



No weak links:

Limiting the impact of
infrastructure failure
on Sydney's essential
services



Committee
for
Sydney



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We acknowledge Aboriginal and Torres Strait Islander peoples as the Traditional Custodians of our land – Australia. We pay our respects to their Elders both past and present. We recognise that sovereignty was never ceded. This was, and always will be, Aboriginal land.

This report is informed by the interdisciplinary knowledge of experts and practitioners across and beyond Greater Sydney.

This report was prepared by Committee for Sydney in partnership with Aurecon. Aurecon is a design, engineering and advisory company whose purpose is bringing ideas to life, to imagine and co-create a better future for people and the planet.

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Executive Summary

All cities rely on an interdependent network of infrastructure, assets and essential services.

Whether due to climate related hazard events, cyber-attacks, rapid urban growth or ageing assets, parts of our complex urban infrastructure systems have the potential to fail.

Power failure is the most significant driver of cross-sectoral infrastructure failure, followed by transportation, energy, and the telecommunication sector.

Interdependency between infrastructure sectors means that shocks or disruptions can flow across services and supply chains, posing major risks to business and community continuity.

We are only as strong as our weakest links.

The 2023 Optus telecommunications outage is a recent example of disruptions in one sector having impacts on other essential infrastructure services such as hospitals, public transport, phone, internet and digital payments.

Flooding in 2022 impacted rail services from Sydney to Goulburn, causing direct consequences for Sydney's ability to move over 1000 tonnes of daily waste to regional landfill sites such as Goulburn. 10 days of rail disruptions resulted in some Councils, hospitals and commercial buildings across Sydney having to store their own waste on-site until rail services were restored.

Infrastructure for resilience requires considering of the role of each asset within the broader network and/or system, a shift from individual to shared responsibility, but also how to strengthen the place or city that the essential infrastructure operates within.

This report draws on workshops and subsequent research with key infrastructure leaders and service providers across Greater Sydney to identify five core insights on how to enable infrastructure for resilience:

1. Decisions about infrastructure assets and systems need to respond to the most likely climate scenarios and most extreme climate scenarios.
2. Post-disaster investment should build on lived experience and betterment opportunities to improve business and community continuity.
3. Existing critical infrastructure legislation (State and Federal) enables sharing of protected data, yet can also restrict sectors to a narrow focus on their own assets, while limiting recognition of the role of social

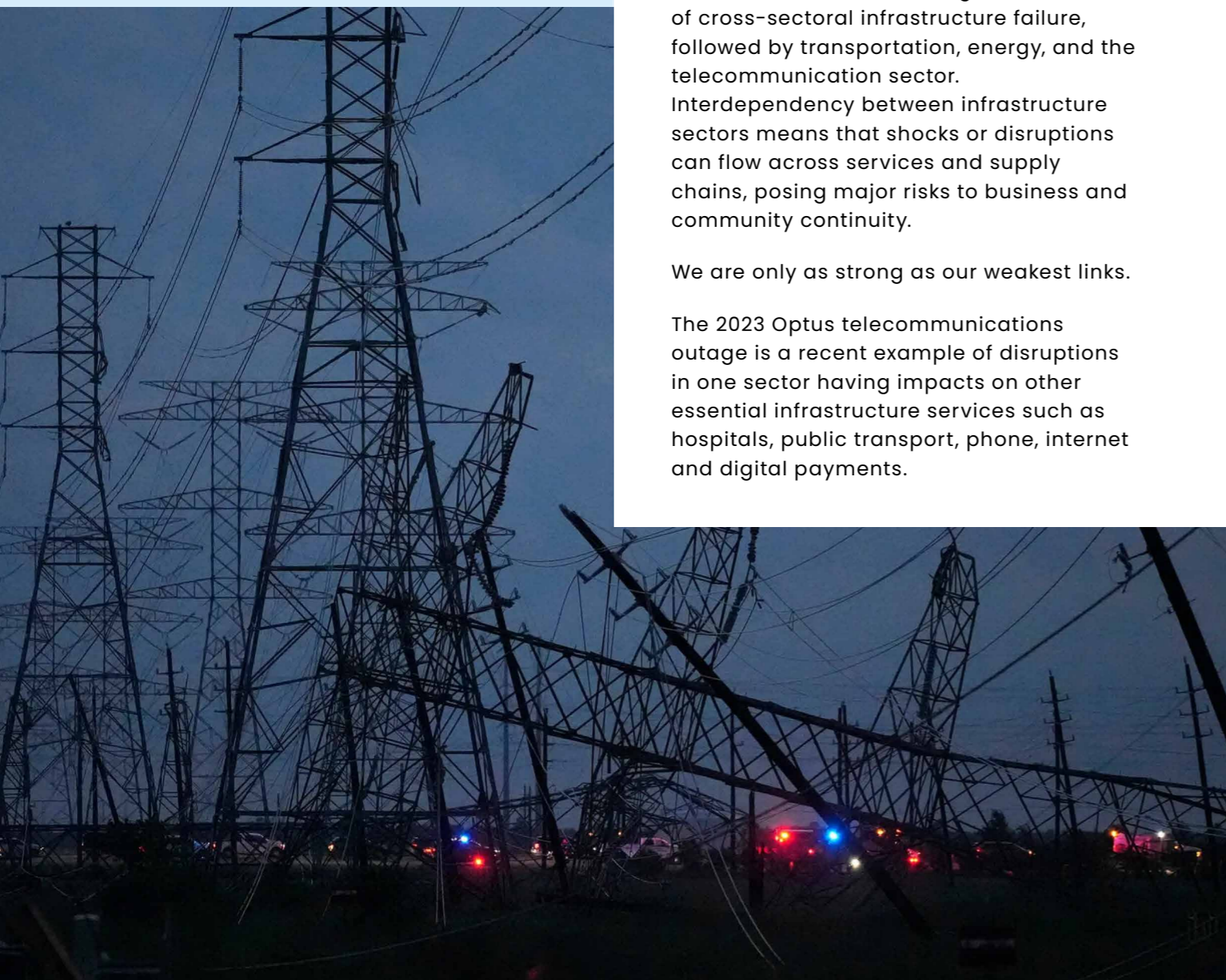
infrastructure in enabling recovery and resilience.

4. Collaborative governance is needed to prepare for future disruption through acknowledgement of 3rd party risks and coordinated investment between infrastructure sectors.
5. There is limited formal recognition of the essential role that blue-green infrastructure (trees, plants, parks and waterbodies) in Sydney play in risk management and community continuity, while First nations knowledge around bushfire and drought management is under-utilised.

Weak links in infrastructure systems pose major risks to communities and businesses from cascading failures in essential service provision.

Three key moves have emerged from the sectoral and Government leaders from across Greater Sydney that will enable cross-sector infrastructure for resilience in Greater Sydney:

1. Use disaster adaptation planning to identify place-based infrastructure strengths and the possible impact of weak links.
2. Ensure lessons from recent disasters are applied in cross-sectoral infrastructure planning and modelling for future emergencies.
3. Develop and share investment logic that account for system risks, and unlock infrastructure for resilience funding and finance.





Key move

1. Use disaster adaptation planning to identify place-based infrastructure strengths and the impact of possible weak links

Drivers

Preparing for possible disruptions to essential services is most relevant in the context of specific places where the cascading impact on other services, and on business and the community, can be understood and prepared for.

This means working through place-based scenarios and identifying the range of possible mitigation measures, from an asset, system, and community perspective.

Guidelines for Disaster Adaptation Plans need to reflect this opportunity to identify place-based infrastructure strengths and the impact of possible weak links.

Responsibility

Proposed Lead: NSW Reconstruction Authority

Key Collaborators: NSW DCCEEW, Infrastructure NSW, Transport for NSW, Sydney Water, Ausgrid, Endeavour Energy, NBN, Local Government, Infrastructure Australia

2. Ensure lessons from recent disasters are applied in cross-sectoral infrastructure planning and modelling for future emergencies

There is an urgent need to move from lesson identification to lesson application in understanding the dependency that each sector has on each other when trying to restore essential services during an emergency.

Business and community continuity are key outcomes for infrastructure agencies to target in undertaking community engagement, modelling of potential future events, and better integrating infrastructure response into collaborative preparedness, planning and decision making.

Proposed Lead: NSW Reconstruction Authority / Resilient Sydney

Key Collaborators: Premiers Department, EPA, Infrastructure sector agencies, NSW State Emergency Management Committee, Local Government, Infrastructure Australia

3. Develop and share investment logic that account for system risks, and unlock infrastructure for resilience funding and finance

For regulated and private sector essential infrastructure providers, demonstrating the case for investing in infrastructure for resilience remains challenging.

Unlocking the funding and finance to act on new climate information, or delivering on business and community continuity, requires regulatory approval, increased rates for customers, a new investment logic or all three.

Accelerating access to investment requires developing and sharing each successful investment logic that delivers infrastructure for resilience.

Proposed Lead: Infrastructure NSW

Key Collaborators: NSW Reconstruction Authority, NSW Treasury, EPA, infrastructure sector agencies, Local Government, Infrastructure Australia, Investor Group on Climate Change (IGCC), Environmental Protection Agency



Introduction

Infrastructure resilience is often focused on ensuring a specific asset or sector can maintain operations in the face of a disruption – whether from natural hazard, cyber-attack, technology failure, or other shocks or stresses. However, most infrastructure sectors have some level of reliance or dependency on other to maintain those operations.

The links between infrastructure sectors also means that disruptions to one asset or service can have flow on (or cascading) effects on other services and supply chains. In turn, this can weaken the capacity of our assets and networks to manage future shocks and stresses. Figure 2 demonstrates the complex interdependencies of these relationships across infrastructure sectors.

Power failure consistently appears as the most significant driver of cascading cross infrastructure failure, followed by transportation, energy, and telecommunication sectors⁽¹⁾. The Black Summer bushfires highlighted the extent to which some communities are at risk of power failure, and the impact of loss of power on households, businesses and local service providers.

The recent Optus telecommunications outage company across Australia in November 2023 had cascading impacts on other essential infrastructure services such as hospital services, financial services, and public transport. The nationwide outage



Credit: Unsplash

left 10 million customers without phone or internet services for over 12 hours, affecting digital payment systems, healthcare operations and restricted the ability to access to emergency services through 000⁽²⁾.

80% of Sydney's drinking water comes from a single source – Warragamba Dam and treatment plant – a source that is dependent on electricity, transport, and communications to function effectively. Less well known is that recent droughts have shown Sydney could run out of water in less than five years unless new investments are made in sources that are not rainfall dependent, such as purified recycled drinking water and additional desalination capacity⁽³⁾.

In Sydney the interdependency between solid waste disposal and rail connections to regional landfill sites such as Goulburn is an emerging weak link. The Banksmeadow transfer terminal in Botany receives up to 400,000 tonnes of waste per annum, with household waste

containerised for transfer by rail for treatment and resource recovery⁽⁴⁾.

During the 2022 East Coast Floods, the disruptions to the rail service for 10 days resulted in some Councils, hospitals and commercial buildings having to stockpile their own waste, as household collections were prioritised for public health reasons. With Sydney's landfill reaching capacity by 2028, and waste volumes continuing to grow, the vulnerability of the waste system to rail disruptions are expected to grow into the future.

Unlike power, water and transport, essential urban infrastructure like solid waste, social infrastructure (schools, parks and libraries) and green-blue infrastructure (bushland, mangroves etc) are not considered 'critical' infrastructure under Australian legislation.

Understanding and acting on the risk from disruption to these critical and essential services is inherent to the resilience of cities like Sydney.



