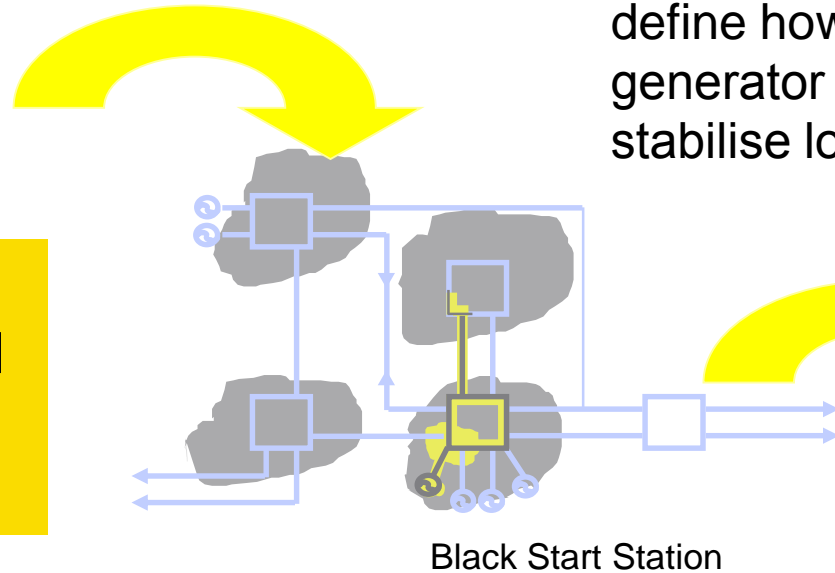
Black start power stations



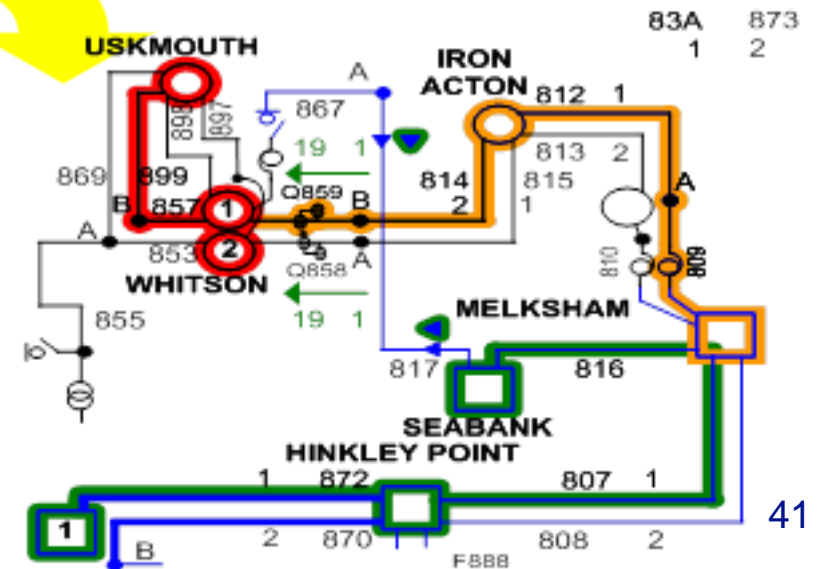
Local Joint Restoration Plans (LJRPs)

define how we and DNOs will connect a generator to the first 'block loads', and stabilise local 'power islands'

Restoration strategy developed, instructed and controlled by NGENSO



LJRP Power islands interconnected to form skeleton network. Significant switching required.



NGET TO's role

Do our 'day job' well:

- Renew and maintain primary assets to a high standard so that failures are rare, and recovery switching 'just works, first time'

Ensure sites are resilient

- Substations have backup batteries and generators, most of which are automated. These must work.
- In-house telecommunications networks *must* be reliable during black start recovery
- Have staff on hand to deal with problems

Implement the System Operator's switching plans

- Resilient control centre
- Competent, well-trained staff

During the next Price Control period

Maintain standards

- Continue to invest and maintain good assets and good people

Support Government and industry improvement

- General desire for shorter restoration times, ever more reliable assets, which may have (modest) impacts on investment plans
- Black start generation sources will change. No fundamental change to our role, but the detail will differ. Policies, procedures and training will need to adapt.

Discussion questions

- **How self-sufficient should National Grid be to recover from a black start scenario?**
- **What are your views on the appropriateness of our plans to remove barriers to restoration?**

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Exercise: society and business expectations

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Society and business expectations

Under exceptional circumstances, which result in the loss of power over a wide geographical area or nationally, how long do you think society and business could expect to be without power for different types of location?

- What do you think the current expectations are?
- What do you think the expectations will be in the future?

Consider the impact on other social aspects such as roads, rail, public transport, water, heating, etc

