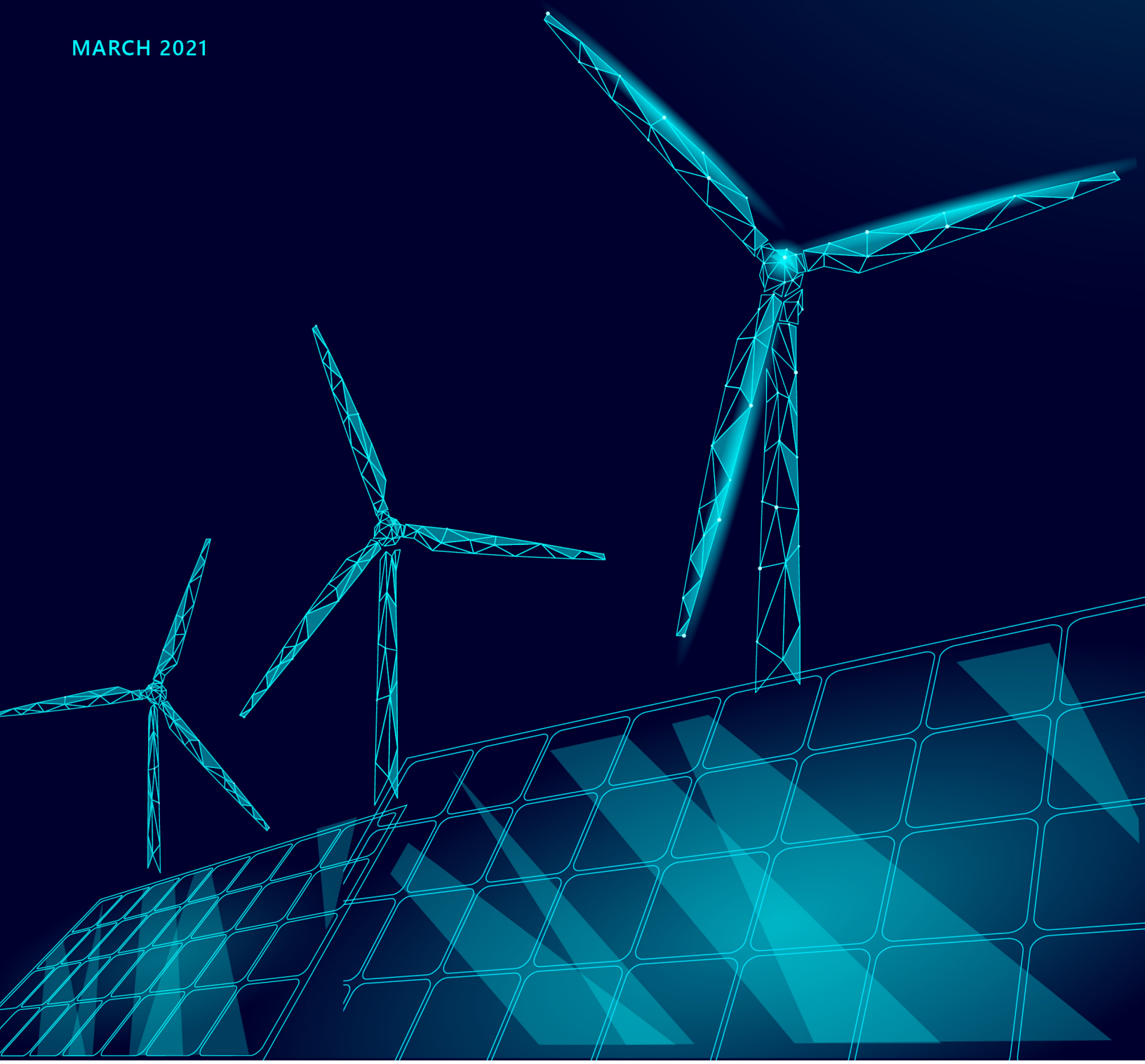
Financial Protection of Critical Infrastructure Services

MARCH 2021



Asia-Pacific Economic Cooperation

APEC 2020 MALAYSIA

THE WORLD BANK
IBRD • IDA | WORLD BANK GROUP

Acknowledgments

This technical report has been prepared by the World Bank Group under the disaster risk-financing and insurance agenda of the 2020 Asia-Pacific Economic Cooperation (APEC) Finance Ministers' Meeting under the presidency of Malaysia.

The World Bank Group's team was composed of Nicola Ranger, Lit Ping Low, and Benedikt Lukas Signer of the World Bank Disaster Risk Financing and Insurance Program (DRFIP), with inputs from Simon Hagemann, Shoko Takemoto, Hideaki Hamada, Beatrice Cassottana, and Matthew Foote - all from the DRFIP of the World Bank's Finance, Competitiveness, and Innovation Global Practice and under the overall guidance of Olivier Mahul.

The team gratefully acknowledges inputs and comments from both the World Bank Group's peer reviewers Catiana Garcia-Kilroy, Leopold Sedogo, and Thu Hang Vu and the external reviewers including Roger Fairclough, Chair of New Zealand Lifelines Council.