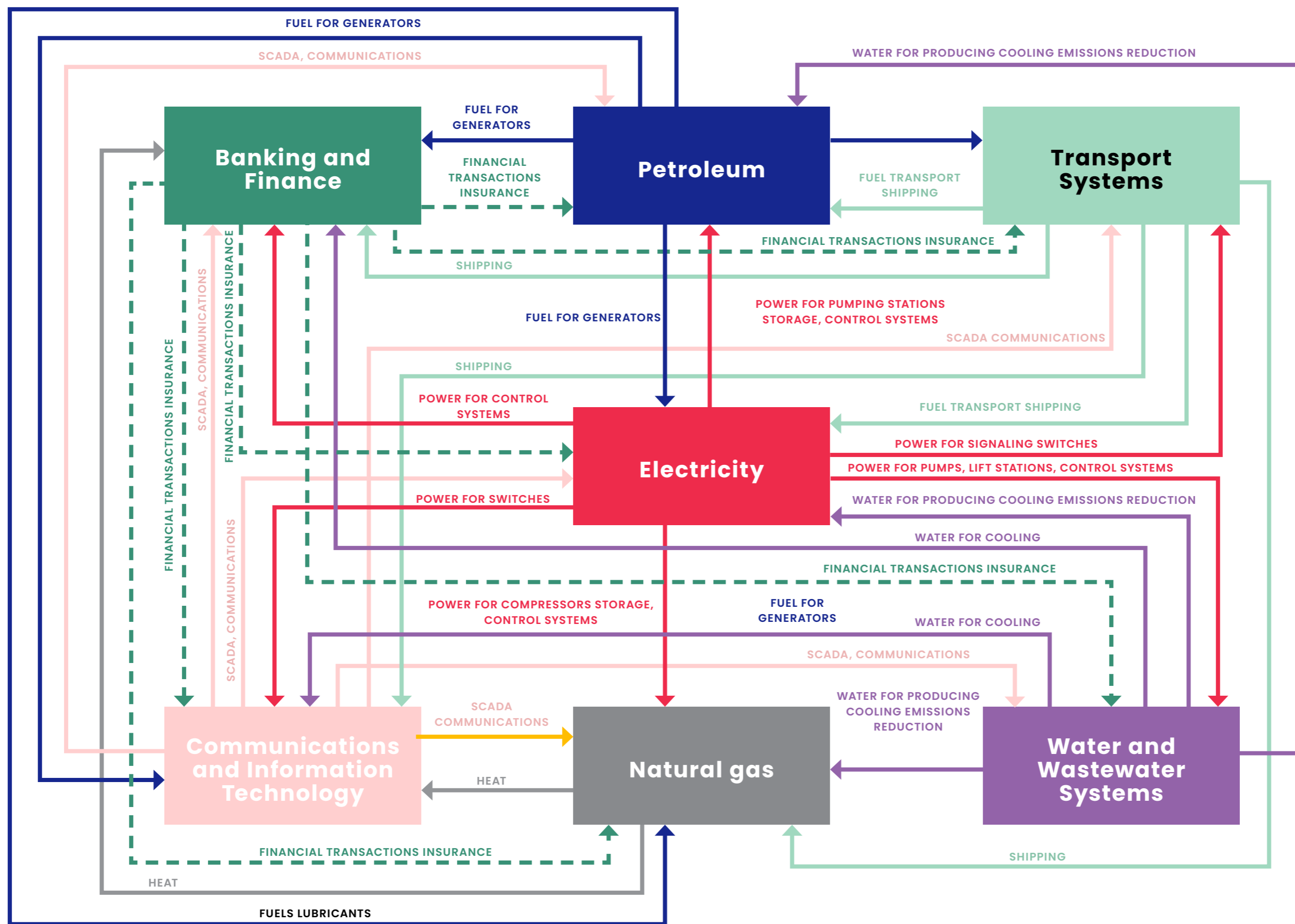
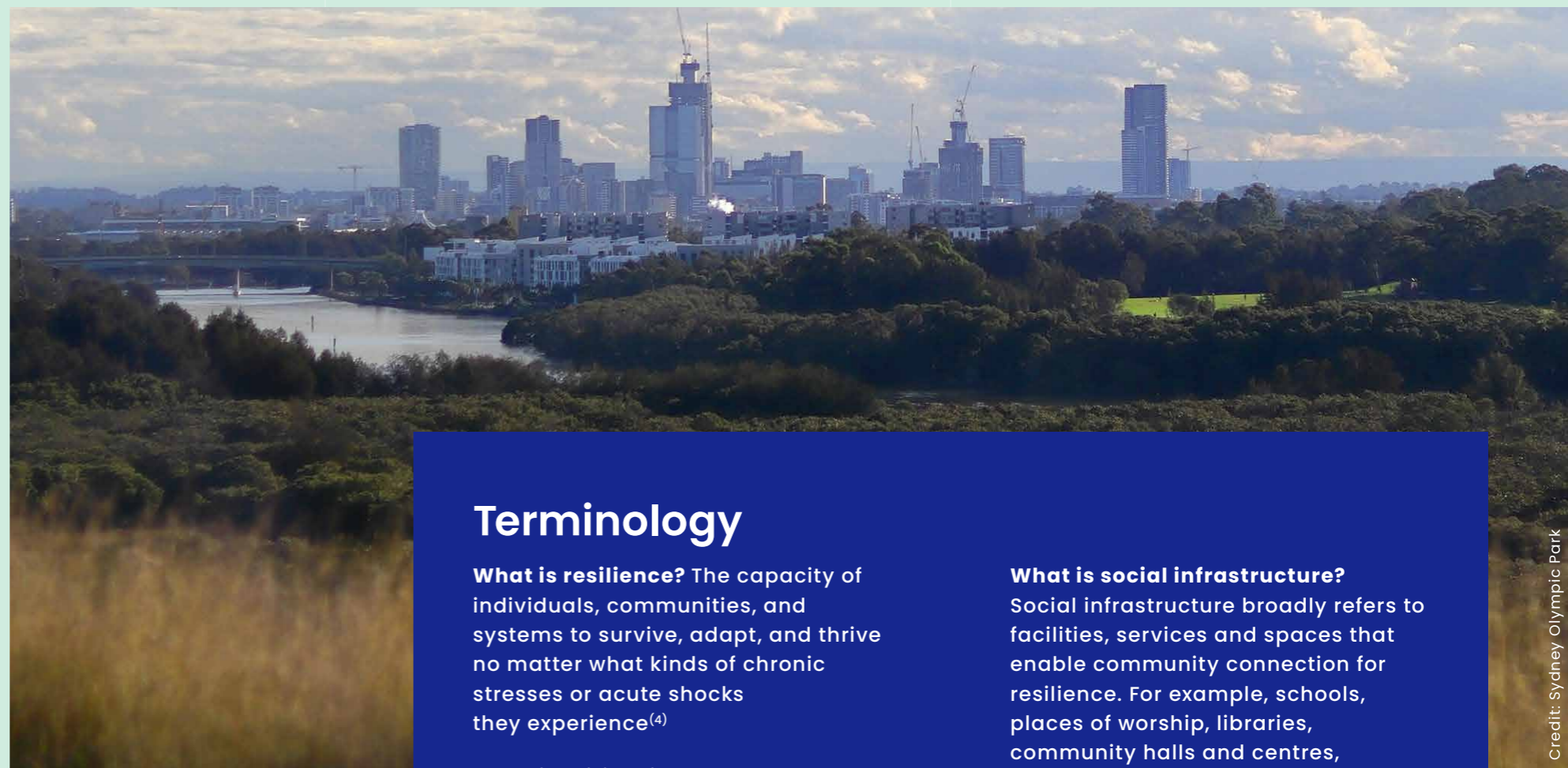


Figure 1 An indicative map of essential infrastructure system interdependencies [reproduced from (34)]



Infrastructure for resilience



Traditional infrastructure risk management relies on the ability to quantify the likelihood, and the impact, of disruption on an asset. It also involves allocating responsibility for action to one organisation or stakeholder to avoid, accept, reduce or transfer a risk⁽⁴⁾.

However, this risk management approach can sometimes fail to consider systemic risks that emerge from compounding shocks or stresses due to a lack of control or agency over those risks – for example, the reliance of waste disposal on the rail network.

Equally, regulatory frameworks can limit the extent to which some infrastructure agencies can invest in reducing systemic risks that might apply to a wider net of physical assets, organisations that manage these assets and systems, and the businesses and communities that rely on these services. Social infrastructure,

largely managed by local government, forms part of a wider set of essential infrastructure that is needed to enable business and community continuity.

There is a growing collection of legislation, plans and collaborations to act on this urgent agenda, reflecting a shift in focus from the resilience of assets themselves, to the contribution of assets to the resilience of the system – known as **infrastructure for resilience⁽³⁾**. This approach requires consideration of the role of each asset within the broader network and/or system, a shift from individual to shared responsibility, but also how to strengthen the place or city that the essential infrastructure operates within.

Terminology

What is resilience? The capacity of individuals, communities, and systems to survive, adapt, and thrive no matter what kinds of chronic stresses or acute shocks they experience⁽⁴⁾

What is critical infrastructure? Those physical facilities, supply chains, information technologies and communication networks, which if destroyed, degraded or rendered unavailable for an extended period, would significantly impact the social or economic wellbeing of the nation, or affect Australia's ability to conduct national defence and ensure national security⁽⁵⁾.

What is essential infrastructure? Essential infrastructure refers to all the physical and social infrastructure assets, sectors and systems that are necessary for Sydney's resilience, not just those covered by the definition of 'critical infrastructure'. For example, waste and social infrastructure are not considered in definitions of critical infrastructure.

What is social infrastructure? Social infrastructure broadly refers to facilities, services and spaces that enable community connection for resilience. For example, schools, places of worship, libraries, community halls and centres, commercial districts with sitting space, sporting grounds and parks among others play a key role in providing better outcomes for disaster risk reduction through increased connection between and across individuals, groups and institutions.⁽²⁶⁾

What is critical infrastructure? Those physical facilities, supply chains, information technologies and communication networks, which if destroyed, degraded or rendered unavailable for an extended period, would significantly impact the social or economic wellbeing of the nation, or affect Australia's ability to conduct national defence and ensure national security.⁽⁵⁾⁽¹¹⁾



A whole-of-system approach

There is a range of key legislation, guidelines and initiatives that govern and inform considerations of resilience in the design, construction, management of and investment in essential infrastructure across NSW, including Greater Sydney.

