

# ENSURING ENERGY SYSTEM RESILIENCE DURING THE NET-ZERO TRANSITION

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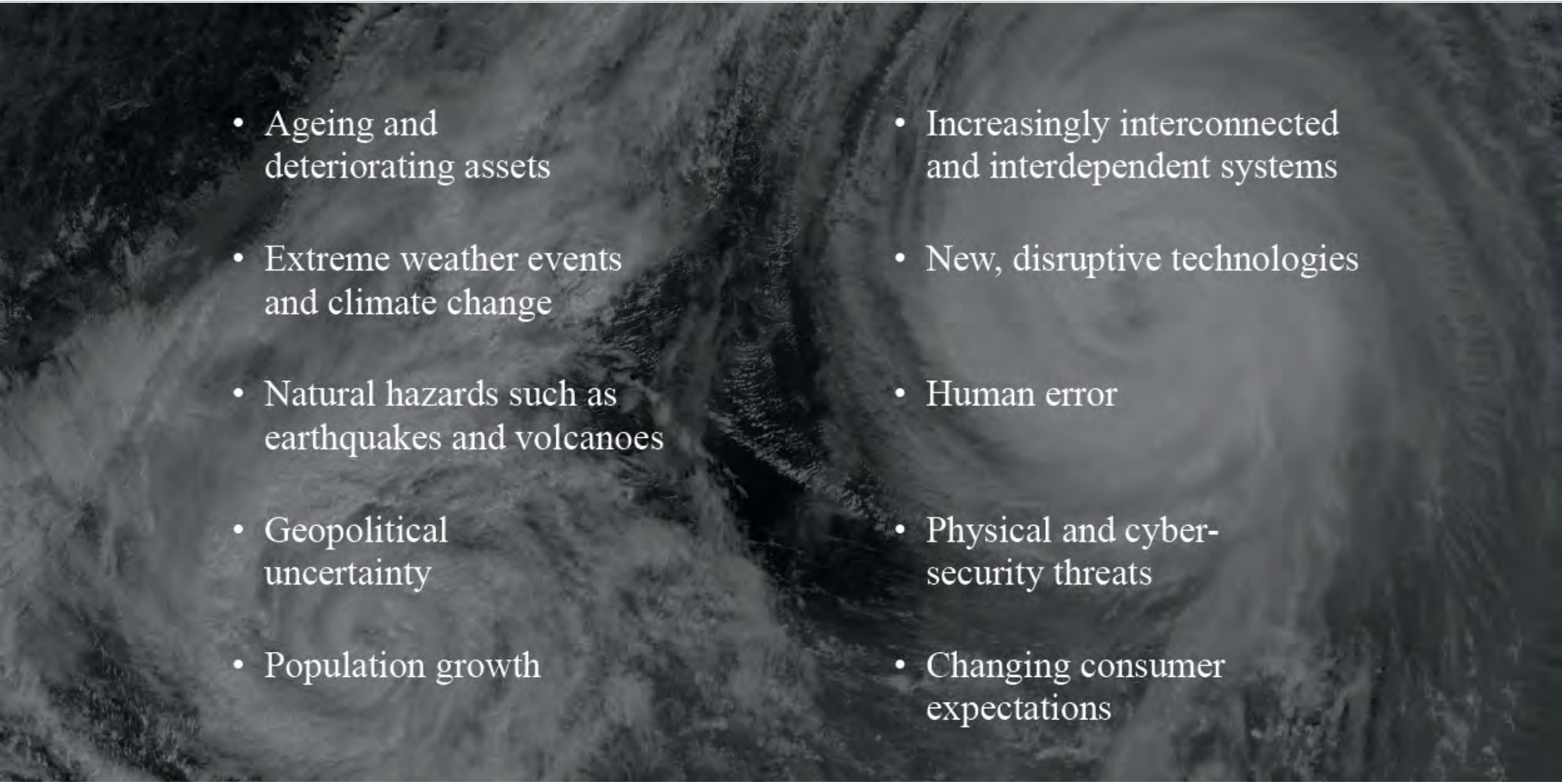


# Tackling the Energy Sector's major Resilience Challenges...

**The energy sector is facing a time of unprecedented change as it faces the challenges of decarbonisation, electrification, climate change and new technologies.**