The report was prepared during the period of February to November 2020 as a part of the activities of APEC Working Group on Regional Disaster Risk Financing and Insurance Solutions. This report has benefited from the support of the Japan-World Bank Program for Mainstreaming Disaster Risk Management in Developing Countries, which is financed by the Government of Japan and managed by the Global Facility for Disaster Reduction and Recovery (GFDRR) through the Tokyo Disaster Risk Management Hub.

Editorial services by Publications Professionals LLC.
Design and layout by X-Tempo Communications.

Contents

Executive Summary 5

1. Introduction 14

2. Planning Financial Protection and Critical Infrastructure Services 21

3. Combining Financial and Operational Preparedness to Ensure Continuity of Critical Services 33

4. Integrating Critical Infrastructure in Government Financial Protection Strategies 47

5. Understanding Financial Preparedness, Critical Services, and Pandemics 56

6. Next Steps 62

Annex I. Critical National Infrastructure: APEC Resilience Strategies 64

Annex II. New Zealand Lifelines Utilities: Integrating Operational and Financial Preparedness 66

Annex III. Japan: Improving Disaster Preparedness and Restoring Critical Infrastructure Services after Disasters through Partnership with the Private Sector 70

Annex IV. Sint Maarten: Reconstruction of Sint Maarten Airport after Hurricane Irma 73

Annex V. United States: Disaster Recovery in Privately Owned Electric Utilities 75

Annex VI. The CARILEC Disaster Assistance Program 79

Annex VII. Australia: Defining Risk Ownership for Rapid Recovery 83

Abbreviations 86

References 88

Executive Summary

APEC member economies are among those most exposed to disasters globally; Asia-Pacific alone faces estimated annual economic losses caused by disasters of US$675 billion.[1] Disaster losses can have a sizable fiscal impact on those economies most vulnerable to disasters, often setting back economic growth and poverty alleviation. In response, financial protection against disasters has gained significant traction globally, to reduce the fiscal impacts of disasters and ensure that finance is available for a speedy recovery. Ensuring high-quality, reliable, sustainable, and resilient critical infrastructure services when faced with such shocks is a growing priority and a part of many countries' core national security planning.

Disruption to critical infrastructure can cause major adverse economic effects and significant harm to the well-being of citizens - especially the poor and vulnerable. The economic and social impacts from disruption to critical infrastructure come primarily from the loss of the service they provide, not from the cost of physical damages to the assets themselves. For example, direct damages from disasters to the power generation and transport infrastructure are estimated at US$18 billion a year in low- and middle-income countries globally. But the estimated cost of the associated disruption to services (energy and transport) ranges from US$391 billion to US$647 billion (at least 20 times larger).[2] Disruption to services can emerge not just from physical damages but also from disruptions to people, inputs, or even shocks to demand. For example, COVID-19 strained water utilities through increased demand, disruptions to supply chains and essential workers, and falling revenues, which ultimately will negatively impact the government's balance sheets if the disruptions require public support. For this reason, the focus of this report is vital because it is about protecting critical infrastructure services rather than just the underpinning assets. The report focuses mainly on disruptions related to natural hazards, such as storms or floods, but also on pandemics; however, disruptions can sometimes result from manmade shocks, such as terrorism and cyber attacks.

Critical infrastructure is defined as assets, systems, and networks that provide essential services for the security of a nation, its economic prosperity, and the health and safety of its citizens. Those services, such as energy, transport, and water, constitute the backbone of modern interconnected societies. A service requires a complete critical infrastructure system: (a) one or multiple physical assets connected in a network (e.g., roads, hospitals, power plants), (b) people, and (c) inputs (e.g., raw materials, fuel, electricity). This report uses the term critical infrastructure to refer to all those aspects required to deliver the critical services (transport, health care, energy). Six sectors are widely classified as being critical: energy, transport, water, information and communications technologies (ICT), health, and finance. Some countries further include education and the critical economic and manufacturing sectors within their definition.[3]

Ensuring the continuity of critical services in the aftermath of a disaster should be one key objective of financial protection of critical infrastructure. The costs associated with disruptions to critical services can strain budgets, reduce productivity, and stall investment, along with having knock-on impacts for growth and well-being. Reducing the risk of disruption - whether through physical resilience, by ensuring good maintenance, repair, and service continuity planning, or both - can significantly reduce the costs of disasters. For critical infrastructure services, ensuring the resilience of the system as a whole is as important as the physical resilience of individual assets. This approach means

[1] UN-ESCAP (United Nations Economic and Social Commission), The Disaster Riskscape across Asia-Pacific (Bangkok: UN-ESCAP, 2019), https://www.unescap.org/sites/default/files/APDRR%20_draft_15%20August%202019_latest%20Delhi.pdf
[2] Stéphane Hallegatte, Jun Rentschler, and Julie Rozenberg, Lifelines: The Resilient Infrastructure Opportunity (Washington, DC: World Bank, 2019).
[3] OECD (Organisation for Economic Co-operation and Development), Good Governance for Critical Infrastructure Resilience: OECD Reviews of Risk Management Policies (Paris: OECD Publishing, 2019), https://doi.org/10.1787/02f0e5a0-en For example, the critical manufacturing sector can include those involved in manufacturing chemicals needed for clean water.

building in redundancy and ensuring that mechanisms are in place to deal quickly with any disruptions and to restore services when needed. Financial preparedness is a critical part of this approach, both to ensure adequate funding for more frequent repair and maintenance after small events and to implement contingency plans for rapid recovery after more infrequent, larger disasters.