These include:

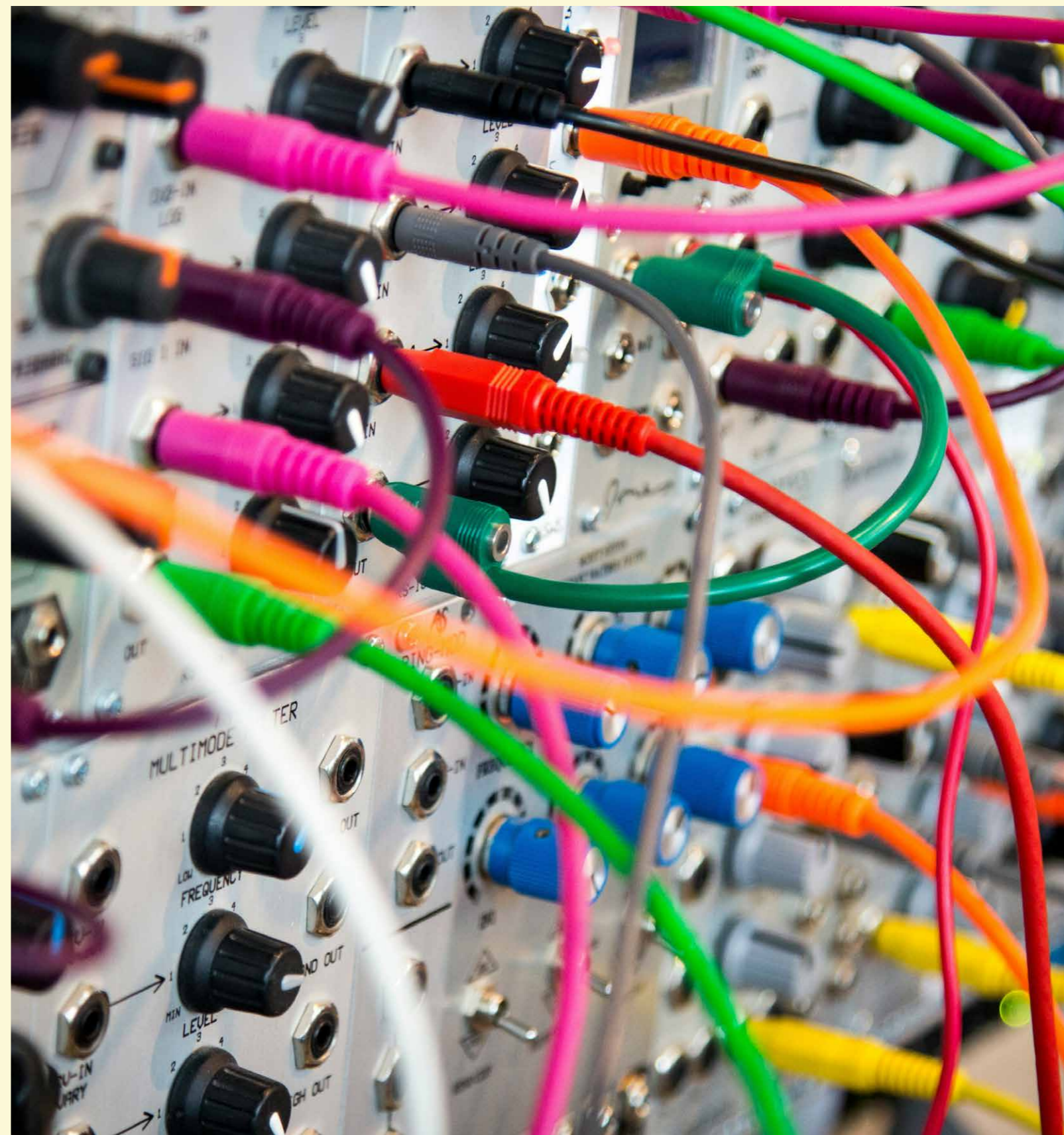
At a national level:

- Independent Review of Commonwealth Disaster Funding 2024
- Critical Infrastructure Resilience Plan 2023
- Second National Action Plan for Disaster Risk Reduction 2023
- Climate Change (Net Zero Futures) Act 2023
- Climate Risk Management Guide, Department of Climate Change, Energy, Environment and Water 2023

- Infrastructure Australia A Pathway to Resilience 2021
- Australian Institute of Disaster Resilience Strategic Climate and Disaster Risk Assessment 2019
- Security of Critical Infrastructure Act 2018 (updated 2023)

At a state level:

- NSW State Disaster Mitigation Plan 2024
- NSW State Infrastructure Strategy 2022
- NSW Critical Infrastructure Resilience Strategy 2022
- NSW Climate Change Adaptation Strategy 2022
- NSW Reconstruction Authority Act 2022
- NSW Flood Inquiry 2022
- Independent Pricing and Regulatory Tribunal Act 1992





At a regional and local level:

- Disaster Adaptation Plans (to be undertaken by local councils and the NSW Reconstruction Authority)
- Local Government Act 1993
- Local Emergency Management Committee Plans

While not a comprehensive list of all infrastructure related legislation, this overview of the legislative and policy landscape underscores the complexity that governs infrastructure service providers. The Commonwealth Security of Critical Infrastructure Act 2018 introduced national security considerations in regulating the management of infrastructure. This means that data sharing and collaboration between infrastructure providers covered by this legislation is subject to non-disclosure agreements and is therefore not visible to others outside of these agreements.

Security of Critical Infrastructure (SOCl) Act 2018

Updated in 2023, sectors subject to the Commonwealth Security of Critical Infrastructure Act 2018 include: Energy, Communications, Data Storage & processing, Financial services & markets, Water & sewerage, Healthcare & medical, Higher education & research, Food & grocery, and Transport.



In 2022, the NSW State Infrastructure Report⁽⁶⁾ outlined a plan to achieve a whole-of-system approach to resilience. This required NSW to:

1. Establish a register of primary hazards and vulnerable locations across the State
2. Prioritise adaptation of assets and services within these locations that are: most vulnerable to primary hazards; most significant in prevention, response and recovery
3. Develop place-based resilience and adaptation strategies for vulnerable locations across NSW
4. Implement targeted asset hardening and adaptation
5. Invest in new assets to address primary hazards, including items that have already been assessed, such as Hawkesbury–Nepean Valley flood mitigation and water security projects

6. Improve accountability for prevention of, response to and recovery from impacts to infrastructure from hazards
7. Create a funding and financing facility to deliver and encourage investment in infrastructure resilience.

In 2024, the NSW State Disaster Mitigation Plan⁽⁵⁾ built on this agenda, noting that identifying the importance or criticality of infrastructure is linked to the level of dependency that a community or a service network has on the continued operation of that asset. Social infrastructure is a key element of this approach given the role of the social realm and social cohesion in disaster recovery⁽⁸⁾.



Assessing systemic resilience at the city scale

In October 2023 the Committee for Sydney convened infrastructure leaders and experts from across Greater Sydney to:

1. Respond to the growing demand for cross-sector engagement on how resilient our infrastructure systems are, and;
2. Identify barriers and enablers for increasing resilience

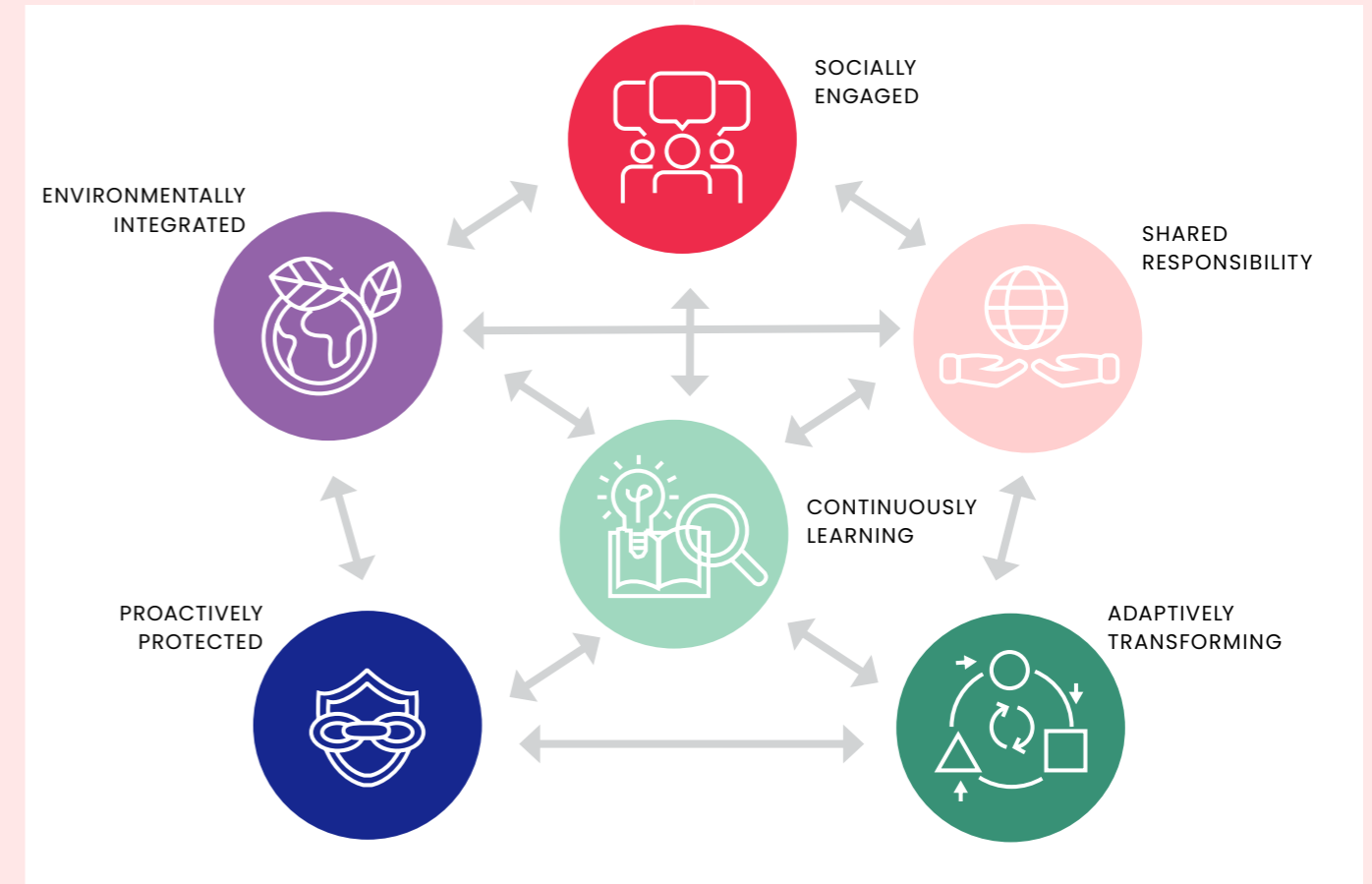
The following sectors were represented:

- Telecommunications
- Financial services and markets
- Water and sewerage
- Energy
- Health care and medical
- Higher education and research
- Transport
- Local Government

The United Nations Office for Disaster Risk Reduction (UNDRR) – supported by Aurecon – developed a global methodology for assessing systemic resilience of infrastructure at a city or country scale. This global methodology uses a Scorecard to reveal resilience gaps between essential infrastructure sectors. It has been developed to support implementation of the Sendai Framework for Disaster Risk Reduction 2015–2030 and the United Nations Sustainable Development Goals.

The six principles of resilience in the UNDRR Scorecard were used to guide the workshop approach allowing the group to explore and discuss challenges for cross-sector interdependencies, collaboration, and investment priorities. The workshop also provided an opportunity to share key lessons learned as well as dissect barriers and enablers for cross-sector essential infrastructure resilience in Greater Sydney. Workshop outputs are captured in Appendix A.

Figure 2 The six principles of resilience in the UNDRR Scorecard for assessing systemic resilience



UNDRR Scorecard for assessing systemic resilience

The Scorecard outlines a set of principles, key actions, and guidelines to create net resilience gain and improve the continuity of essential services to function effectively.

1. **Continuously Learning:** Understand and manage the interdependencies and correlations in an infrastructure network
2. **Proactively Protected:** Determine and increase the level of hazard/ threat preparedness and response
3. **Environmentally integrated:** Integrate natural environment implications into infrastructure planning and management

4. **Socially Engaged:** Empower communities to participate in infrastructure resilience and disaster prevention

5. **Shared Responsibility:** Empower communities to participate in infrastructure resilience and disaster prevention

6. **Adaptively Transforming:** Critical assets are designed to operate comfortably in hazardous conditions and during extreme disruption events



Insights

Emerging from the panel discussion, workshop and subsequent expert engagement were five core insights from across the diverse sectors and perspectives involved in this discussion paper:

- a. Incorporate diverse climate risk scenarios into infrastructure investment decision-making
- b. Build back based on disaster experience and betterment opportunities to improve business and community continuity
- c. Harness the strengths of regulated and non-regulated partnerships to share data and experience
- d. Enable collaborative governance through formal and informal relationships within and between sectors
- e. Ensure blue-green infrastructure is considered as essential infrastructure

Within each of these insights stakeholders identified the current barriers and potential enablers to building enhanced resilience of Sydney's infrastructure.