- Heavy industry
- Cities
- Towns
- Villages
- Rural communities



Electricity
Transmission

Juliet Mian
Arup

nationalgrid



National Grid | Electricity Transmission Resilience Workshop

Transferring learning between sectors

The City Resilience Framework and the City Water Resilience Framework

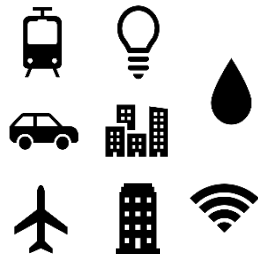
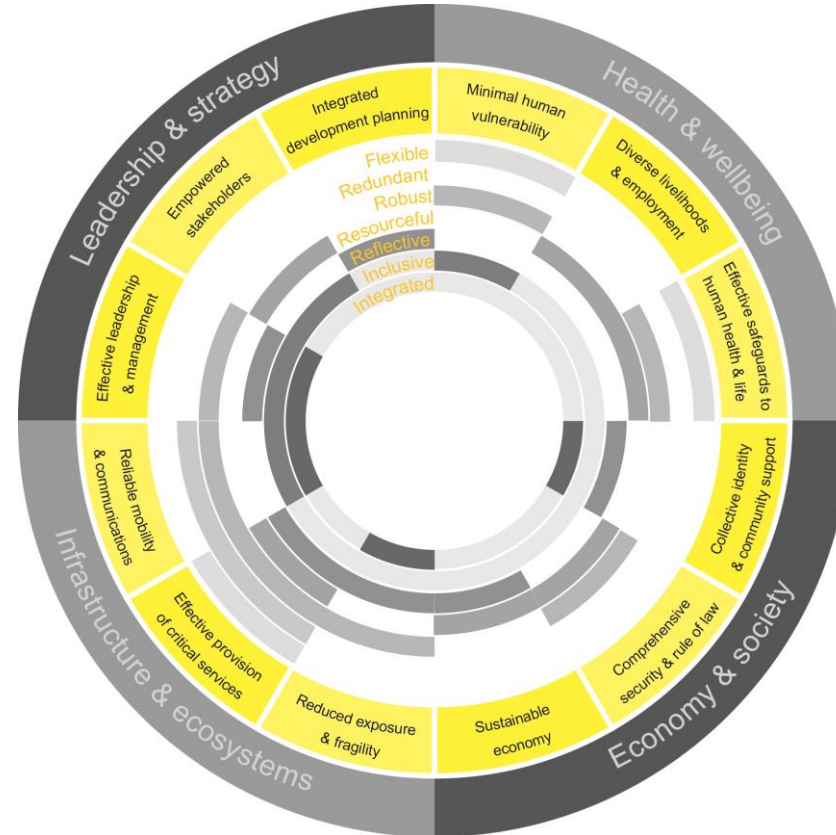
Dr Juliet Mian

Infrastructure resilience | Arup

October 2018

City Resilience Framework

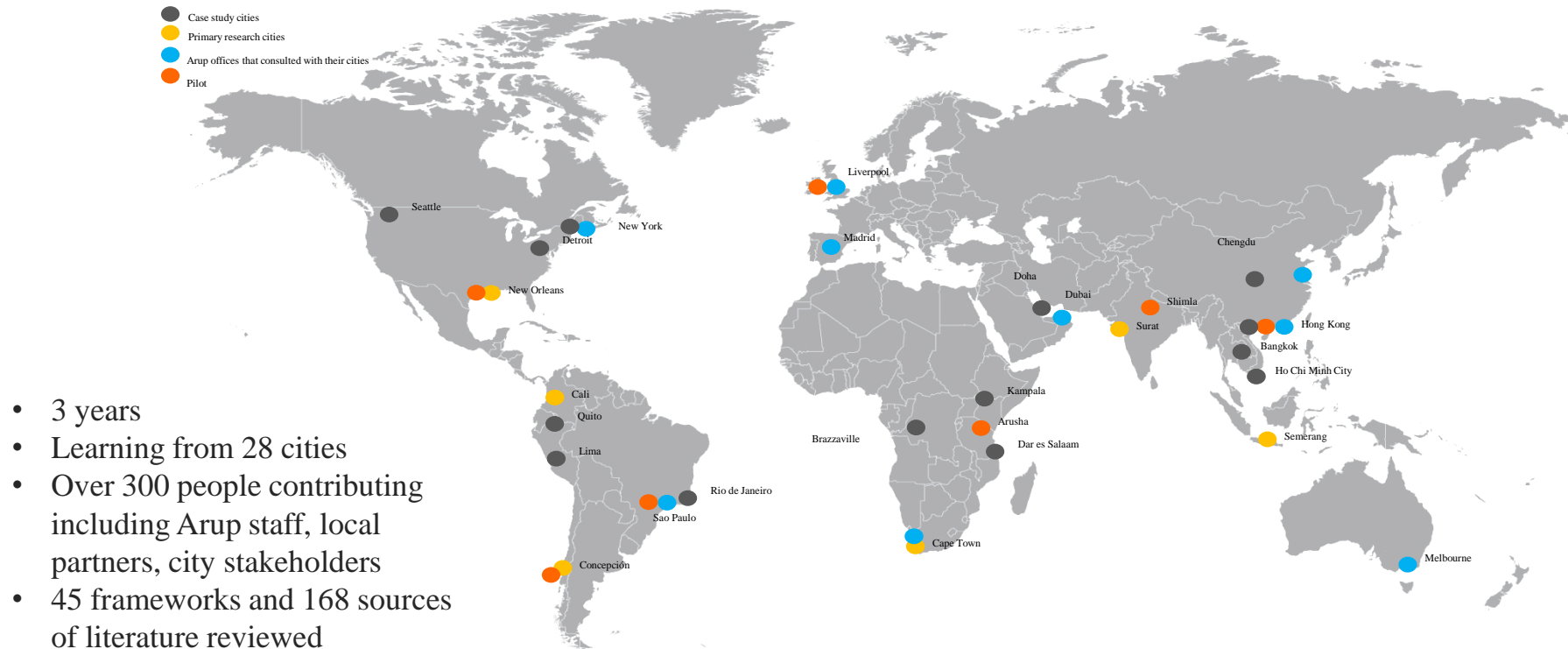
4 Dimensions
12 Goals
7 Qualities
52 Indicators
What matters?



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Research



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Health & Well Being



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1. Minimal human vulnerability



2. Diverse livelihoods and employment



3. Effective safeguards to human life and health



Economy & Society



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4. Collective identity and mutual support