In addition to ensuring that finance is available to minimize disruptions, financial protection of critical infrastructure should manage the fiscal impact from any shock. An increasing number of APEC economies account for the potential cost of damage to public assets within public finance frameworks. But the potential fiscal impact from disruptions to critical services is often not fully quantified and recognized. Two sources of contingent liability are associated with critical services beyond the cost of the physical assets and are in addition to the potential loss of revenues from the economic disruption:

- **Costs for maintaining and reinstating critical services.** This liability includes government expenditures related to providing services during emergencies. For example, Typhoon Haiyan heavily disrupted education and health care in affected areas in the Philippines in 2013. The government had to provide temporary health and education services to thousands of citizens, in addition to rebuilding hospitals and schools. This cost can also include government expenditures for maintaining critical services disrupted by pandemics such as COVID-19, rather than physical damages to assets. A pandemic can have a major fiscal impact; for example, in Brazil, the losses to state-owned enterprises (SOEs) in the water sector caused by COVID-19 have been estimated at more than US$100 million.

More than 2500 public schools were damaged or destroyed as a result of Typhoon Haiyan

- **Costs of implicit contingent liabilities.** Although in many countries a large part of critical infrastructure is owned or operated by the private sector, the government may still act as the insurer of last resort. For example, the government may end up paying the costs of recovery after a large disaster because the service is so critical to the population. This implicit contingent liability on the government is often not recognized and not managed. Such unexpected expenditures can have a sizeable impact on government budgets. Clarifying in advance who owns the risk (who is responsible after a disruption) is important for managing this contingent liability. A lack of clarity can also create poor incentives for resilience and can lead to delays in recovery contingent liability. A lack of clarity can also create poor incentives for resilience and lead to delays in recovery.

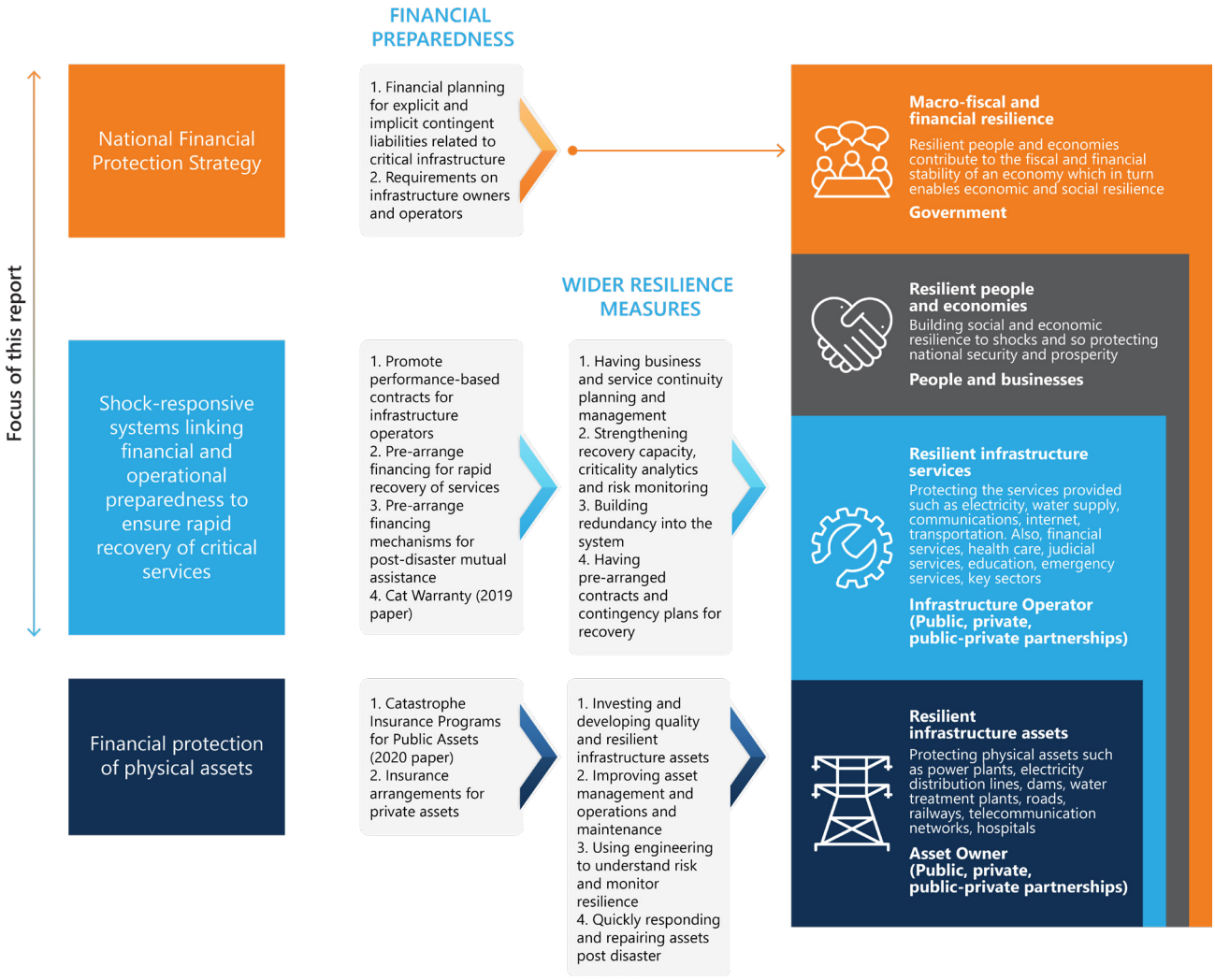
Bringing those aspects together creates an operational framework for financial protection of critical infrastructure that should combine three interconnected parts (as illustrated in figure ES.1).