Figure 3 Panel discussion on critical infrastructure priorities Credit: Flourish Studios



A. Incorporate diverse climate risk scenarios into infrastructure investment decision-making

The ability for infrastructure assets to cope with future climate change needs to be considered in all infrastructure investment decisions. Existing climate projections available for NSW and Sydney point to an intensification of climate impacts post-2050, when today's new infrastructure will be mid-lifecycle. Without designing and planning for infrastructure to be operating in this more volatile climate, we are increasing the risk of disruption to assets, the communities they serve and dependent infrastructure.

Existing climate projections show high confidence in an increasing intensity and frequency of heatwaves and high volume rainfall events. Equally, there is growing concern about intersecting impacts from natural hazard events, such as the drought, bushfire and flood sequence NSW experienced in 2020/2021.

Infrastructure providers are considering this in decision making and operations. For example, Endeavour Energy have identified where they expect more frequent events and the likely impact to occur across their network to justify current adaptation focussed investments. Sydney Water is making investment decisions about assets and systems based on adapting to the current trajectory for likely climate future

(RCP 4.5)¹, while demonstrating capacity to adapt to the most extreme scenarios (RCP 8.5)².

Infrastructure NSW guidelines incorporates resilience and the cost of disruption into decision making⁽⁶⁾. However, these guidelines do not currently include consideration of the cost of low probability, high consequence events as part of investment decision-making.

Investment that avoids the costs from low likelihood, high impact events is compounded by the reality that the costs of damage for future events are given less value in financial models compared to immediate ones, and regulated industries often have limits on what they can spend to improve resilience due to investment justification constraints or approval systems.

Following 12 natural disasters in five years in NSW, these low probability, high consequence events, and their impacts on infrastructure systems, need more attention to understand the growing impacts and what can be done to prepare for them.

¹ Regional Concentration Pathway or RCP 4.5 is described by the Intergovernmental Panel on Climate Change (IPCC) as a moderate climate scenario in which emissions peak around 2040 and then decline.
² Regional Concentration Pathway or RCP 8.5 is the highest baseline emissions scenario in which emissions continue to rise throughout the twenty-first century.

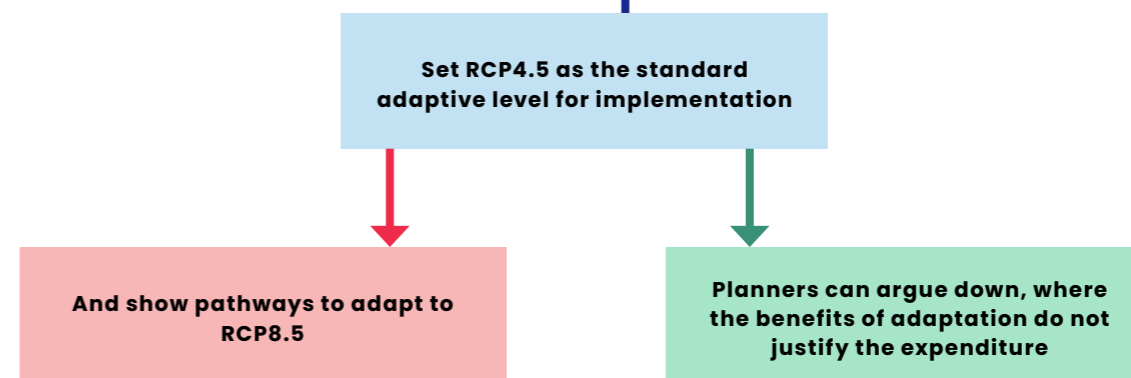
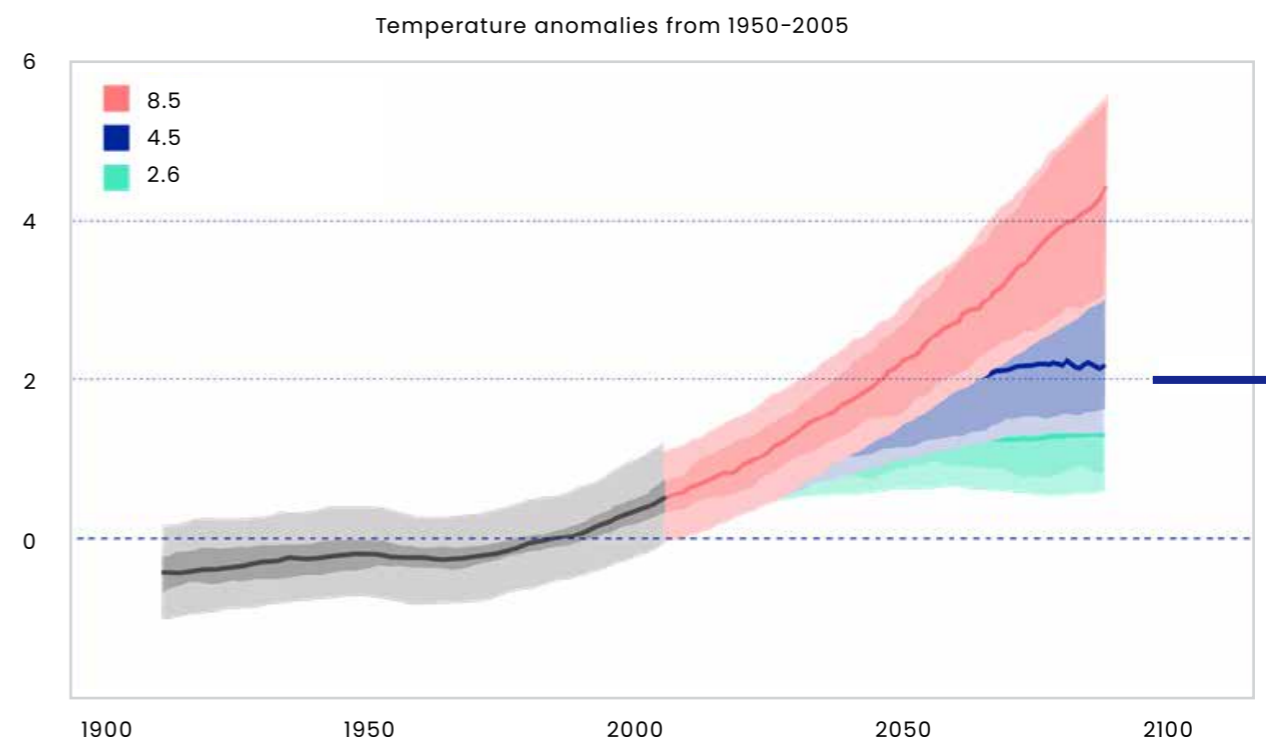


Figure 4 Sydney Water Climate Adaptation Approach





B. Build back based on disaster experience and betterment opportunities to improve business and community continuity

Workshop conversations covered disaster recovery, and the opportunity to deliver on 'build back better' outcomes through the post-disaster recovery and reconstruction window.

For essential infrastructure, responding to disasters, and ensuring the safety of people and return to community often means there often isn't time to consider whether the resilience of the asset or the network more generally can be improved, in the rush to restore services. To ensure the most effective response, there needs to be better engagement by government with impacted communities, and more willingness to hear from people who have been impacted to inform planning for business and community continuity.

Proactive planning for post-disaster response and enabling betterment and disaster recovery funding to cover additional resilience measures in new or upgraded assets and systems, are both key opportunities for preventing future asset and community impacts.

Although investment in infrastructure for increased resilience can incur larger upfront costs, the long-term savings from avoiding future recovery costs are well evidenced. The Queensland Reconstruction Authority has shown, for example, that a \$1.3 million investment in building back water supply infrastructure assets to a higher level of resilience after a disaster (known as betterment) at Gonyah in 2013 has so far avoided natural hazard related losses of over \$10million⁽⁹⁾.



Figure 5 Gonyah water supply infrastructure, QLD (9)



C. Harness the strengths of regulated and non-regulated partnerships to share data and knowledge, while boosting flexibility.

Legislation can assist sectors in requesting information from and implementing resilience measures with interconnecting sectors. Commonwealth legislation such as the Security of Critical Infrastructure Act 2018 were identified as enabling regulated organisations to share protected data, while also promoting sectors to focus on their own resilience and response to events or hazards, rather than a cross-sector approach.

Good practice at state level in Australia involves legislation supporting a risk-based and all hazards approach, partnership between government and industry to build resilience, and a transparent and consistent method for assessing the 'criticality' of infrastructure, including social infrastructure⁽¹⁰⁾.

Engagement with communities is needed to build on their intense knowledges of risk reduction and resilience development.

This approach is being progressively implemented in NSW through the 2022 NSW Reconstruction Authority Act, and emerging policy such as the 2022 State Infrastructure Strategy and 2023 State Disaster Mitigation Plan and which are reflecting an increasing trend and appreciation of cross-sector collaboration for infrastructure resilience (See Figure 6). The NSW Critical Infrastructure Resilience Strategy also promotes regulated and non-regulated partnerships as part of increasing cross-sector collaboration.

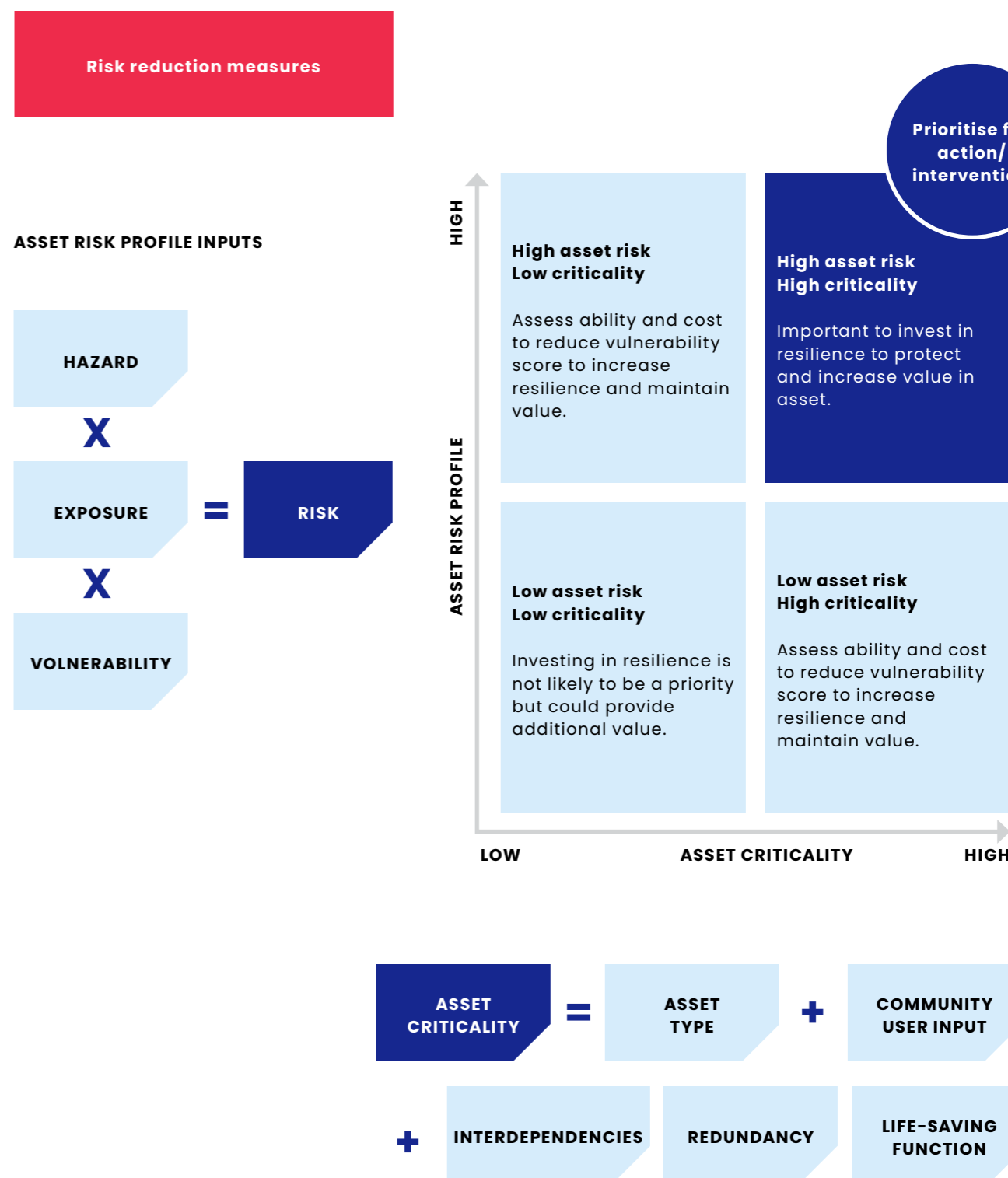


Figure 6 State Disaster Mitigation Plan Criticality Assessment (7)