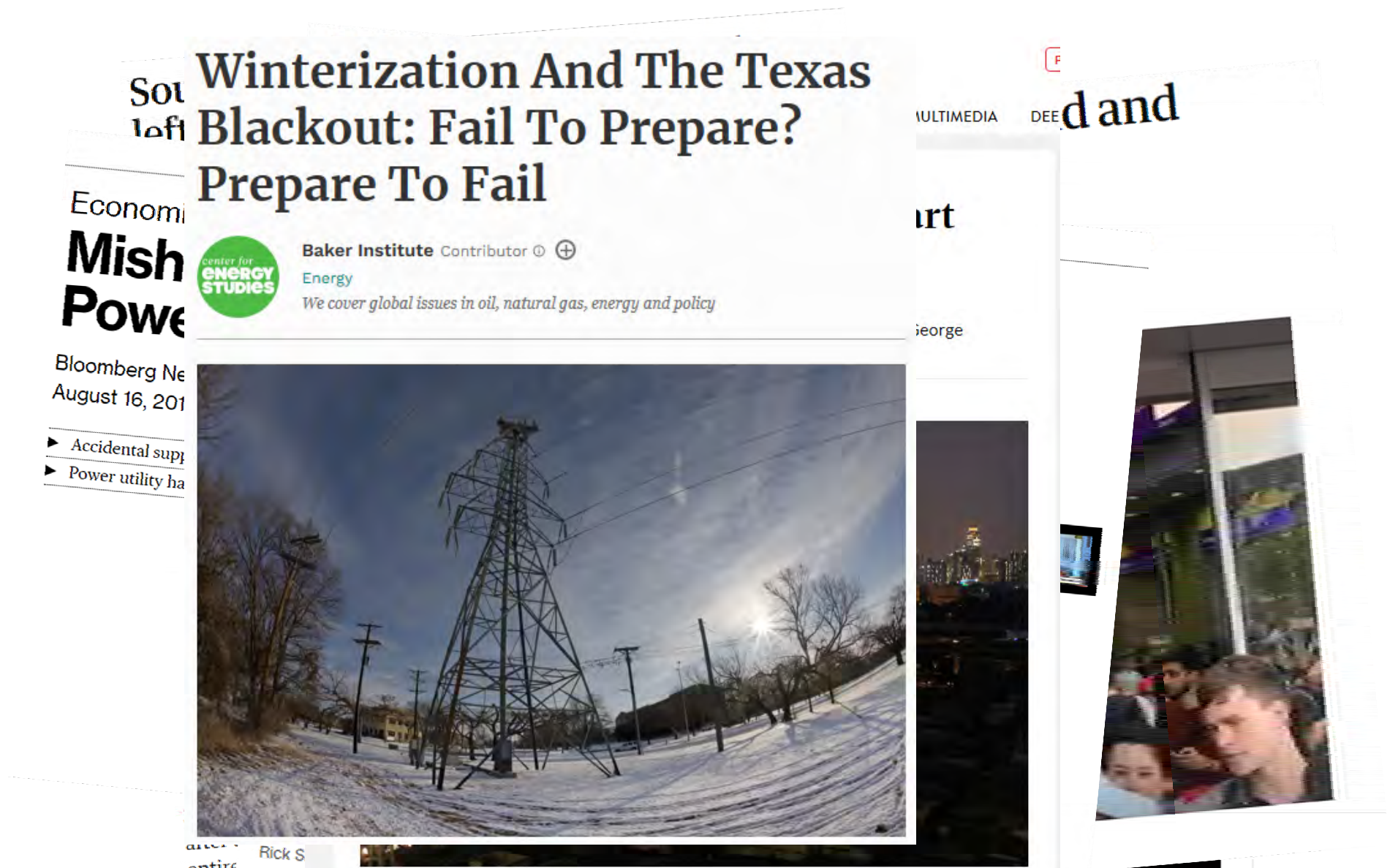
# WE ARE LIVING IN AN INCREASINGLY VUCA ENVIRONMENT

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- 
- Ageing and deteriorating assets
  - Extreme weather events and climate change
  - Natural hazards such as earthquakes and volcanoes
  - Geopolitical uncertainty
  - Population growth
  - Increasingly interconnected and interdependent systems
  - New, disruptive technologies
  - Human error
  - Physical and cyber-security threats
  - Changing consumer expectations