1. **Financial protection of physical assets.** This protection means having finance and plans in place to rehabilitate or reconstruct critical assets after a disaster. Protection could include, for example, public assets insurance or budgetary mechanisms such as disaster funds. In 2018, APEC and the World Bank collaborated on an operational framework for catastrophe insurance programs for public assets, which drew on the experience of Australia, Colombia, Japan, Mexico, and New Zealand.

2. **Shock-responsive systems that link financial and operational preparedness to ensure rapid recovery of critical services.** Such preparedness means having plans, finance, and systems in place to rapidly mobilize action in the event of a shock, thereby either ensuring continuity or reducing the severity and duration of any disruptions to critical services. This report proposes an operational framework for the financial protection of critical services by bringing together good practice from risk financing and infrastructure planning. It introduces case studies from the Caribbean, Japan, and the United States.

3. **A national financial protection strategy that integrates critical infrastructure to efficiently manage the contingent liabilities related to such shock-responsive systems.** Here the focus is on (a) reducing any financial shock to government balance sheets that might arise from the costs of recovering and reinstating critical services post-disasters and (b) ensuring that timely, predictable, and cost-effective finance is available in emergencies so the government can quickly restore services when needed. Several APEC economies already have a national financial protection strategy in place. This report considers how to appropriately include critical infrastructure within such a national financial protection strategy. It includes case studies from Australia and the United Kingdom.

Figure ES.1. Interaction Of Financial Resilience Of Assets, Services, And Countries



Source: World Bank staff.

Note:
a. The schematic shows the links among critical infrastructure assets (dark blue), services (light blue), wider economic and social resilience (grey), and macro-fiscal and financial resilience (orange). The left-hand side of the schematic summarizes the three components of financial protection of critical infrastructure services and shows how they contribute to financial preparedness and resilience as well as how they link to resilience at the different levels on the right-hand side.
b. This report focuses on the additional aspects of financial preparedness related to critical infrastructure services in light blue and on the links to national financial protection strategies to strengthen macro-fiscal resilience to disasters and to safeguard the continuity of services post-disaster. Previous reports such as the following have covered aspects of infrastructure assets resilience:
(1) World Bank, "Catastrophe Infrastructure Warranty against Climate and Disaster Shocks," Draft Technical Proposal for discussion at 2019 APEC Finance Ministers Meeting and 2019 Investor Forum, 2019.
http://mddb.apec.org/Documents/2019/MM/FMM/19_fmm_007.pdf
(2) World Bank, Catastrophe Insurance Programs for Public Assets: Operational Framework (Washington, DC: World Bank, 2020).
https://openknowledge.worldbank.org/bitstream/handle/10986/34440/Catastrophe-Insurance-Programs-for-Public-Assets-Operational-Framework.pdf?sequence=1&isAllowed=y

Approaches to strengthen financial protection of critical infrastructure services should be integrated in already ongoing work to strengthen resilience. This integration includes particularly (a) efforts to enhance the physical resilience of critical infrastructure systems and of social and economic resilience[4] and (b) the use of existing good practice for resilience within public-private partnerships in infrastructure.[5,6]

Enhanced financial protection can deliver significant benefits for wider resilience. Putting in place rules that determine who pays for what damages in the event of a disaster not only helps to manage the risks to public finances but also creates incentives for infrastructure owners and operators to invest more in building long-term resilience. There is also growing evidence that strengthening preparedness for disasters can support building back better.

This report proposes an operational framework for strengthening the financial preparedness of critical infrastructure through shock-responsive systems that are embedded in strong national risk management and financial preparedness. It builds on existing principles and approaches to disaster risk financing, including many developed by APEC economies in collaboration with the World Bank.

Combining Financial and Operational Preparedness to Ensure Continuity of Critical Services

Effective financial protection of critical infrastructure services requires the integration of operational preparedness and financial preparedness in shock-responsive systems. Strengthening response and recovery capabilities requires both components to be in place pre-disaster (figure ES.2):