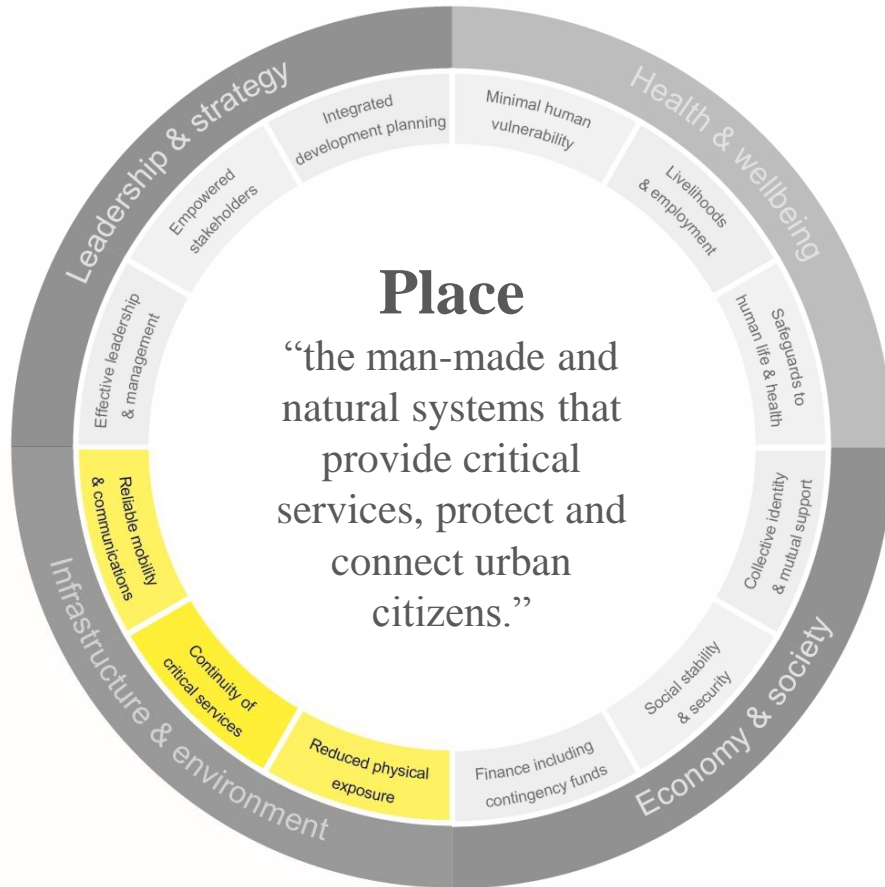
5. Comprehensive security and rule of law



6. Sustainable economy



Infrastructure & Environment



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7. Reduced physical exposure



8. Continuity of critical services



9. Reliable communications and transport



Leadership & Strategy



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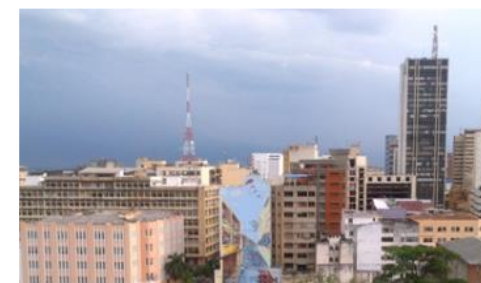
10. Effective leadership and management



11. Empowered stakeholders



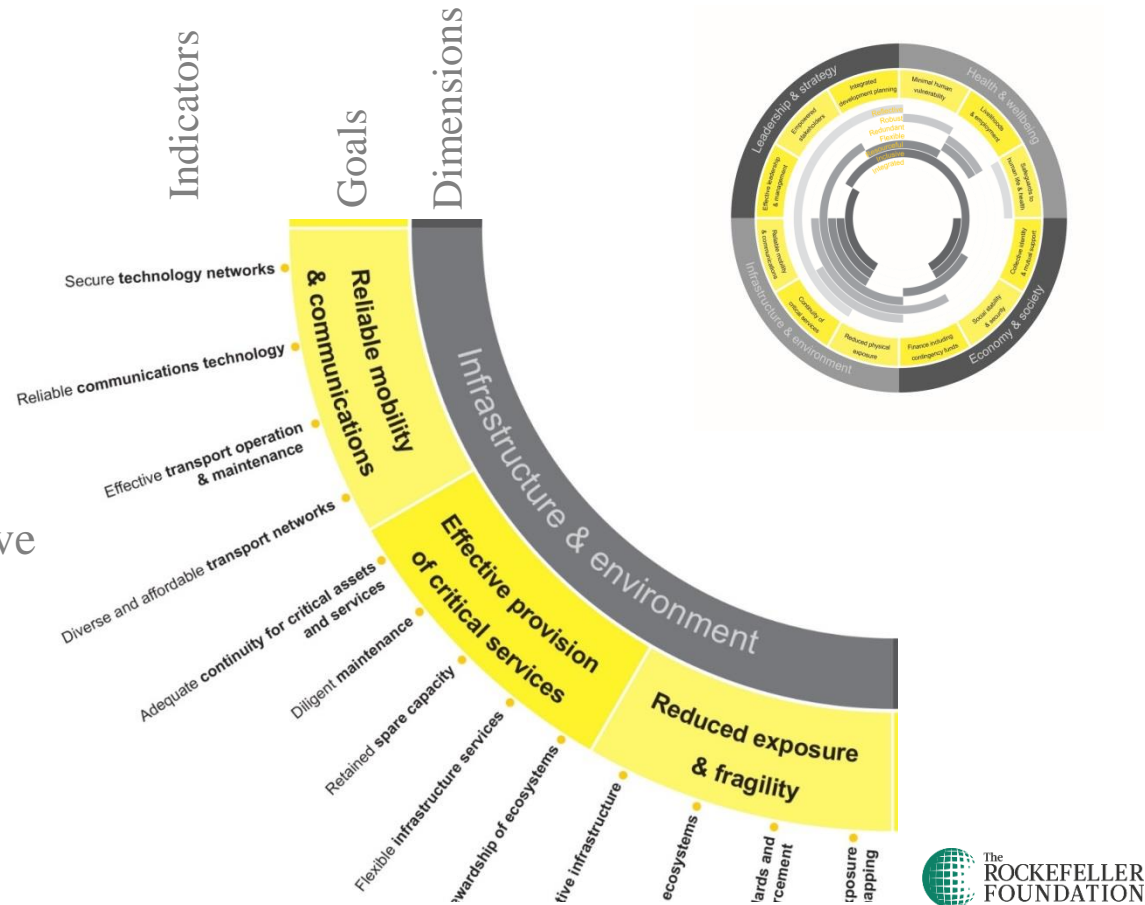
12. Integrated development planning



52 Indicators What to observe

E.g.