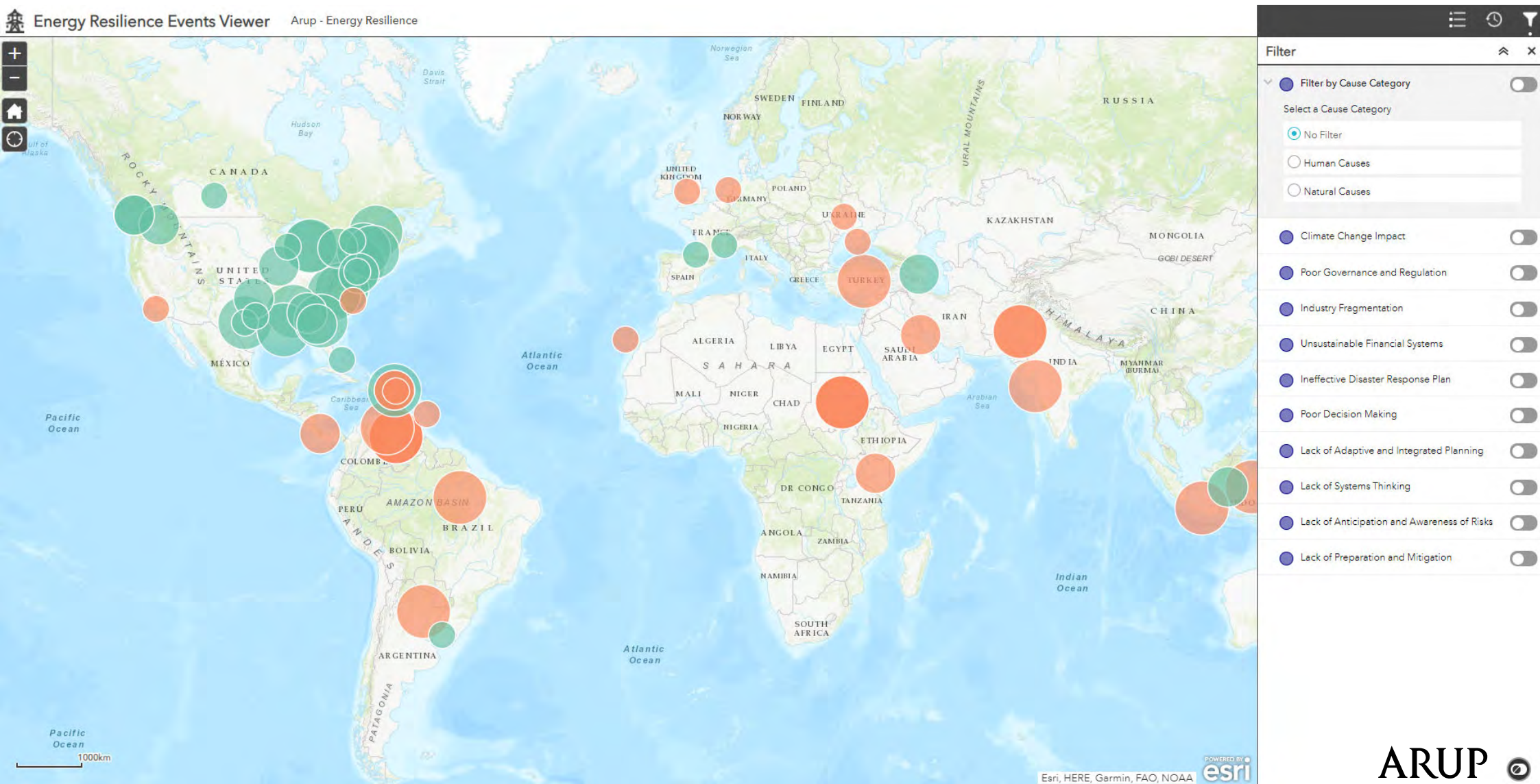


WE ARE LIVING IN AN INCREASINGLY VOLATILE AND UNCERTAIN WORLD






# ENERGY RESILIENCE MAP





An aerial photograph showing a massive forest fire. Thick, dark smoke billows from the burning area, partially obscuring the sky. Bright orange and yellow flames are visible through the trees, which appear charred and blackened in some areas. The fire is spreading across a large section of the forest.

**Through this transition, it is imperative that the resilience of our energy system is maintained and ultimately improved...**



# WHAT IS RESILIENCE?

The **capacity of cities** (individuals, communities, institutions, businesses and systems) **to survive, adapt, and thrive** no matter what kinds of chronic **stresses** and acute **shocks** they experience

Rockefeller Foundation, 2013



The ability to prepare for and adapt to changing conditions and to withstand and recover rapidly from disruptions

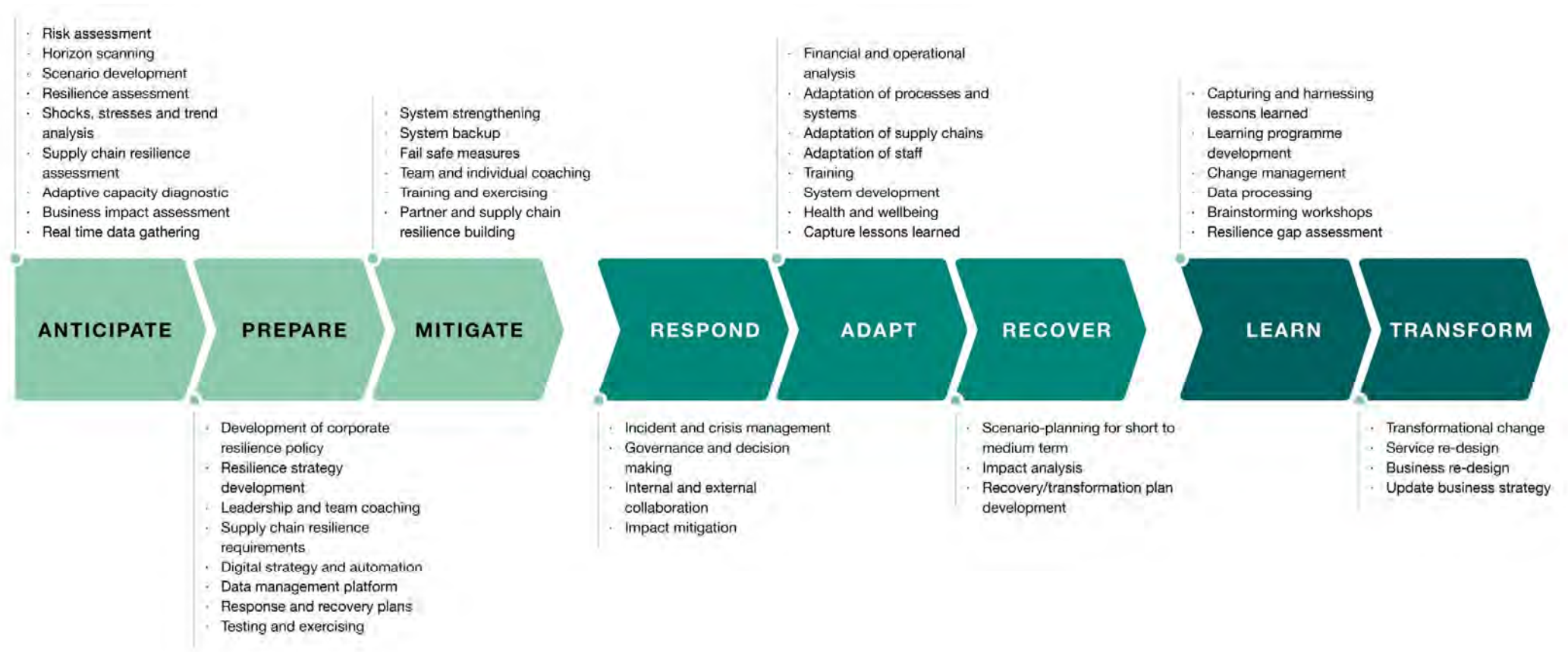
Presidential Policy Directive 21 (2013)