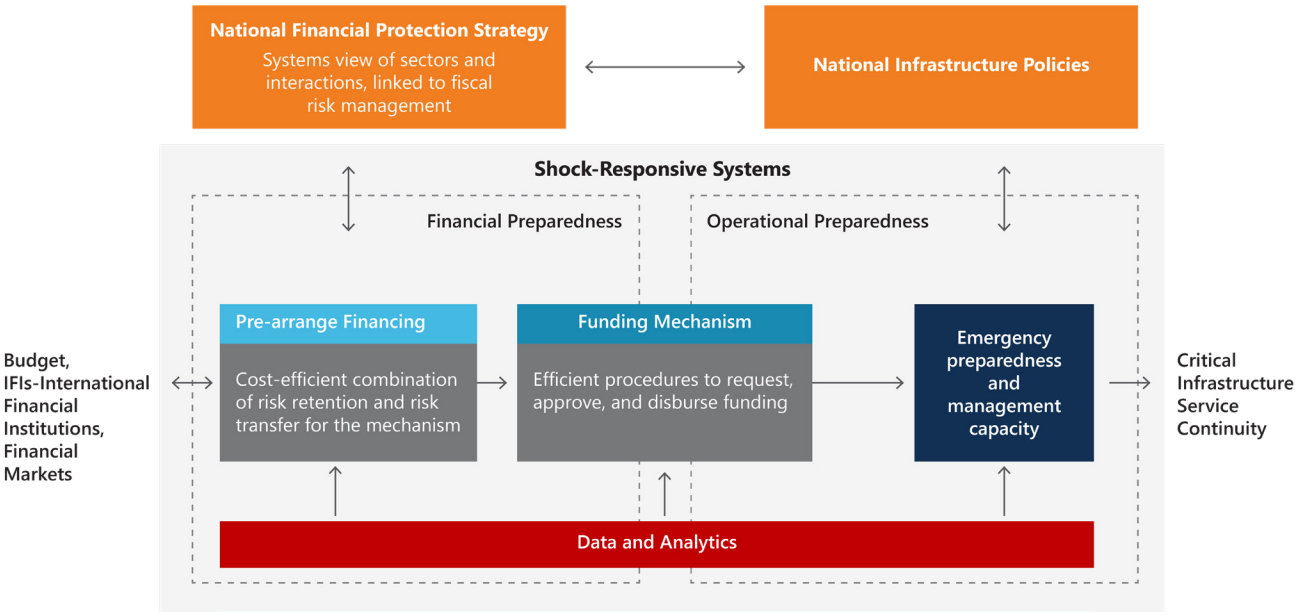
- **Operational preparedness.** The right plans, standard operating protocols, and capabilities (e.g., people, equipment, resources) must be in place to quickly restore critical services.

- **Financial preparedness.** A mechanism or a plan to ensure adequate and timely financing is available to implement those overall plans that can be accessed effectively.

In February 2021, as a result of record snowfall and the lowest temperatures in more than 30 years in Texas, USA, 4.5m Texan households were cut off from power and major electricity firms are facing risks of bankruptcy.

[4] Stéphane Hallegatte, Jun Rentschler, and Julie Rozenberg, Adaptation Principles: A Guide for Designing Strategies for Climate Change Adaptation and Resilience (Washington, DC: World Bank, 2020).
[5] World Bank, Technical Brief on Resilient Infrastructure Public-Private Partnerships: Policy, Contracting, and Finance (Washington, DC: World Bank, 2019).
[6] World Bank, Resilient Infrastructure Public-Private Partnerships: Contracts and Procurement - The Case of Japan (Washington, DC: World Bank, 2017).

Figure ES.2. Three Components for Shock Responsive Systems (center) to Protect Critical Infrastructure Services and the Relationship to National Risk Financing and Infrastructure Policies (top)



Source: World Bank staff.

Financial preparedness can be further broken down into two aspects: mobilizing and delivering funding. First, it requires the right financial engineering to ensure cost-efficient access to sufficient funding for shocks of different severity, alongside sufficient funding for regular operations and maintenance (O&M). Second, it requires the right public finance mechanism to ensure effective flow of funds. For example, an O&M fund can be established with standard operating procedures for quick approval of emergency expenditures to implementing agencies. This fund can then be backstopped by insurance or other financial instruments to ensure that it has enough resources to meet needs after catastrophic events. Such financial preparedness can be centralized for the government as a whole or decentralized (e.g., by sector or region). The best approach will depend on each country's specific context, institutions, laws, and policies.

The term shock-responsive systems means infrastructure operators know they have the financing to put in place as they implement the plans, equipment, and agreements necessary to ensure rapid recovery. It also means financial planners have comfort that any allocation of funding can be executed quickly and in line with agreed objectives. Experiences from the Caribbean, Japan, and the United States are examples of where such financing has reduced service disruptions. Systems should be underpinned by data and analytics to assess probable impacts, to prioritize planning, to trigger early action, and to guide recovery interventions.

Example: In **Japan**, local governments establish agreements with private companies in advance to initiate relief and recovery work immediately following a disaster. Following the Great East Japan Earthquake, damaged major motorways were repaired within the first week through such pre-arranged contracts.

Example: In the Caribbean and the **United States**, private energy infrastructure operators have established mutual assistance agreements, which are backed by pre-arranged finance. When Hurricane Sandy left 8.5 million customers without power in New York and New Jersey, electric utilities executed mutual assistance agreements to deploy more than 70,000 workers to the affected areas and enabled air transportation of 229 power-restoration vehicles and 487 personnel to restore power.[7]

Integrating Critical Infrastructure in National Financial Protection Strategies

National financial protection strategies-usually championed by Ministries of Finance-set out the policies and financial instruments to increase countries' financial resilience to shocks and to ensure that finance is available for a speedy recovery. As both financiers and conveners, the Ministries of Finance are well positioned to take an integrated, national perspective about the financial risk management of critical infrastructure and also to use public finance frameworks for aligning incentives across government and the private sector in order to strengthen resilience at a national level. This role should balance two pillars: (a) protect the government's balance sheet through efficient management of contingent liabilities and (b) protect society by ensuring continuity of services in line with national critical infrastructure strategies.