D. Enable collaborative governance through formal and informal relationships within and between sectors



Across Australia and NSW, existing infrastructure collaborations work towards the protection and maintenance of essential infrastructure, including:

- Australian Critical Infrastructure Advisory Council (CIAC) provides leadership and strategic direction for the Trusted Information Sharing Network to support collaboration and advance initiatives to uplift the security and resilience of Australia's essential infrastructure.
- Trusted Information Sharing Network (TISN) enables members of the critical infrastructure community to collaborate to strengthen the resilience of their organisations and industry sectors in the face of all hazards(11).

- Resilient Sydney is a collaborative initiative that involves all 33 metropolitan councils of Greater Sydney, with the goal of implementing a coordinated and cohesive city-wide strategy. The program is governed by a metropolitan steering committee which includes representatives from local governments, NSW government, business and the community sector (see Figure 7).

However, the need to continue working to improve collaborative governance across Sydney and NSW remains a key challenge to effective decision making and investment. This issue was reinforced in the NSW State Disaster Mitigation Plan⁽⁷⁾, which has led to emerging sectoral infrastructure collaborations convened by NSW Reconstruction Authority.

Figure 7 Resilient Sydney Strategy consultations 2024 Credit: Cassandra Hannagan



E. Blue-green infrastructure is essential infrastructure

Despite the provision of some green-blue infrastructure being elevated as a priority across the city (especially open space, tree canopy cover, and swimmable rivers and lakes), there is limited formal recognition of the role that trees, plants, parks and waterbodies (also known as nature-based solutions) in Sydney play in risk management and community continuity.

Blue-green infrastructure – such as mangroves – are not considered critical infrastructure despite their key role in riparian and coastal protection. First Nations knowledge are only now being adopted into western practices, including how bushfire is managed through cultural burning practices, and similarly for drought by selecting native flora that are adapted to the extremes of local conditions.

Multi-purpose infrastructure assets like railway corridors, canals and water easements, have the potential to be designed to create multiple benefits for the city, as have been achieved in the Cooks River to Iron Cove Greenway.

This lack of recognition, and subsequent investment means we miss out on at least five key benefits⁽¹²⁾ of blue-green infrastructure:

1. Reduced heat and improved air quality;
2. Better climate resilience through mitigation of flooding, storms and sea level rise;



3. Increased mental health and happiness;
4. Enhanced biodiversity protection;
5. Reinforcing connected city systems as waterways and green spaces deliver active travel, carbon capture, water filtration and stormwater capture benefits.

Across Sydney, electricity providers are also met with the challenge of trees exceeding overhead power lines' minimum safe distances, resulting in disruptions to power supplies, especially during storms. However, tree canopy on streets, as well as parks and green and blue corridors across our city are essential for heat mitigation and reducing energy bills. This reinforces the need to overcome connected challenges in how we design, maintain and operate our infrastructure sectors – in this case to ensure reliable electricity and more liveable suburbs.

Figure 9 The Inner West Greenway Credit: McGregor Coxall

City-wide scale

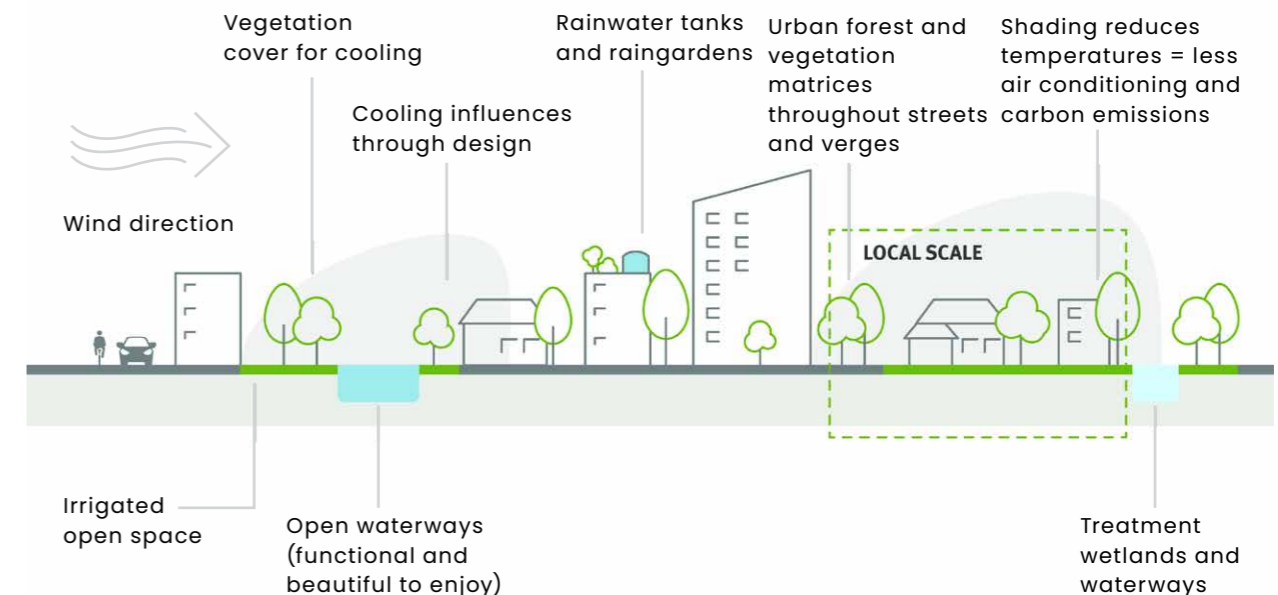


Figure 8 Blue-green infrastructure Credit: Aurecon

Industry example: Inner West – Cooks River to Iron Cove Greenway

- The GreenWay is an environmental and active travel corridor linking the Cooks River at Earlwood with the Parramatta River at Iron Cove. It mostly follows the route of the Inner West Light Rail and Hawthorne Canal and features bike paths and foreshore walks, cultural and historical sites, cafes, bushcare sites and a range of parks, playgrounds and sporting facilities.
- It has taken several decades to bring together the major infrastructure owners, utilities, and local governments to agree to the shared use of this corridor in order to achieve multiple community outcomes (urban canopy, active travel, biodiversity, recreation), as well as to continue to operate light rail and stormwater.
- Where there's contested use of land and growing urban intensification pressures, there is clearly value in pooling our assets to achieve multiple place based resilience through shared use of government-owned assets.



Key Moves



Three key moves have emerged from the sectoral and Government leaders from across Greater Sydney that are essential to enable cross-sector infrastructure resilience in Greater Sydney:

1. Use disaster adaptation planning to identify place-based infrastructure strengths and the impact of possible weak links

Preparing for possible disruptions to essential services is most relevant in the context of specific places, where the cascading impact on other services, and on business and the community can be understood and prepared for. This means working through place-based scenarios and identifying the range of possible mitigation measures, from an asset, system and community perspective.

Proposed Lead: NSW Reconstruction Authority

Key Collaborators: INSW, NSW DCCEEW, Transport for NSW, Sydney Water, Ausgrid, Endeavour Energy, Nbn, Local Government, Infrastructure Australia

The NSW Government's Critical Infrastructure Resilience Strategy (2018) identifies the need to increase cross-sector resilience – “manage uncertainty through scenario planning: A common set of future scenarios to streamline planning and support cross-sector coordination and shared responsibility”.

Legislation (particularly the Security of Critical Infrastructure (SOCl) Act), and Utility and NSW State Government leadership on natural disaster risk means that there are already efforts to understand sectoral vulnerabilities including in the energy and water sectors, and ongoing formal and informal collaboration with Local Government.

Image credit: Ausgrid



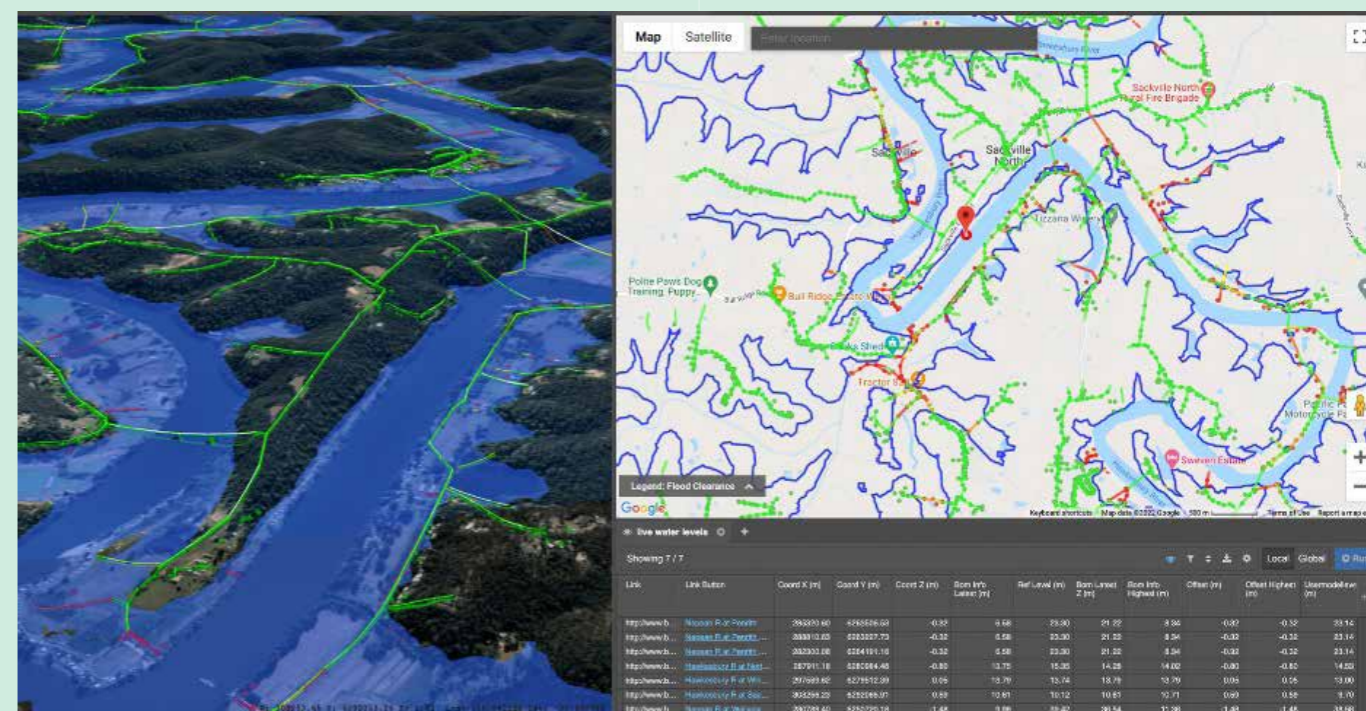
While some of these collaborative efforts are not visible due to legislative restrictions, sharing the depth and scale of ongoing collaborative efforts would increase transparency across sectors, and highlight where opportunities for improvements still exist to enhance collaboration and prepare for a changing climate.