The ability to absorb and adapt in a changing environment

International Standards Organisation

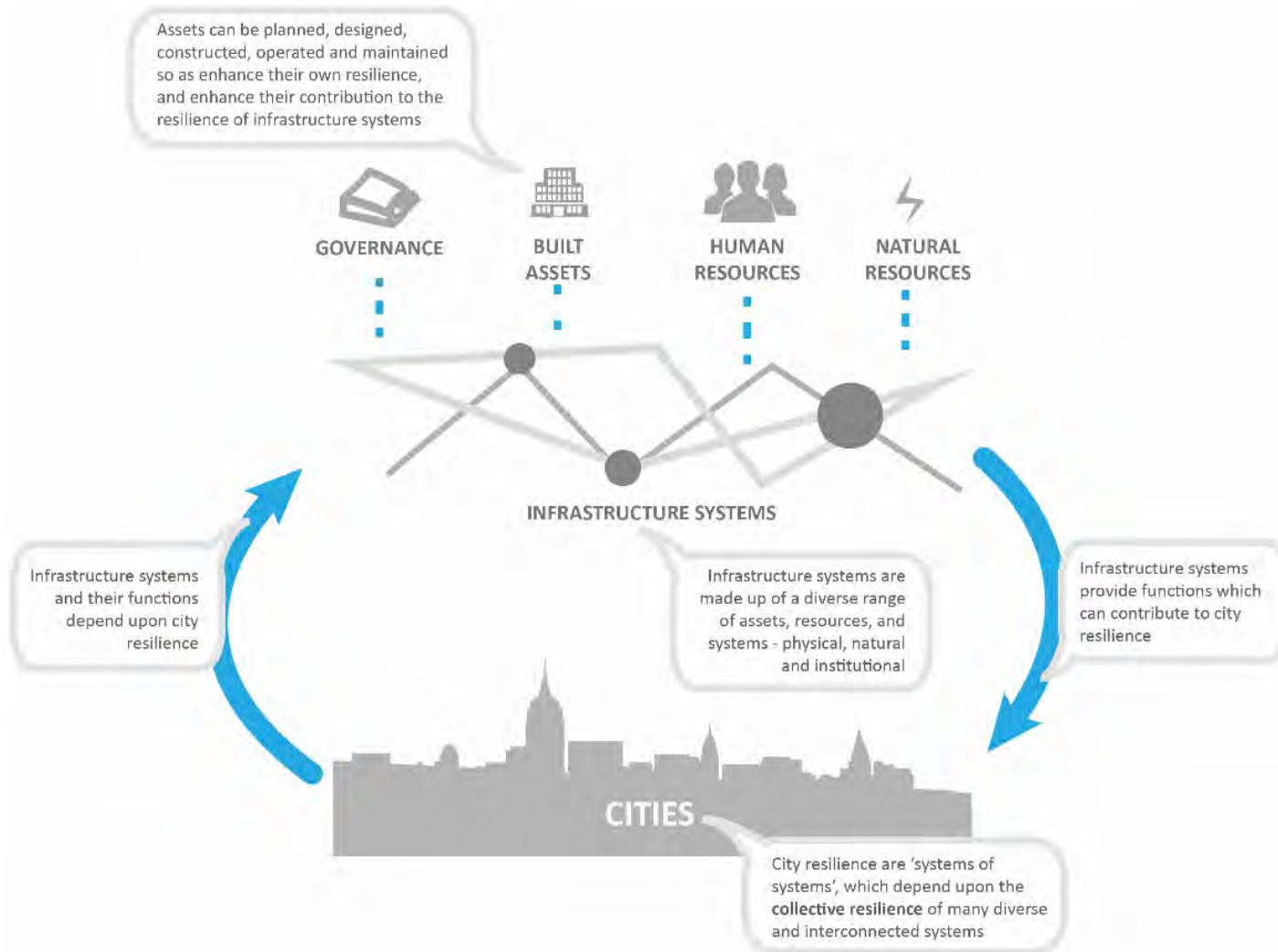
# RESILIENCE CYCLE

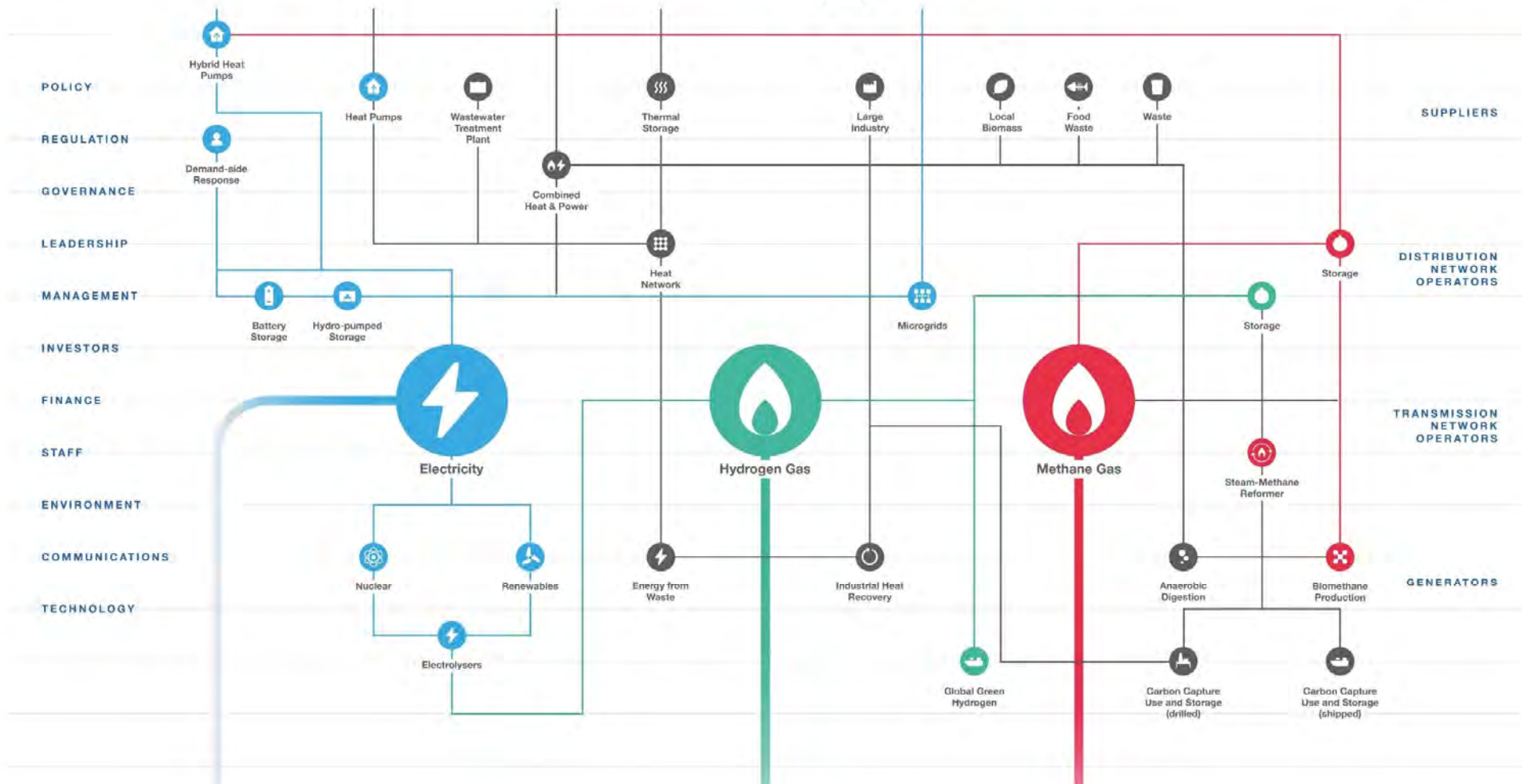




# SYSTEMS NOT SILOS

Urban systems comprise physical, institutional, environmental and social assets









## STRUCTURE & STAKEHOLDERS

System Interdependencies  
Fragmentation  
Distributed systems  
Energy eco-system



## CUSTOMERS

Expectations  
Behaviour Change  
Awareness  
Prosumers



## COLLABORATION

Cross-sector collaboration  
Live Exercises  
Systems Approach to Interdependencies



## MEASURING RESILIENCE

Standards  
Frameworks  
Metrics



## TECHNOLOGY & DATA

Demand & supply mgmt  
Energy storage  
Real-time data, Automation  
Carbon capture / storage  
Hydrogen



## FINANCE

New finance models  
Investors need  
certainty/clear policy  
Role of insurance  
Carbon pricing



## POLICY & REGULATION

Long term planning  
More agile & proactive  
National frameworks

# RESILIENCE SHIFT ENERGY STUDY – KEY ACTIONS



## Influencing **policy**

- **Policy & Regulation** – including resilience and adaptability requirements
- **Insurance** – linking reduced premiums to resilient infrastructure
- **Financing Resilience Infrastructure** – managing risk and RoI



## Shaping **practice**

- **National Energy Resilience Guidance** – policy, frameworks and indicators
- **Resilience Business Case** – a common framework and metrics for articulating the business case for investing in resilience
- **Systems Thinking** – mapping energy systems and their interdependencies as a way to better understand resilience