Both assessing and managing disaster-related contingent liabilities from critical infrastructure in public finance frameworks are important for efficient public financial management of disasters. Such an approach can support more efficient management of disaster risk in three ways: (a) it supports planning for adequate financial arrangements to cushion the impact of disasters on the government's balance sheet, (b) it ensures that timely finance is available for recovery across all sectors, and (c) it can inform policy and regulation to clarify risk ownership (who is responsible to pay) and can create positive incentives for risk management.

Clarifying risk ownership is particularly important for critical infrastructure, because a large portion of critical infrastructure will often be owned or operated by SOEs or the private sector. This lack of clarity can lead to problems over who is responsible to pay after a shock, and can pose implicit contingent liabilities on government. Clarifying (and enforcing) risk ownership and cost-sharing requirements can reduce the overall disaster-related contingent liabilities over time. This clarity of role is also necessary to create the right incentives on infrastructure owners and operators (public or private sector) to invest in resilience and to avoid delays in recovery that may result from lengthy negotiations over who pays. Making contingent liabilities explicit can create a foundation for stronger risk governance across government and enhanced societal resilience.

Example: The **United Kingdom** has taken major steps to implement a framework to assess and manage contingent liabilities to better manage fiscal risks and improve both integrated risk governance and proactive risk management across government. The steps include assessing potential implicit contingent liabilities related to shocks. International Monetary Fund (IMF) research found that implicit contingent

[7] FEMA (Federal Emergency Management Agency), "Hurricane Sandy FEMA After-Action Report" (U.S. Department of Homeland Security, Washington, DC, 2013), https://www.alnap.org/help-library/hurricane-sandy-fema-after-action-report

liabilities from shocks such as financial crises, natural disasters, and pandemics create some of the largest fiscal risks to government balance sheets.

Through policy, regulation, and procurement practices the government can encourage adequate financial protection by critical infrastructure owners and operators. Moreover, infrastructure owners and operators bear the primary responsibility for protecting their assets and maintaining the continuity of services they provide. But priorities and levels of risk tolerance will often be different between the public and private sector. As a policy maker, financier, and regulator, the government often plays a key role to set required levels of preparedness that will ensure acceptable levels of risk for citizens and national security.[8] This approach can involve (a) setting minimum requirements for risk management and risk-transfer arrangements through regulation, (b) making cost-sharing arrangements within public-private partnerships (PPPs), (c) requiring disclosure of information about risks, or (d) using performance-based contracts that incentivize service continuity. Requiring operators to have some form of insurance in place can also put a price tag on risk and can require proper O&M as a condition of payout - all of which further incentivize resilience.

Example: Cost-sharing arrangements between levels of government in **Australia** and **Mexico**, as well as requirements to purchase minimum levels of insurance on private infrastructure operators in **New Zealand**, have built incentives to invest in wider resilience. In **Japan** and the **United States**, regulation clearly defines who - government or utilities companies-is responsible for recovery from different sizes of disasters. This regulation has formed the basis of shock-responsive systems in the transport and energy sectors.

Examining Financial Preparedness, Critical Infrastructure Services, and Pandemics

The COVID-19 pandemic has highlighted the threat to critical infrastructure services from many different sources of risk and has underscored the need for more holistic planning across risks. Pandemics do not damage physical assets but can severely disrupt services through the impact on people, inputs, and demand. During the current pandemic, health services have been most directly impacted, but education, finance, water, energy, and transport have also been severely affected. Such disruptions can have a sizeable fiscal impact, both through losses of revenue and increases in expenditure. The negative fiscal impact is direct in the case of state-owned enterprises, for example critical services in the water or energy sectors have been heavily affected by COVID-19.

Other risks may affect critical services in the future (for example, cyber risks). Such a risk can be a significant contingent liability that is often underestimated or not assessed at all. A national financial protection strategy can be a mechanism to support comprehensive financial risk management, which is integrated in broader fiscal risk management.

Governments around the world are starting to explore new ways to better manage such liabilities. For example, the United Kingdom and the United States are exploring new financial arrangements to better manage such contingent liabilities in the future so the governments can avert major fiscal impacts from pandemics, including through PPPs to strengthen the market for pandemic insurance. Disaster risk finance and insurance could also support measures to manage such risks to the continuity of critical services. Public interventions should ensure that infrastructure owners

[8] OECD, Good Governance.

and operators assess and disclose risks and put in place adequate financial protection.

Investing in financial resilience is critical to enable stronger preparedness across society, especially for new and unexpected risks. Global experiences show that the benefits of good financial risk management are not just in the early, predictable finance received after an event, but are also in the greater understanding of risk, the discipline of pre-planning for disasters, and the use of decision-making systems that can enable wider resilience. For governments to be better prepared for future shocks, strengthening financial preparedness should be a core part of post-COVID-19 recovery.[9] Financial protection of critical infrastructure is even more important in a post-COVID-19 context when countries face fiscal constraints and when households and firms are less economically secure.

Looking Forward

This report presents a preliminary operational framework for economies to improve financial resilience of critical infrastructure services. It complements ongoing World Bank work with APEC economies to improve financial protection of public assets (for example, with Indonesia, Mexico, Peru, the Philippines, and Vietnam). This framework is intended as a first step to advance discussion. Furthermore, it is a new area, and no complete international benchmarks exist. The framework aims to synthesize learning, to highlight the importance of this agenda, and to provide a basis for further development. It can act as a diagnostic and checklist to assist countries in identifying priority actions that will strengthen resilience. APEC could play an important role in this endeavor through facilitating further knowledge exchanges across the region.