Local Governments across Greater Sydney each manage hundreds of millions (sometimes billions) of dollars worth of infrastructure assets, including stormwater, waste (including collection, transfer, disposal, recycling), local roads and community buildings (such as town halls, libraries, leisure/aquatic centres, playing fields). While not considered ‘critical’ under legislation, this essential social infrastructure is increasingly recognized for its role in enabling and building community resilience, including in the recent bushfires and floods in Western Sydney⁽⁸⁾.

At the NSW scale, climate change scenario analysis is underway led by DCCEEW in collaboration with the Common Planning Assumptions Trends and Scenarios sub-group^[9]. The NSW Common Planning Assumptions are the agreed information assets (data sets, parameters and assumptions, models and analytical tools) used by the NSW Government and external stakeholders, to prepare proposals, business plans and strategies that rely on projections. DCCEEW is the lead agency delivering the NSW Climate Change Adaptation Strategy (Action 4), and the practical application of climate change scenarios.

Emerging Australian Sustainability Reporting Standards (Disclosure of Climate-related Financial Information) will prompt businesses to increasingly develop and disclose the impact of climate change on their own assets and operations in place. This reporting requirement is expected to drive an increased interest in how Governments and Utilities are managing climate related risks across their own portfolios, and the spatial implications of those risks.

Disaster Adaptation Plans – a key feature of the NSW State Disaster Mitigation Plan – are a place-based approach that have the potential to bring together these diverse efforts to where they meet the city and its community. Disaster Adaptation Plans are a key mechanism through which essential infrastructure providers (including local Government and civil society organisations) can engage to capture interdependencies and possible points of failure, better understanding natural hazard related risks, and possible impacts on businesses and communities.



INDUSTRY EXAMPLE:

Endeavour Energy Digital Twin

- A ‘digital twin’ is a virtual model designed to reflect a physical object, process or system that includes relational interactions with data and simulations.
- Endeavour Energy’s digital twin can be used to see how cables might sag in hot temperatures, which feeders might be impacted first as floodwater rises and determine the exposure of poles to high winds.
- During flood recovery, the digital twin allowed Endeavour Energy to quickly identify flood impacted properties without waiting for ‘on the ground’ assessments, dramatically improving the time to restore essential electricity supplies to flood-affected customers.

Figure 10 Digital Twin with flood layers Credit: Endeavour Energy



2. Ensure lessons from recent disasters are applied in cross-sectoral infrastructure planning and modelling for future emergencies

There is an urgent need to move from lesson identification to lesson application in understanding the dependency that each sector has on each other when trying to restore essential services during an emergency. Business and community continuity are key outcomes for infrastructure agencies to target in undertaking community engagement, modelling of potential future events, and better integrating infrastructure response into collaborative preparedness, planning and decision making.

Proposed Lead: NSW Reconstruction Authority/ Resilient Sydney

Key Collaborators: Premiers Department, EPA, Infrastructure sector agencies, NSW State Emergency Management Committee, Local Government, Infrastructure Australia

The NSW 2022 Flood Inquiry recommended the emergency management sector, and sectors that it depends on, be better informed on climate risk. Emergency response is fundamentally reliant on functioning infrastructure – power, water, roads, communication networks. When there are disruptions to any of these services we know that this can have immediate impacts on emergency response efforts and community safety.

Individual agencies have all identified ‘third party’ risks that are outside their control and recognise that greater coordinated efforts are required, including infrastructure investment between sectors to directly reduce these collective disaster risks to Sydney communities.

Industry leaders further identified the scope to improve exchange of knowledge and practice between essential infrastructure and emergency management practitioners, and gaps in understanding of climate risk.

Emergency management in NSW (as delivered by frontline combat agencies Police, Rural Fire Service, State Emergency Service etc) has a coordination structure that enables clear allocation of responsibility and decision making is well structured (LEMC, REMC, SEMC), and regularly debriefs to improve future response.

A similar governance mechanism is needed for infrastructure planning and investment for those essential services that enable communities to cope and adapt to changing climate risk, and which brings local government to the table where appropriate. This governance group would develop and deploy an aggregated risk matrix that includes all relevant third party risks.

INDUSTRY EXAMPLE:

New Zealand Lifeline Infrastructure Groups

- Collective approaches like regional lifeline infrastructure groups in New Zealand coordinate essential infrastructure and services to reduce the impact of service disruption on communities when power, drinking water, or communications are affected by natural disasters⁽⁷⁾.
- Regional infrastructure groups formally coordinate activities aimed at reducing infrastructure vulnerabilities to regional scale emergencies.
- The lifelines approach recognizes that to enable community continuity during floods or any hazard related disruption, infrastructure needs to be designed with the user in mind, and where that user lives or works.



Figure 11 Image credit: Endeavour Energy



3. Develop and share investment logic that account for system risks, and unlock infrastructure for resilience funding and finance

For regulated and private sector essential infrastructure providers, demonstrating the case for investing in infrastructure for resilience remains challenging. Unlocking the funding and finance to act on new climate information, or delivering on business and community continuity, requires regulatory approval, increased rates for customers, a new investment logic or all three. Accelerating access to investment requires developing and sharing each successful investment logic that delivers infrastructure for resilience.

Proposed Lead: InfrastructureNSW

Key Collaborators: NSW Reconstruction Authority, NSW Treasury, EPA, infrastructure sector agencies, Local Government, Infrastructure Australia, Investor Group on Climate Change (IGCC), Environmental Protection Agency

As noted in the 2022 NSW State Infrastructure Strategy⁽³⁾, allocating adequate funding for resilience is challenging. Asset maintenance and renewal result in a 'like-for-like' replacement of assets which may be unsuitable for the changing risk profiles over their operational lives. This is also the case for disaster funding and insurance arrangements, which typically replace assets on a 'like-for-like' basis or to existing design standards missing the opportunity for 'betterment' of those assets, and then benefits to the resilience of the wider system.

The Independent Pricing and Review Tribunal (IPART) is the independent pricing regulator for water, public transport and local government in NSW. IPART have



Image credit: Ausgrid

INDUSTRY EXAMPLE:

Resilient Asset Management Program (RAMP) Pilot Project

- The South Australian Resilient Asset Management Program pilot is a collaborative project between the cities of Marion, Mitcham, Holdfast Bay and Onkaparinga, and the South Australian Government, delivered by Aurecon, and the CSIRO and Value Advisory Partner's 'Enabling Resilience Investment (ERI) initiative'.
- The project will develop an approach to assess and mitigate climate-related risks to council assets, so that key decision-makers in councils can consider climate risks in management of current assets and future investments.
- The pilot is supporting councils to develop options to retrofit existing assets to improve asset performance over time and develop ways to fund actions needed to meet community expectations.

recently adopted a positive statement and framework on tackling climate change⁽²¹⁾ that has translated to a new clause in Sydney Water's draft operating licence about managing climate risk and adapting to the changing climate. To meet this clause Sydney Water have developed an updated investment logic in order to seek adaptation funding in their pricing proposal for the 2024-2029 licensing period⁽¹⁹⁾.

For energy utility owners, funding is regulated on a 5-year basis and is determined by an investment case to Australian Energy Regulator. The regulatory

proposal that informs investment in asset resilience is co-designed with the community and balanced between priorities of dependability, value for money and innovation investment that serve customers' long-term choices and interests. In support of its 2024-2029 Regulatory Proposal, Ausgrid prepared a Climate Resilience Investment program which was informed by climate experts who modelled the impacts of climate change on Ausgrid services and found a 26% increase (on average) in exposure to climate risks across the network area by 2050.

Although investment in infrastructure for resilience can incur larger upfront costs, the long-term savings by avoiding recovery costs is well-evidenced. This is also true for social infrastructure, given the lifesaving benefits and faster recovery associated with social cohesion. The increasing financial costs of climatic risk needs to be incorporated into investment decisions and planning given that integrating resilience into new assets and network performance is demonstrably cheaper than reactive replacement or upgrading protection later.

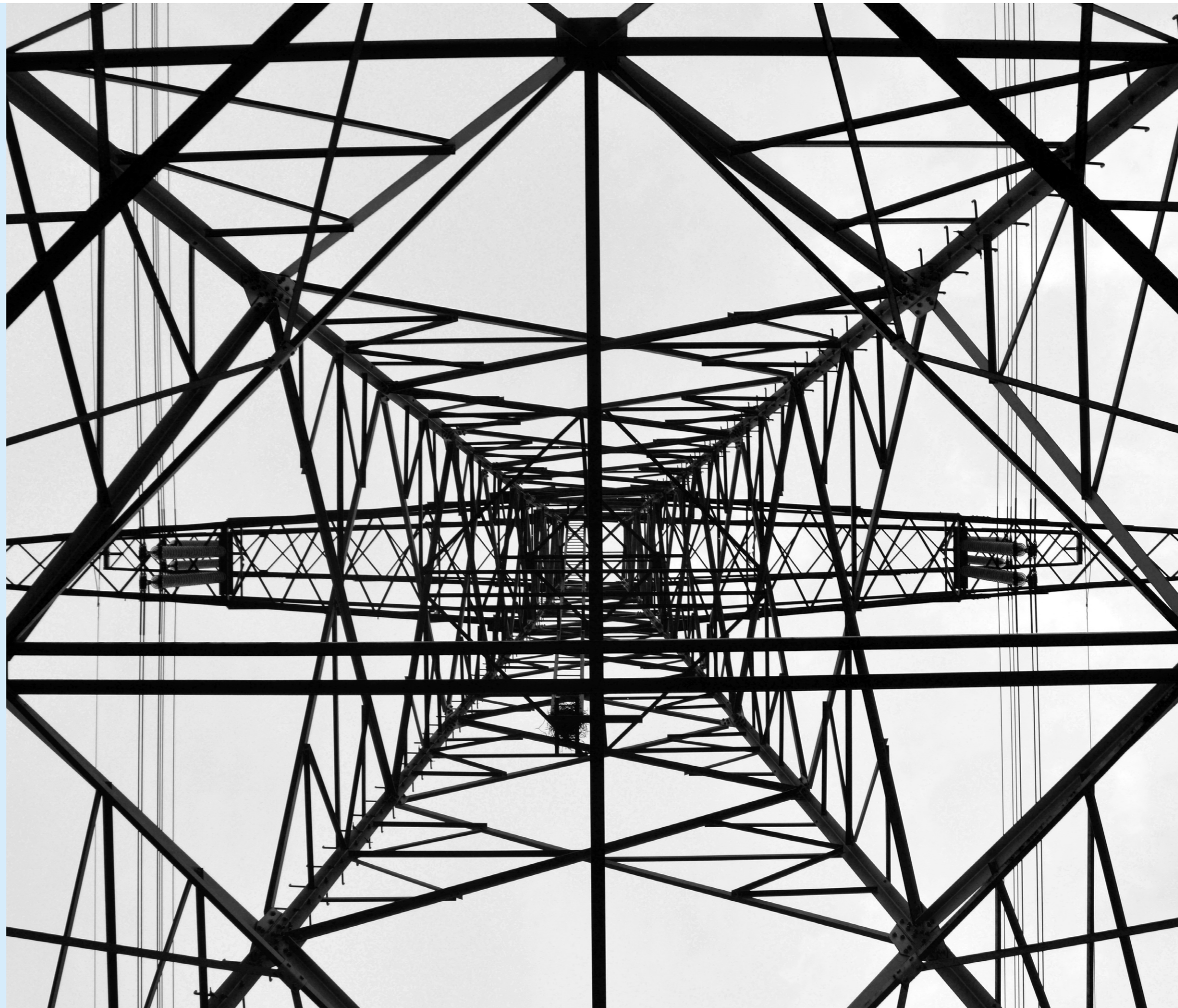


Next steps

This paper is based on expert insights and shared perspectives. The essential infrastructure landscape is dynamic, and structures that govern collaboration and investment need to mirror that context of constant change.