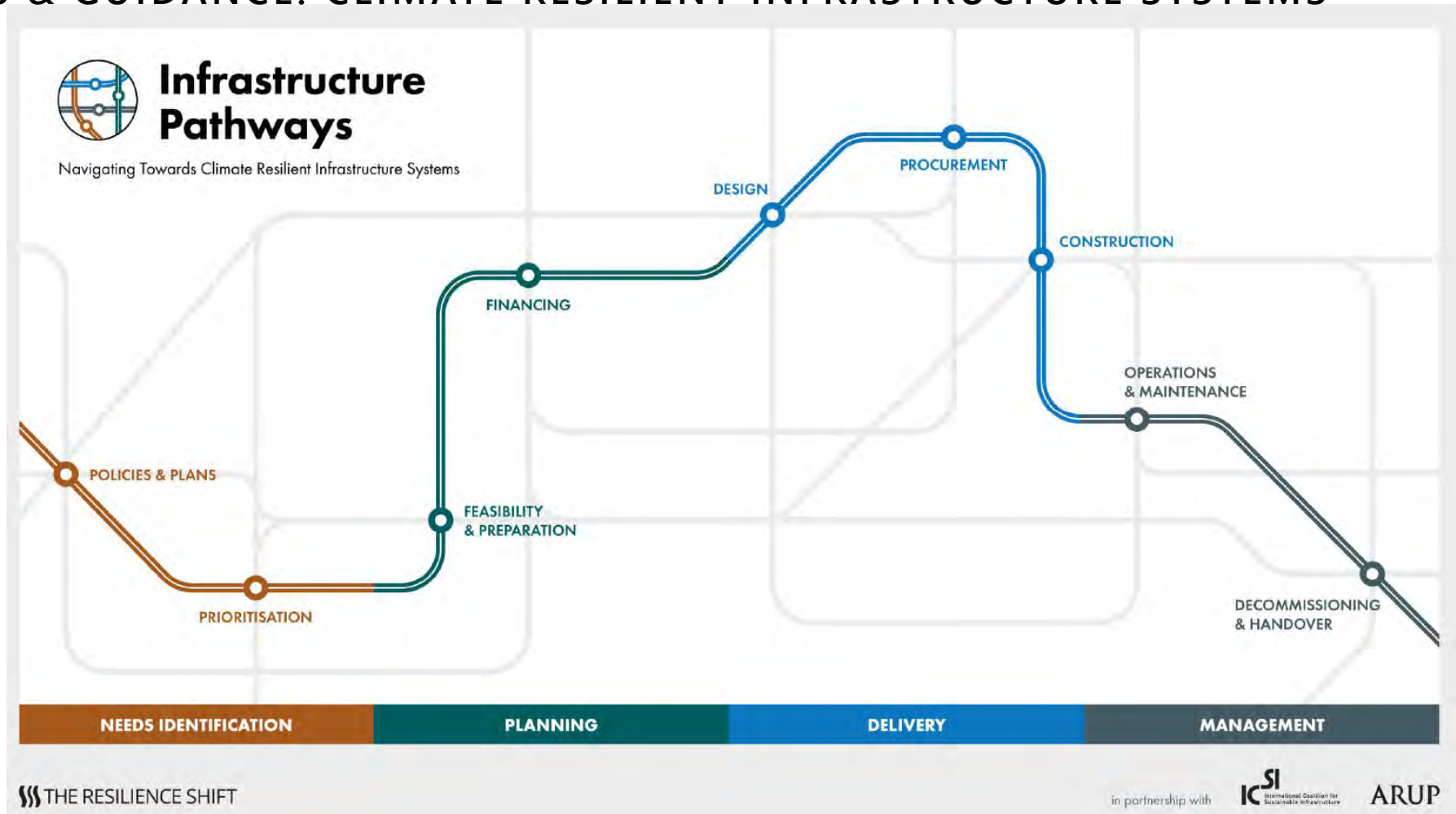


## Sharing **learning**

- **Cross-sector** problem solving networks / workshops
- **Consumer Behaviour Change at Scale** – increasing understanding and ownership of energy usage and energy resilience at the consumer level
- **Lessons Learned** – capturing global lessons learned from incidents around the globe



## TOOLS & GUIDANCE: CLIMATE RESILIENT INFRASTRUCTURE SYSTEMS



To provide a mechanism for more informed decision-making, improved coordination, and better collective impact by practitioners across the infrastructure lifecycle to deliver climate-resilient infrastructure.