- *Safe and affordable housing.*
- *Secure technology networks*
- *Well managed protective ecosystems*



© Arup 2015



156 Variables What to measure

8.1 Diverse and affordable transport networks

Diverse road network with adequate route planning and navigation

Diverse public transport system that is affordable for all

Informal/personal travel options (car sharing, walking paths, cycle routes and associated infrastructure)

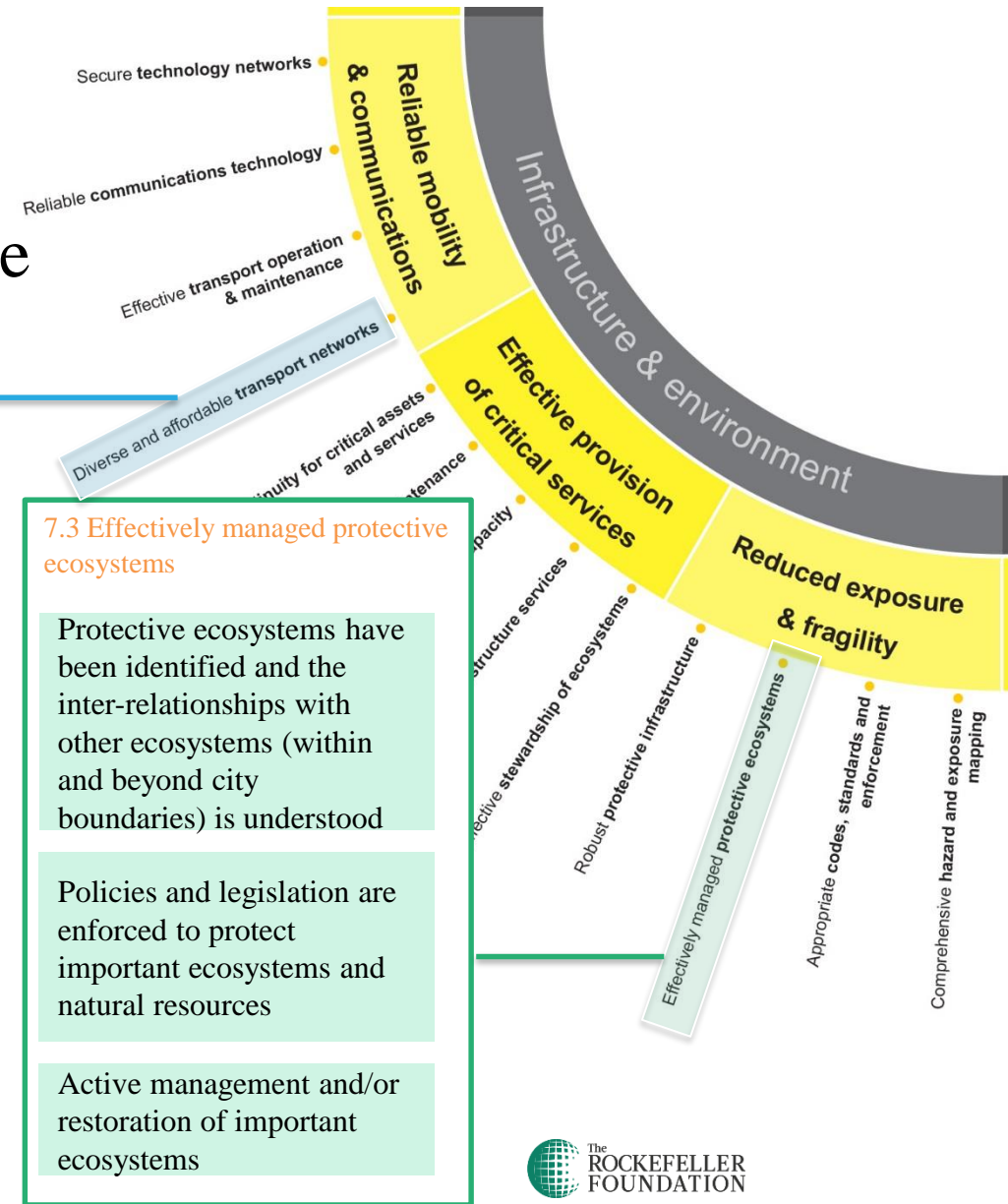
Diverse and effective transport links to other cities/regions

7.3 Effectively managed protective ecosystems

Protective ecosystems have been identified and the inter-relationships with other ecosystems (within and beyond city boundaries) is understood

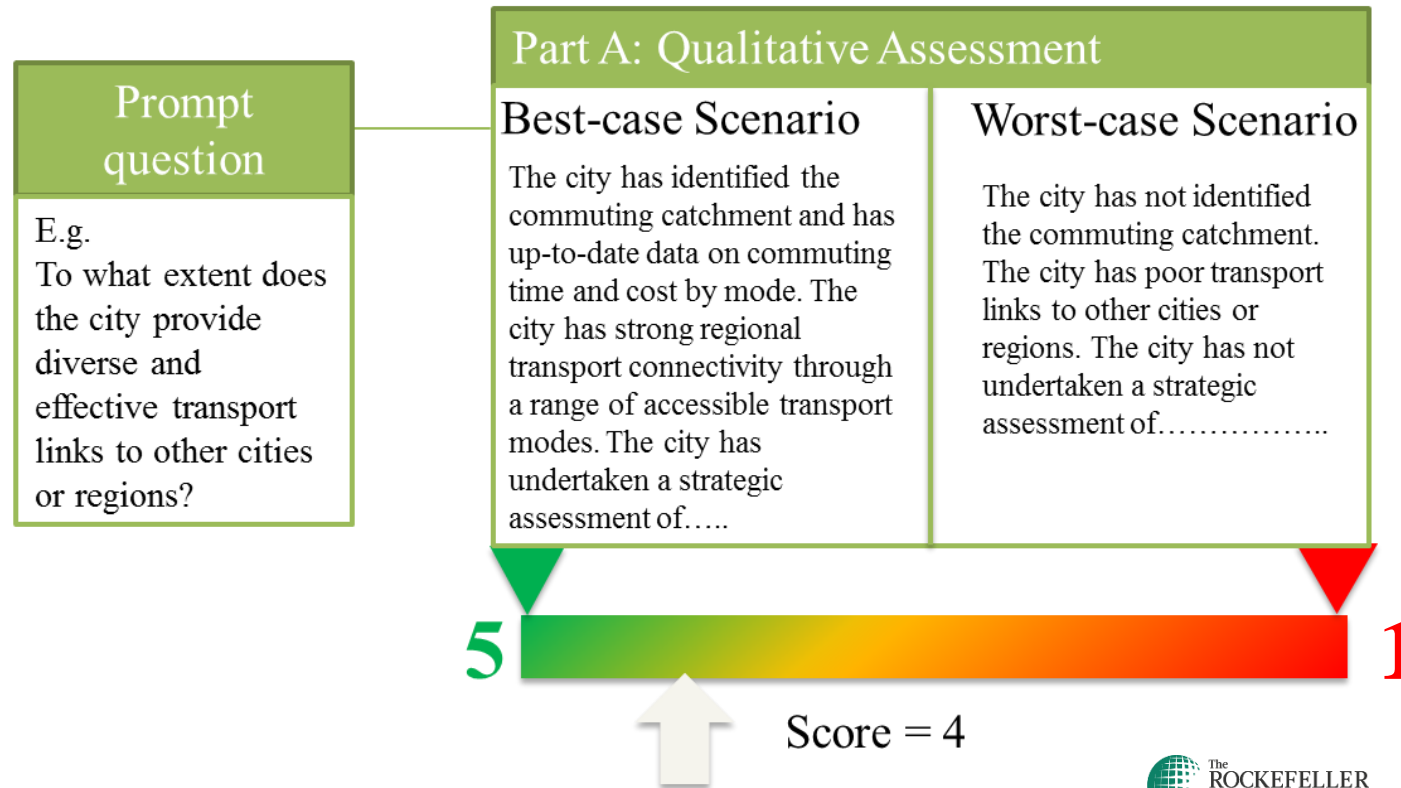
Policies and legislation are enforced to protect important ecosystems and natural resources