The World Bank is exploring projects to embed financial protection against disasters that affect critical infrastructure investment in high-risk countries. Although such projects are at an early stage, lessons are beginning to emerge. For example, the absence of asset-level data is a key constraint to understanding risk and to designing strategies, particularly in lower-income countries and economies, as well as the lack of data about interdependencies of assets and services and the lack of modeling of the resulting systemic risks. The World Bank and others are exploring ways to close such data gaps by using new technologies, satellite data, and risk models, as well as by using risk analytics for systemic infrastructure risks. Early work suggests that even where there are constraints, significant opportunities exist to strengthen financial preparedness. A key challenge is linking financial preparedness to operational preparedness that will execute funds effectively following a shock.

APEC finance ministers could promote priority policy actions to strengthen financial resilience of critical infrastructure services against shocks. Specifically, APEC finance ministers could promote activities in the following areas: (a) assess the potential fiscal impact from disruptions to critical services, (b) strengthen the integration of operational and financial preparedness planning, (c) integrate the contingent liability from critical service interruptions in national risk-financing frameworks, and (d) consider ways to promote comprehensive risk management during recovery from the COVID-19 pandemic.

Support from international partners is available to further strengthen financial resilience of critical services. For example, the Japan-World Bank Program for Mainstreaming Disaster Risk Management in Developing Countries helps bring Japanese and global lessons to vulnerable countries around the world. The Global Risk Financing Facility (GRiF) with more than US$200 million in financial support from Germany and the United Kingdom provides large grants to pilot shock responsive systems that are integrated in World Bank projects.

[9] Olivier Mahul and Benedikt Signer, "The Perfect Storm: How to Prepare against Climate Risk and Disaster Shocks in the Time of COVID-19," One Earth 2, No. 6 (2020): 500–502.

1. Introduction

APEC member economies are among those the most exposed to disasters globally; Asia-Pacific alone faces estimated annual economic losses caused by disasters of US$675 billion.[10] Many APEC member economies have experienced losses from earthquakes, floods, and typhoons of 1 percent to 10 percent of GDP over the past 20 years.[11] Disaster losses can have a sizeable fiscal impact on economies and can even set back long-term economic growth and poverty alleviation. Climate change will exacerbate such risks; recent research by the World Bank estimates that losses of 7.3 percent of GDP could be seen by the end of this century across the region, with member economies near the equator likely to experience the largest economic losses.[12,13]

Disruption to critical infrastructure can cause major adverse economic effects and significant harm to the well-being of citizens, especially the poor and vulnerable. This issue affects all APEC member economies (box 1.1). For example, the 2011 Great East Japan Earthquake led to a 50 percent reduction in electricity production, thereby causing substantial energy disruptions across the country and damaged roads. The Wellington earthquake in New Zealand disrupted supply chains for months, which means that investments strengthening the resilience of critical infrastructure are an especially good value for money. Returns on the investment in resilience are estimated to be more than four dollars for every one dollar invested.[14] The importance of weather-related events was particularly clear in middle- or high-income countries, whereas in the lowest-income countries, poor maintenance tended to be the largest driver of disruptions. Such investments can become even more important and cost-effective in a changing climate; even today, weather-related damage is one of the largest drivers of disruptions to critical infrastructure.

Box 1.1. Examples of Impacts of Critical Infrastructure Disruptions Caused by Disasters in APEC Economies

- The 2011 Great East Japan Earthquake and Tsunami significantly affected the energy sector in **Japan**.[15] The subsequent shutdown of nuclear power plants throughout the country led to a 50 percent reduction in electricity production, thereby causing substantial disruptions to the energy supply across the country.

- The 2012 Superstorm Sandy affected the East Coast of the **United States**, flooding key roads and tunnels that connect Brooklyn and Manhattan as well as flooding train and subway lines in the greater New York-New Jersey metropolitan area.[16] As a result, 5.4 million commuters were stranded without a means of transportation, thereby disrupting business continuity more widely than did the hurricane itself. In addition, an estimated 8.5 million households suffered from electricity shortages.

[10] UN-ESCAP, Disaster Riskscape.
[11] Alessandro Cantelmo, Giovanni Melina, and Chris Papageorgiou, "Macroeconomic Outcomes in Disaster-Prone Countries," IMF Working Paper 19/217, International Monetary Fund, Washington, DC, 2019.
[12] World Bank, Climate Change in APEC: Assessing Risks, Preparing Financial Markets, and Mobilizing Institutional Investors (Washington, DC: World Bank, 2020), https://openknowledge.worldbank.org/handle/10986/33423
[13] Stéphane Hallegatte et al., Shock Waves: Managing the Impacts of Climate Change on Poverty (Washington, DC: World Bank, 2016).
[14] Hallegatte, Rentschler, and Rozenberg, Lifelines.
[15] OECD, Good Governance, box 1.1. | [16] Ibid.

The flooded South Ferry Subway Station in New York sheltered after Superstorm Sandy.