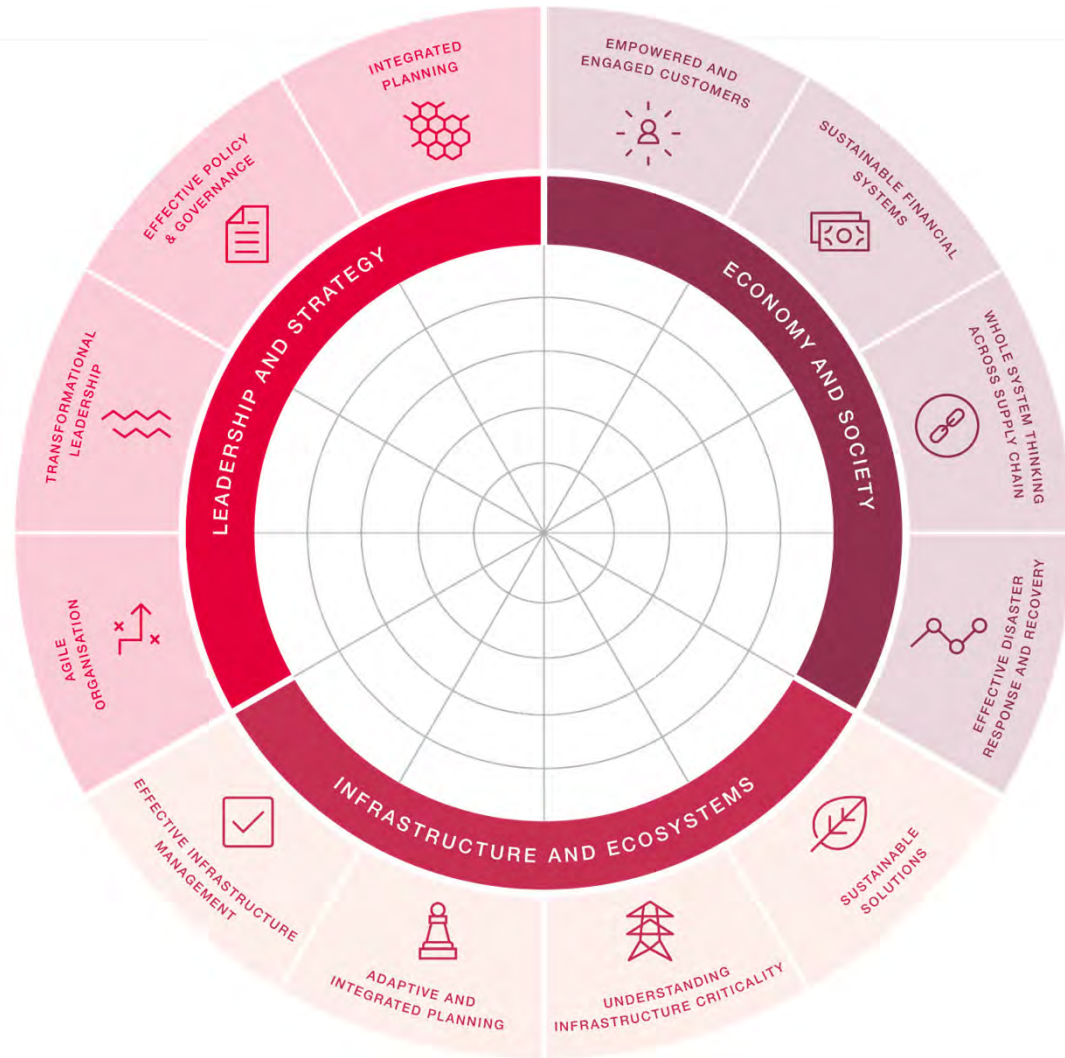
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# TOOLS & GUIDANCE: A FRAMEWORK TO MEASURE PROGRESS

**3** Dimensions

**12** Goals

**66** Indicators



THE ARUP ENERGY RESILIENCE FRAMEWORK

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# CONVENING FOR COLLABORATION & SHARING BEST PRACTICE

## GRID OPERATORS NETWORK

This network provides a forum for global grid operators and distributors to come together and accelerate resilience and sustainable best practice through sharing and learning together and providing the global coalition needed to catalyse meaningful change.



RESILIENCE FIRST

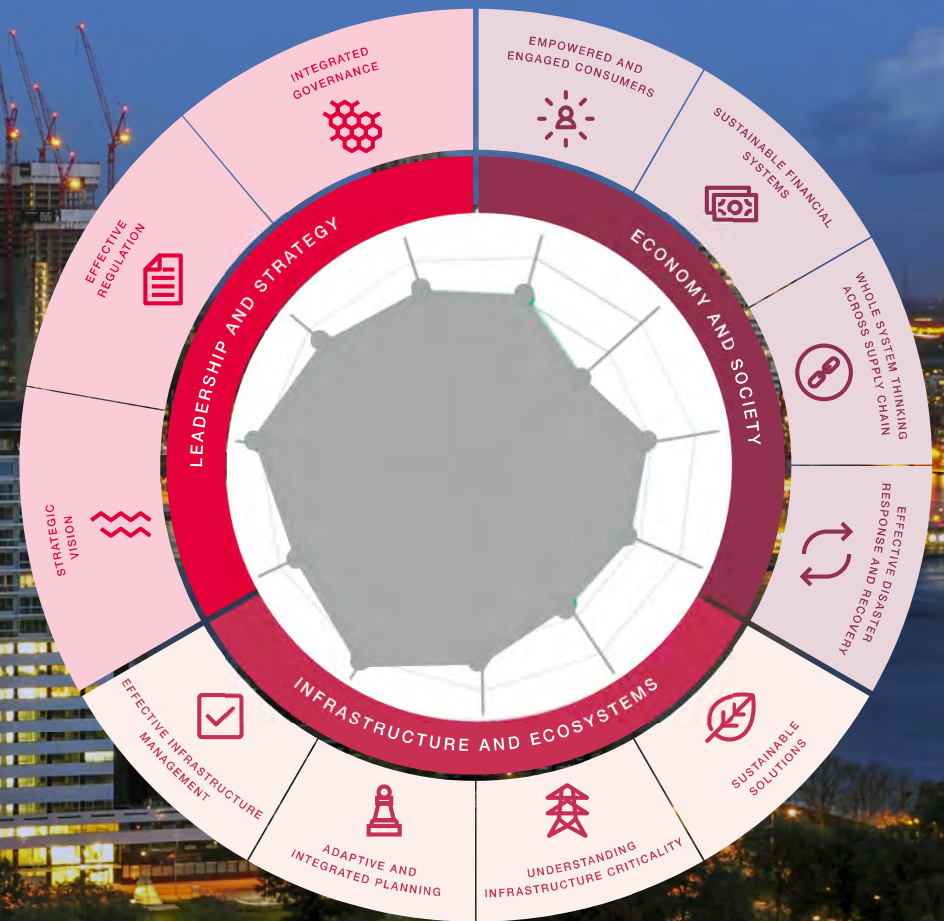


THE RESILIENCE SHIFT

Joining forces to drive global  
resilience best practice

# ENSURING A RESILIENT ENERGY TRANSITION FOR ROTTERDAM

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# NATIONAL GRID ELECTRICITY TRANSMISSION: FORWARD RESILIENCE MEASURES