Active management and/or restoration of important ecosystems



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Qualitative Scenarios assess the adequacies of the mechanisms in place



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Visual Outputs



Qualitative



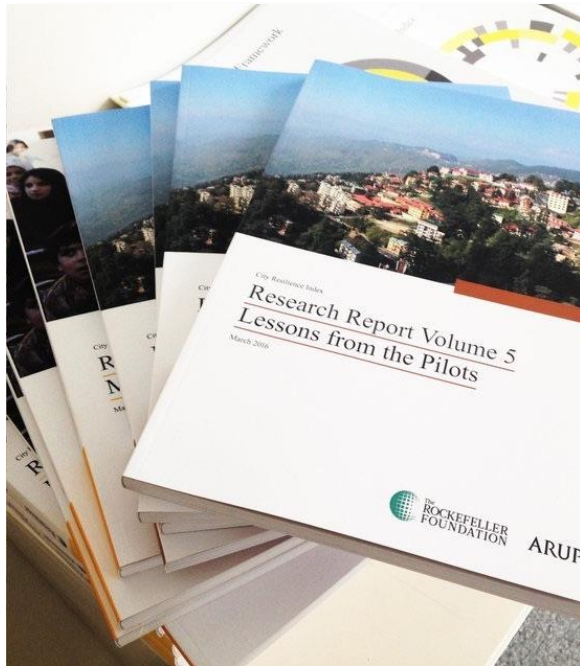
Quantitative



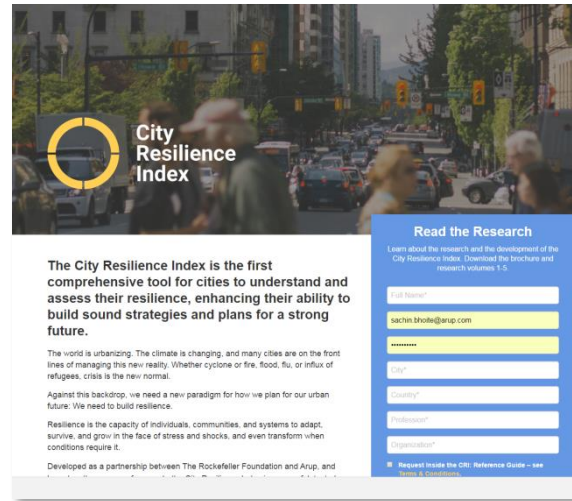
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Dissemination of Research



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- Knowledge Products
- On Line Platform
- Database
- Training materials
- Pool of experts

For further information:

www.cityresilienceindex.org





Can Tho, Vietnam

Dallas, USA

Mexico City, Mexico

Amman, Jordan

Cape Town, South Africa

Miami, USA

Hull, England

Greater Manchester, England

Rio de Janeiro, Brazil

Ramallah, Palestine

Surat, India

Santa Fe, Argentina

Thessaloniki, Greece

Urban Water Resilience

“the capacity of the urban water system - including the human, social, political, economic, physical and natural assets - to anticipate, absorb, adapt, respond to, and learn from shocks and stresses, in order to protect public health, wellbeing, the natural environment and minimise economic disruption.”

(CWRF, Jan 2018)



City Water Resilience Framework

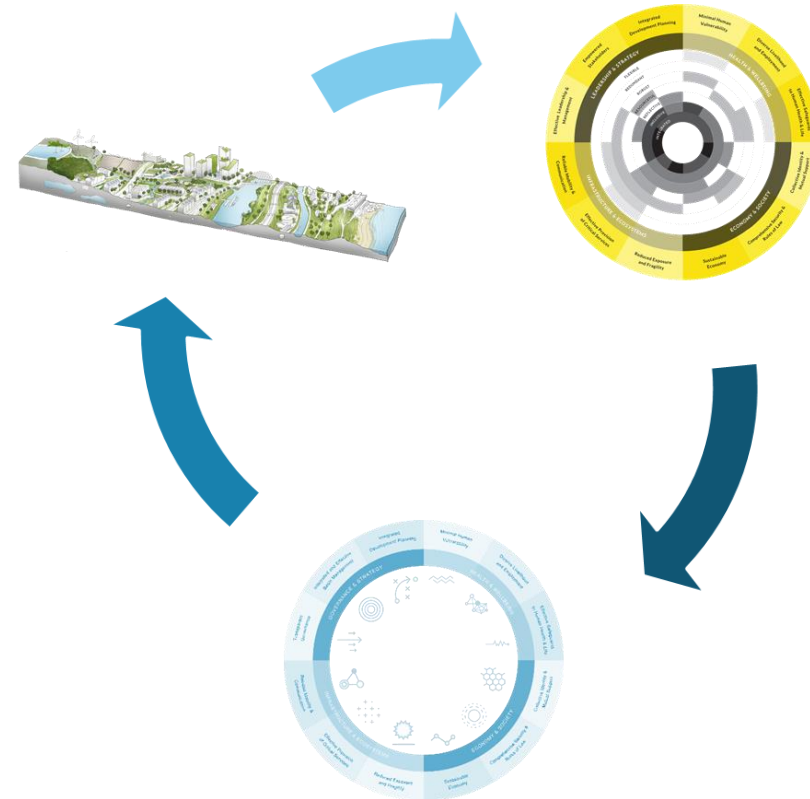
Our principles

Urban resilience cannot be achieved without urban water resilience.