There are significant challenges in how to target, identify and manage interdependencies across diverse and differently regulated sectors, including social infrastructure that is largely delivered by Local Government.

Identifying the weak links, understanding possible cascading risks on business and the community, and continuing to build collective and collaborative ways of working that solve for cross-sectoral interdependencies are critical to enhancing infrastructure for resilience across Greater Sydney.





Appendix A:

Workshop findings and analysis

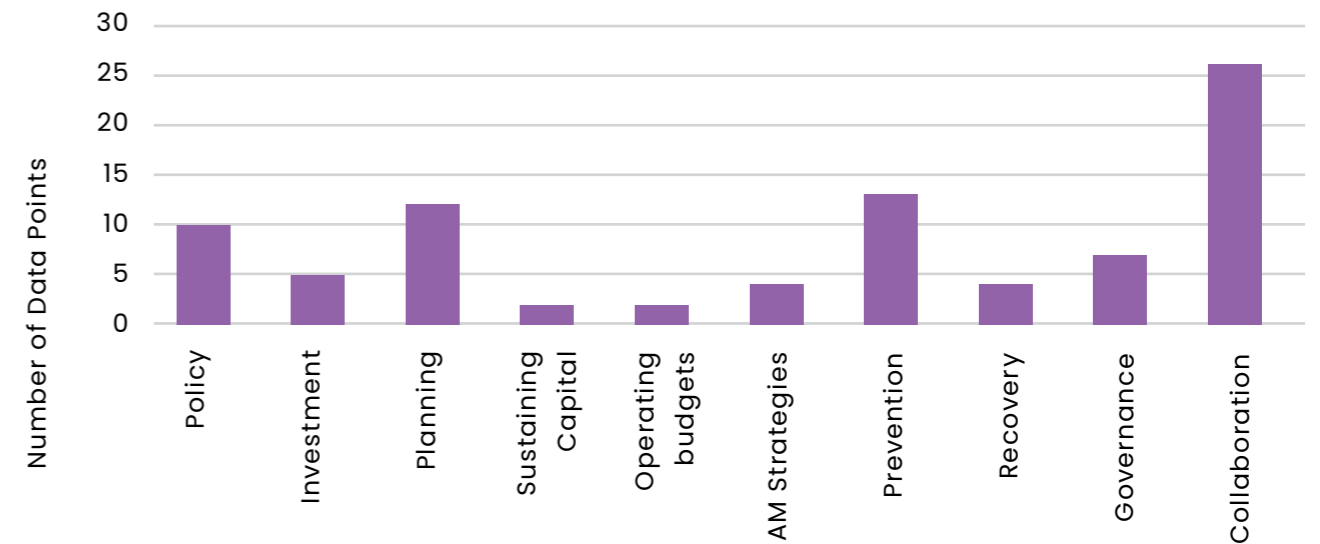
Workshop results were analysed using a taxonomy approach to categorise the barrier or enabler identified into the type of intervention proposed. These interventions include:

- Policy: definitions, strategic themes, guidelines, and plans.
- Investment: financial and economic analysis/mechanism.
- Planning: initial scoping at start of infrastructure project.
- Sustaining Capital: how we might augment an existing, operational asset to deliver more benefit and value.
- Operating Budgets: the financial allocation that organisations invest into the normal operations and maintenance of existing assets.
- Asset Management Strategies: how to efficiently manage assets, whilst maintaining cost efficiency and value for money.
- Prevention: pre-emptive planning for minimising disruption during a disaster either through infrastructure or systems resilience.
- Recovery: the response enacted during and after a disaster, stress or shock has occurred.
- Governance: overseeing mechanisms for accountability.
- Collaboration: engagement with stakeholders, including other organisations, governments, businesses and the community.

Question One: How can cross-sector, post disaster/disruption lessons learnt be more effectively analysed and distributed?

- **Key Barriers:** Lack of data collection, lack of structured knowledge sharing, lack of consistency, disconnect between reflection on disaster response and investment decisions, lack of clarity regarding responsibility/accountability.
- **Key Enablers:** Lessons learned sharing, information sharing across sectors, community engagement, sector wide governance/guidance on resilience, industry conferences/membership for knowledge sharing.

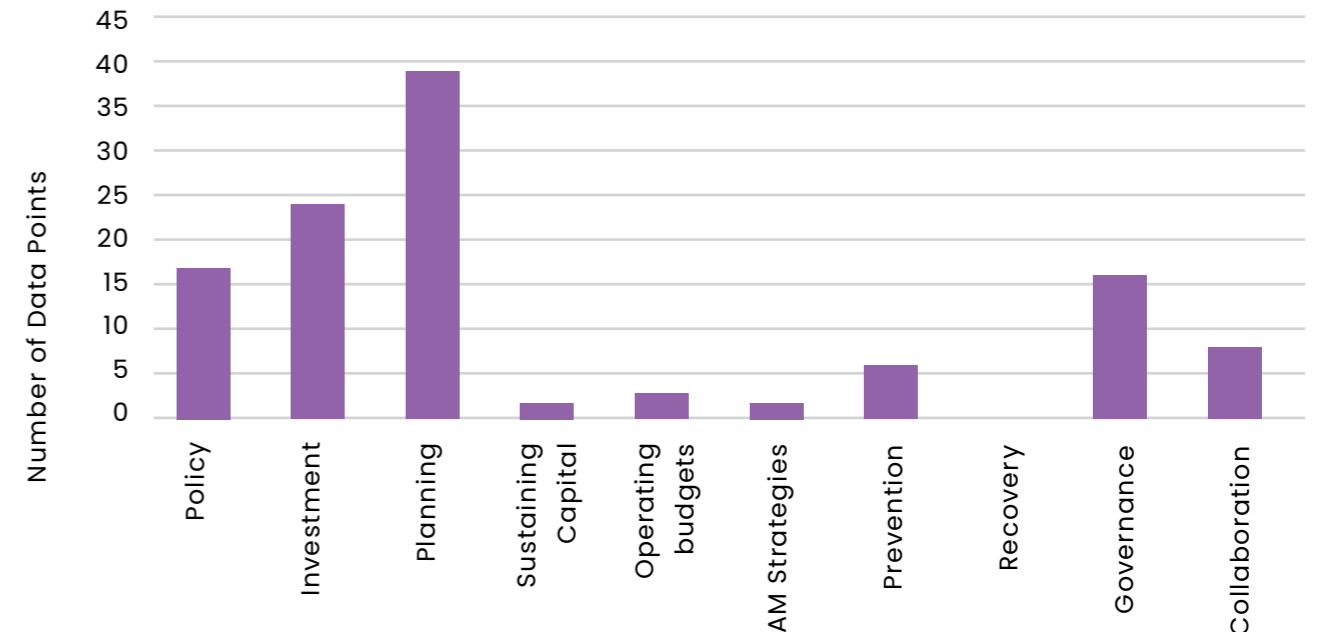
How can crosssector, post disaster/disruption lessons learnt be more effectively analysed and distributed?



Question 2: How can we increase investment in resilience for long-term infrastructure projects and systems?

- **Key Barriers:** Lack of education, disjointed governance, lack of financial incentives, funding, lack of understanding of long-term impacts, no standard methodology and climate risk scenarios.
- **Key Enablers:** Incentives (e.g. low/no discount rate on investment), demonstration of value to stakeholders/community, education on risk/consequence, increase understanding of long term cost benefit, quantify benefits.

How can we increase investment in resilience for longterm infrastructure projects and systems?

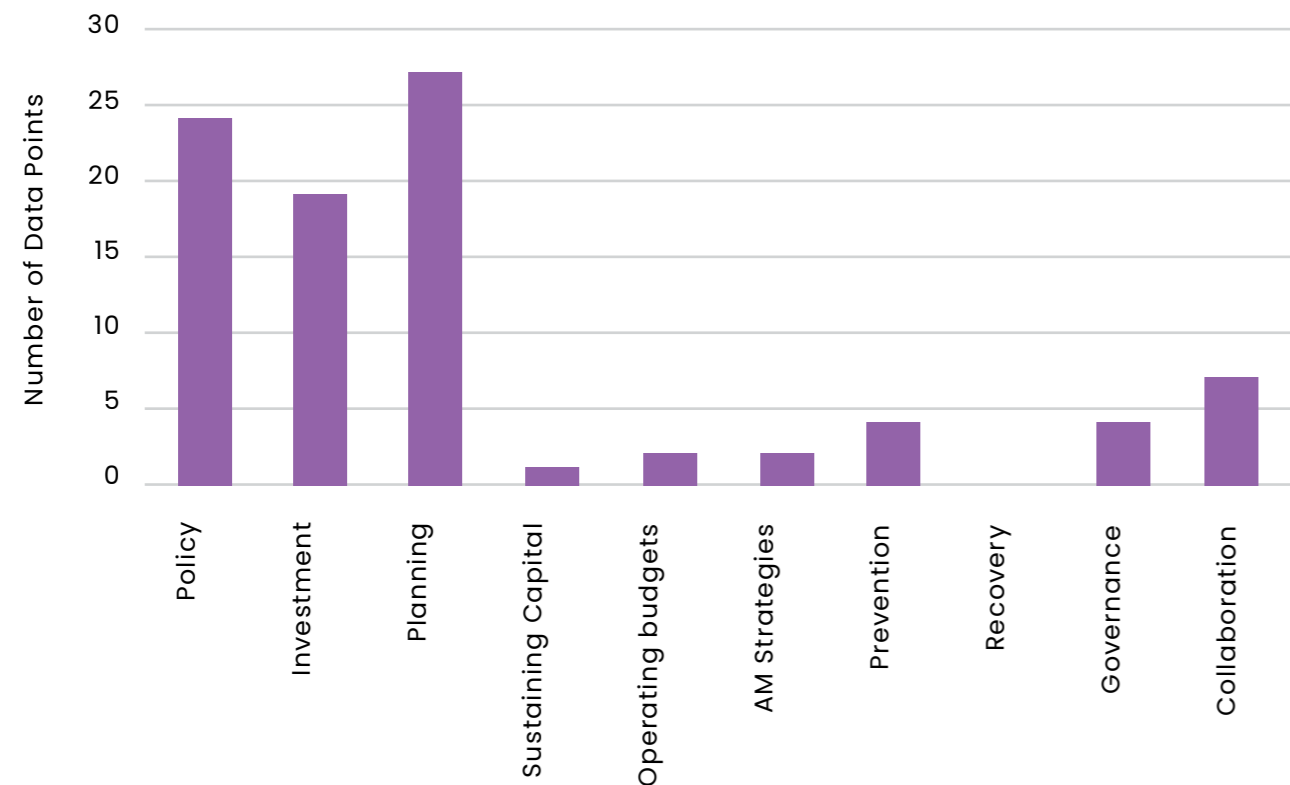




Question 3: How can we improve the consideration and use of nature-based solutions in increasing the resilience of infrastructure projects and systems?