## Tier 1

Screening models or indexes to identify easy improvements and guide focus of further analysis

## Tier 2

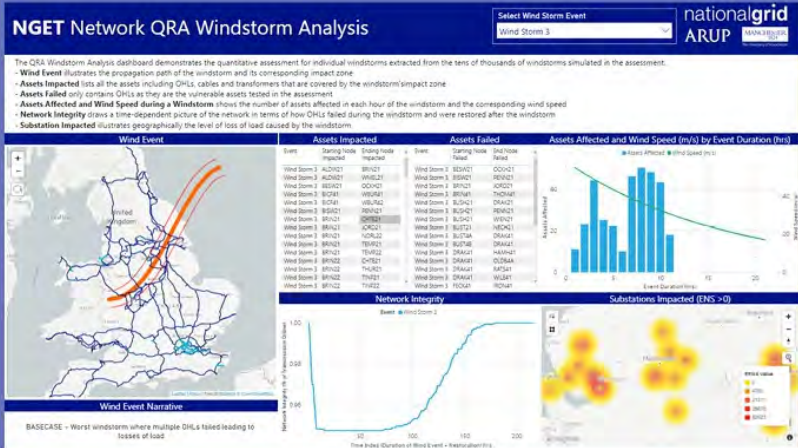
Details models using formal decision analysis to prioritise

## Tier 3

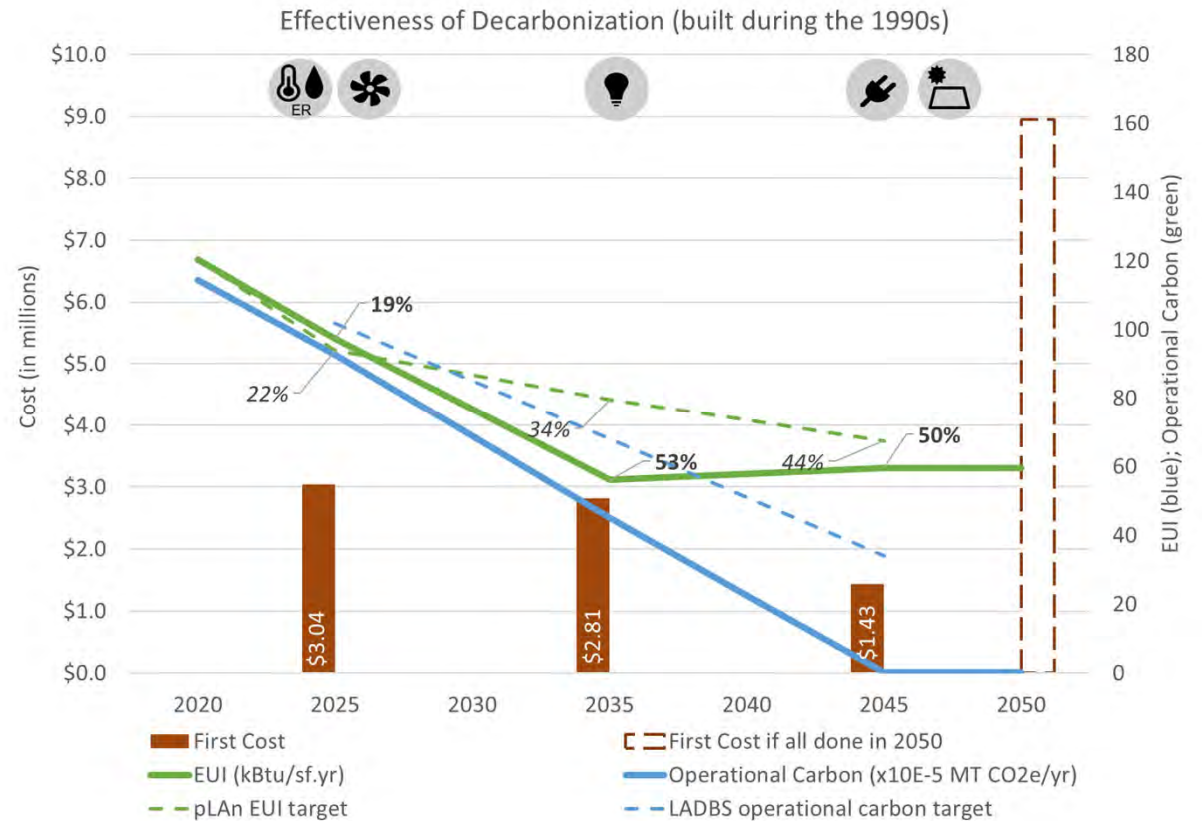
Complex modelling of interactions between sub-systems and using robust scenario analysis



- Existing NGET Initiatives -



# ENSURING A RESILIENT AND EQUITABLE TRANSITION FOR SOCIAL EDISON





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