Urban water resilience cannot be achieved without a catchment-scale resilience.

A catchment-scale resilience cannot be achieved without urban resilience.

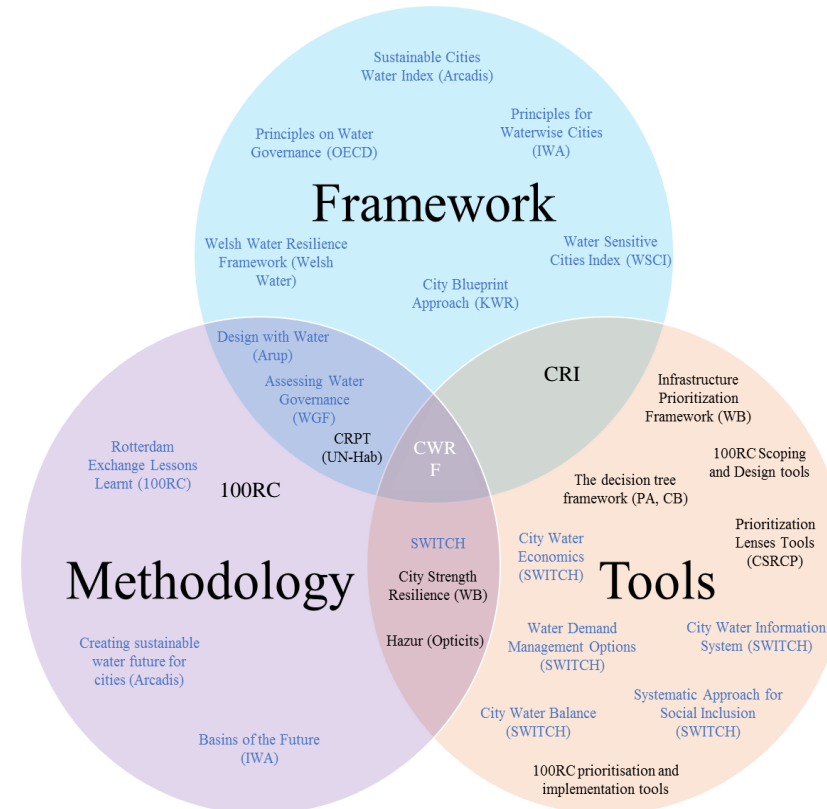
Understanding who is responsible for elements across the water cycle & across the catchment is fundamental.



Key findings from the Research

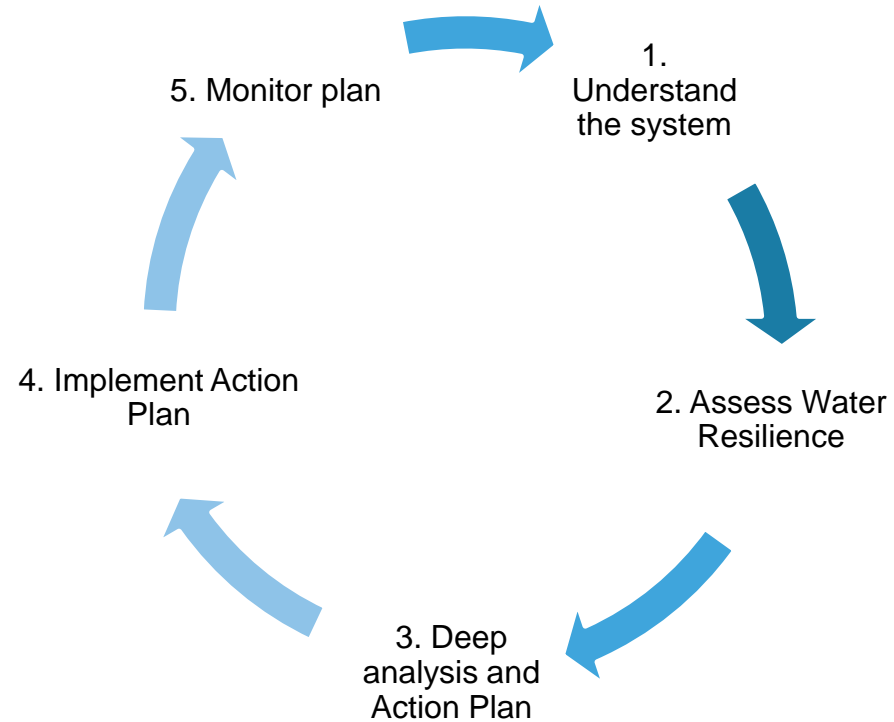
September 2017 – Jan 2018

- Many frameworks, methodologies and tools but little that supports the user through the entire decision making process.
- Poor understanding of interdependencies between critical infrastructure systems.
- Little data on how shocks and stresses play out at city scale, top down vs bottom up.