- **Key Barriers:** Hard to communicate value of natural solutions, upfront cost but may take time to realise benefits, unpredictability of natural systems, green infrastructure not in EPA policy.
- **Key Enablers:** Circular economy, life cycle costing, quantify value of natural assets (TNFD/TCFD), quantify downstream benefits (may not be directly related to infrastructure) from upstream investment.

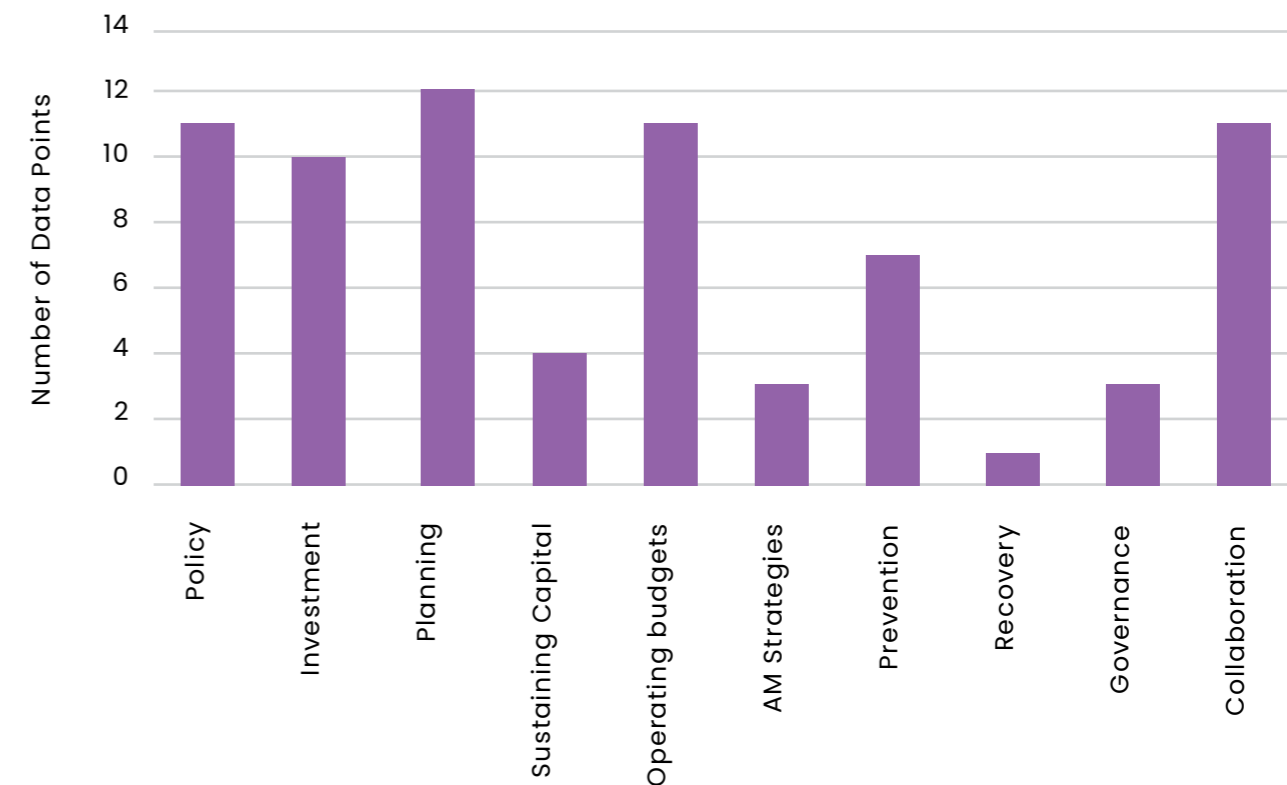
How can we improve the consideration and use of nature-based solutions in increasing the resilience of infrastructure projects and systems?



Question 4: How can we improve our ability to incentivize demand behaviour to prevent and manage service disruption?

- **Key Barriers:** Lack of access to data/information, lack of financial incentive, lack of choices (monopoly), lack of understanding/interest from consumers.
- **Key Enablers:** Education to increase empathy, access to real time data, smart meters/tech, tariff charges/peak time pricing structures.

How can we improve our ability to incentivize demand behaviour to prevent and manage service disruption?

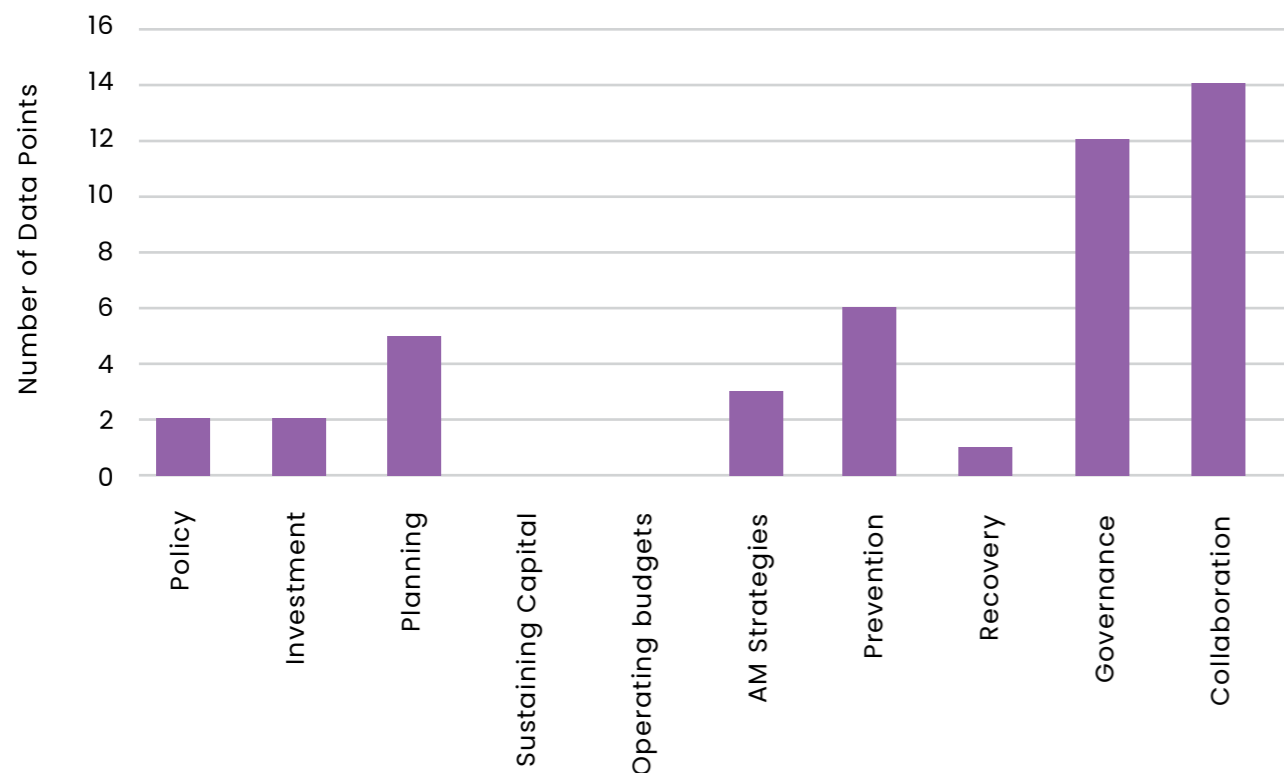




Question 5: How can we better identify and manage cross-sector roles and responsibilities for those in interdependent essential infrastructure sectors, in responding to threats/failures?

- **Key Barriers:** Funding (individual project priorities), no incentive to collaborate, no nominated leader, competing priorities.
- **Key Enablers:** Behaviour/culture changes, place-base compliance/regulation across sectors/markets, data sharing, funding to facilitate collaboration.

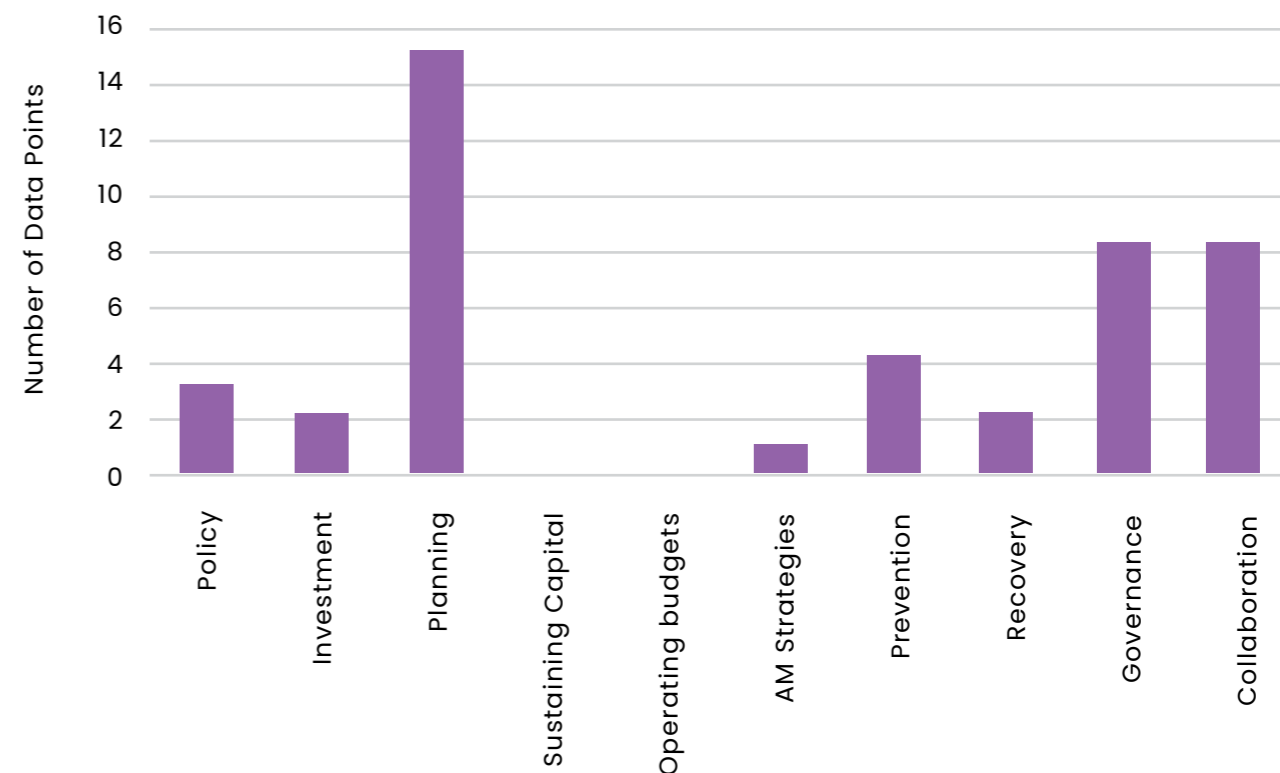
How can we better identify and manage crosssector roles and responsibilities for those in interdependent essential infrastructure sectors, in responding to threats/failures?



Question 6: How can we better understand, plan and manage the capacity to maintain continuity of cross-sector critical services in hazardous conditions and/or disruption?

- **Key Barriers:** Lack of understanding of interdependencies, lack of ownership/responsibility, lack of communication between providers, lack of resources.
- **Key Enablers:** Prioritisation of services and supply chain resources during disasters, scenario testing, early planning, better access to data/information.

How can we better understand, plan and manage the capacity to maintain continuity of cross-sector critical services in hazardous conditions and/or disruption?





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