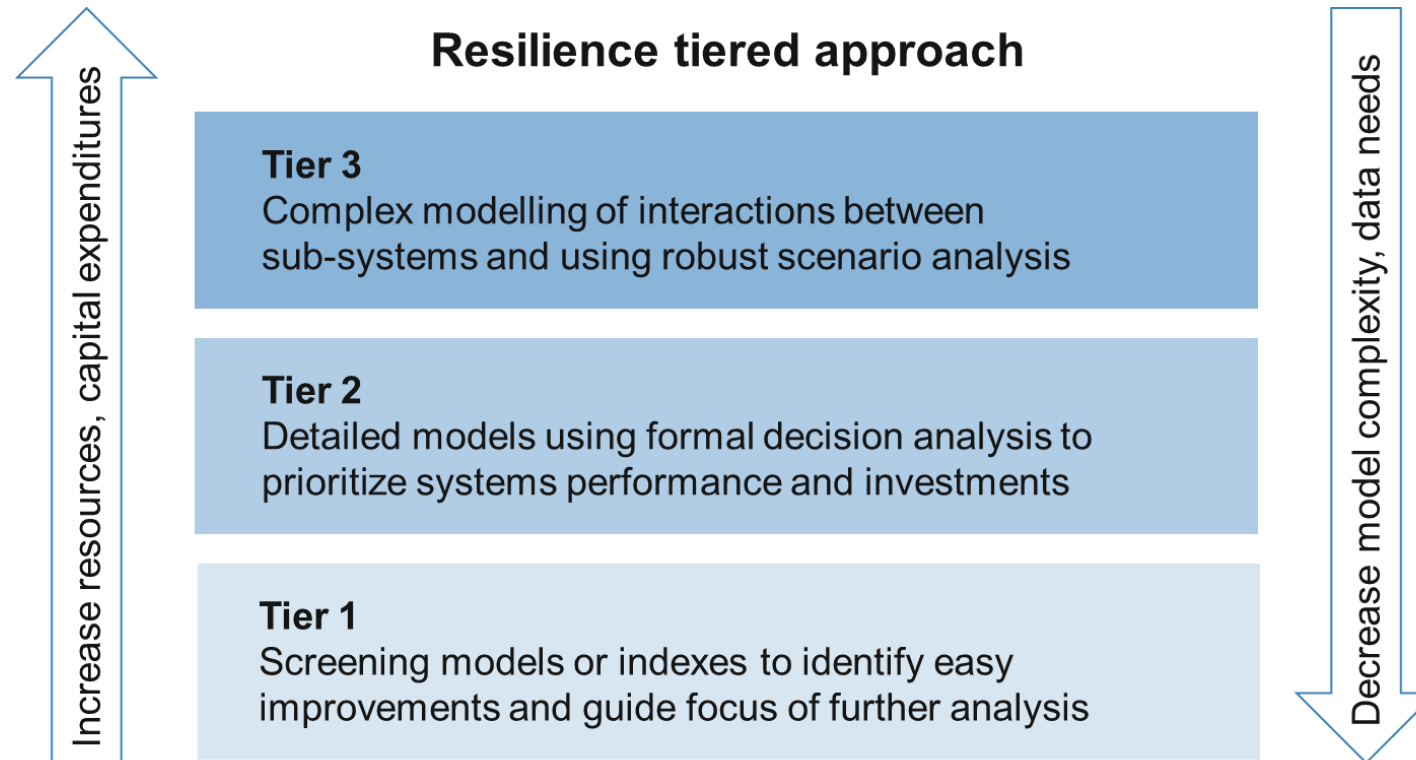


City Water Resilience Framework

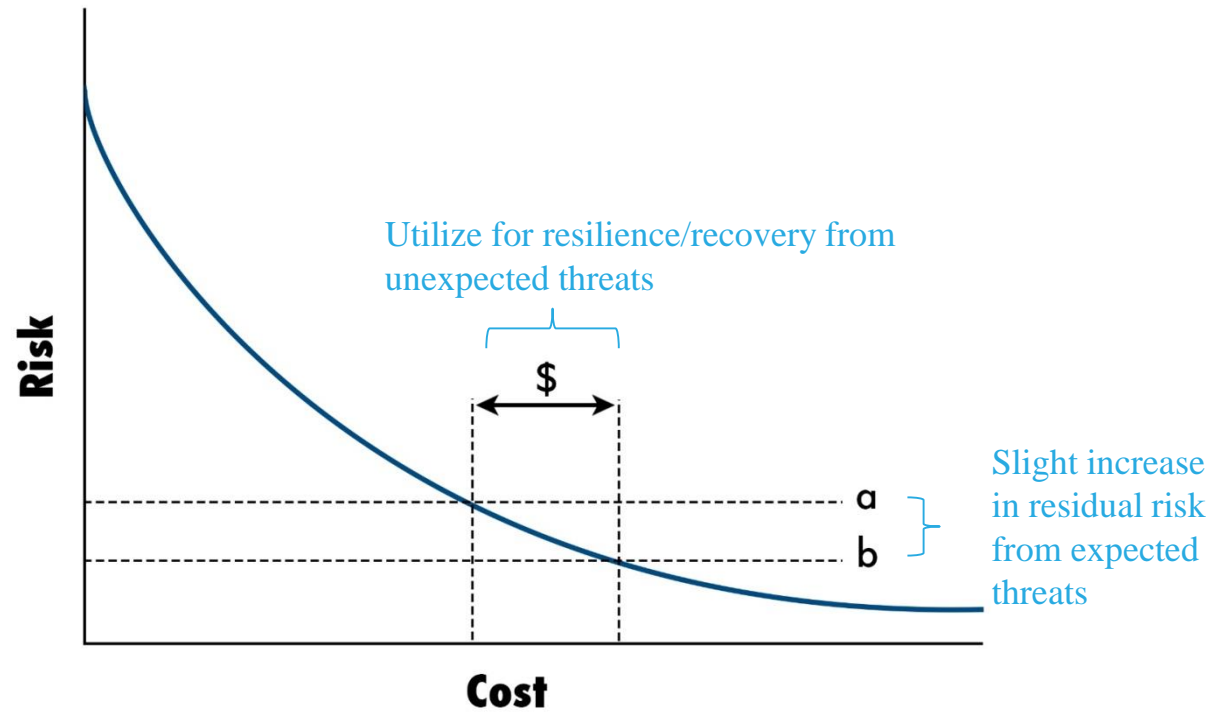
A decision support framework



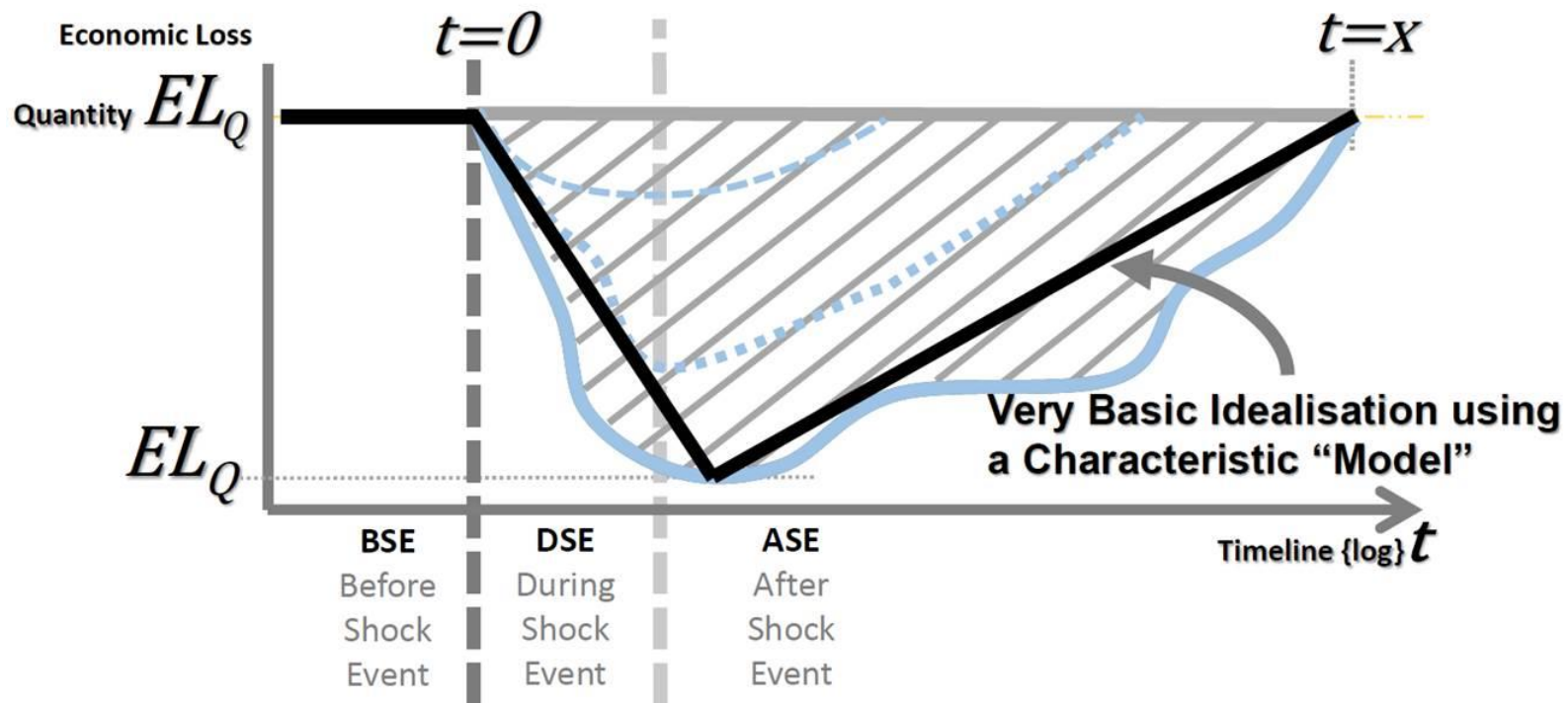
A tiered approach for tools and models



Thanks to Igor Linkov



Buying down risk - thanks to Igor Linkov



Thanks to Dr Paul Smith, Arup

Thank you

juliet.mian@arup.com

CRI: sachin.bhoite@arup.com

CWRF: martin.shouler@arup.com

www.resilienceshift.org

≡ THE RESILIENCE SHIFT

Electricity
Transmission

Resilience measures

Ursula Bryan

nationalgrid

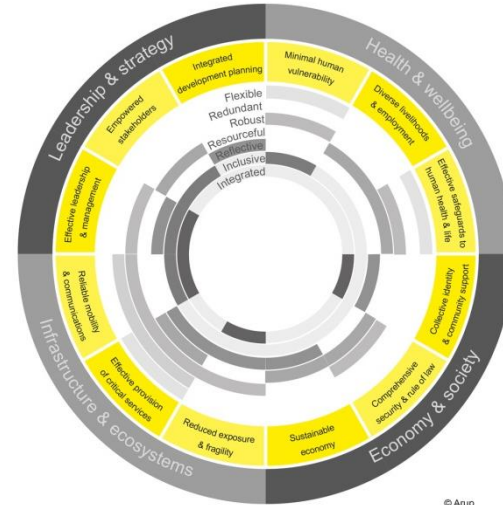


Resilience measures

Cyber security



City Resilience Index*



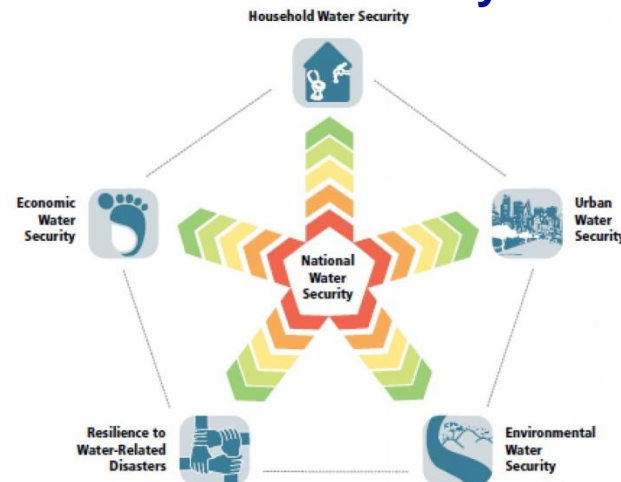
Black start



Flood protection



National Water Security Index**



Physical security



*Source: Arup (2017) *City Resilience Index* <https://www.arup.com/perspectives/city-resilience-index>

**Source: ADB (2013) *Asian Water Development Outlook* <https://www.adb.org/sites/default/files/publication/189411/awdo-2016.pdf>

What happens next

Our commitment

- We'll process everything you've told us today
- We'll summarise today's event and send it to you
- We'll use your comments to plan our future engagement activities
- We will present your comments to our stakeholder group
- We'll keep you informed

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