- The 2010 earthquake in Chile caused major disruptions to transport and telecommunication systems.[17] Of the US$30 billion worth of damages (18 percent of GDP), US$21 billion was due to infrastructure damage. The total decline in national economic activity that resulted from the damages was assessed at 5 percent in March 2010 (one month after the earthquake). Economic disruption continued for more than three months.

- The 2013 power outage in the northeastern United States and Canada was caused by trees falling on a high-voltage power line in Ohio, thus triggering cascading failures in southeastern Canada and the northeastern United States.[18] The outage affected 50 million people in both the United States and Canada at an estimated cost of US$6 billion.

- Following a rupture of the Wellington Fault in New Zealand, the time to get to 90 percent restoration of service was approximately 10 days for telecommunications, 25-75 days for water, 40-95 days for electricity, 60-80 days for gas networks, and more than 100 days for some roads, thus leading to a major disruption affecting both people and the economy.[19,20,21]

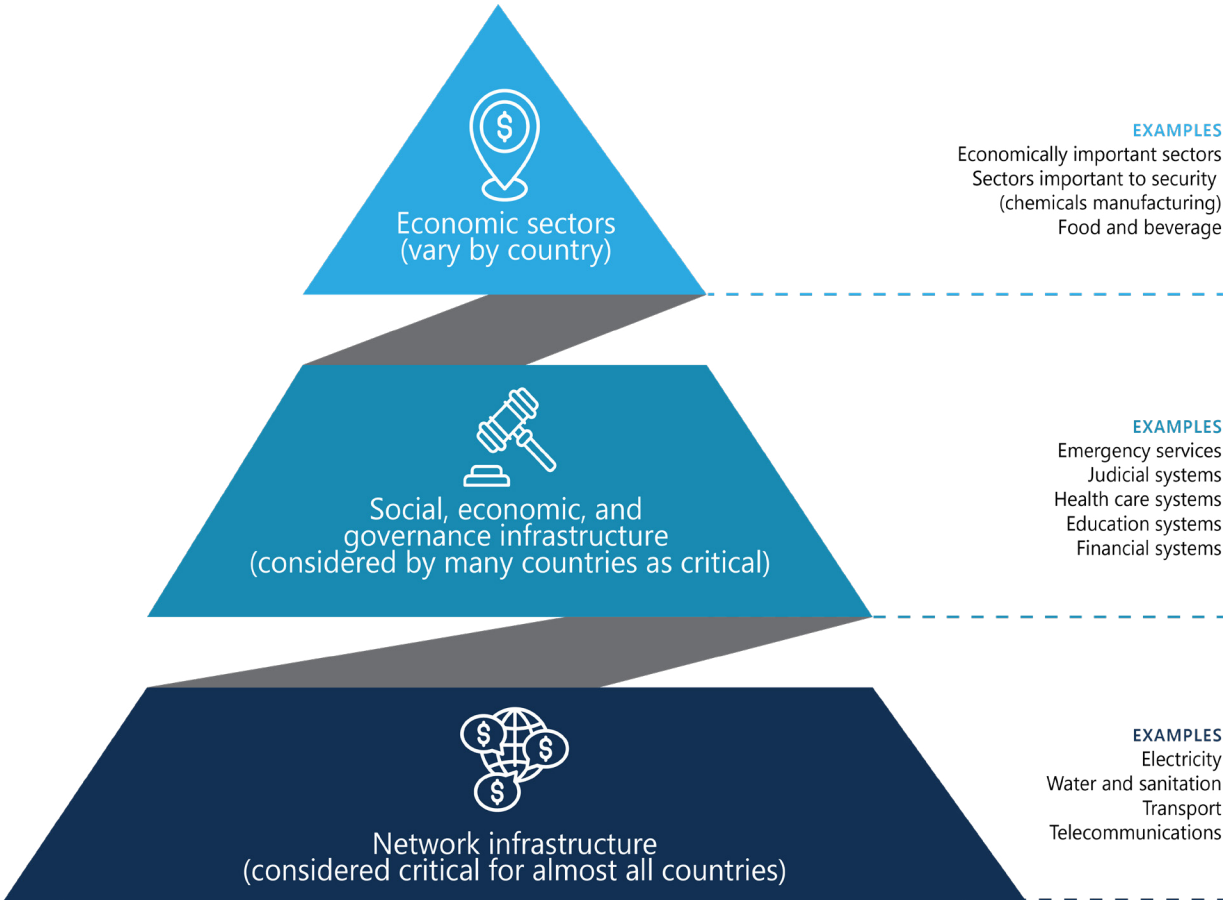
Critical infrastructure is defined as those assets, systems, and networks that provide essential services for the security of a nation, its economic prosperity, and the health and safety of its citizens. The services such as energy, transport, and water constitute the backbone of modern interconnected societies (box 1.2).[22] The delivery of a service requires a complete infrastructure system: (a) one or multiple physical assets connected in a network (e.g., roads, hospitals, power plants), (b) people, and (c) inputs (e.g., raw materials, fuel, electricity).

[17] Ibid. | [18] Ibid.
[19] WELG (Wellington Engineering Lifelines Group), "Restoring Wellington's Transport Links after a Major Earthquake," WELG Project Report, Wellington, 2013.
[20] Zorn, Conrad, and Asaad Shamseldin, "Post-disaster Infrastructure Restoration: A Comparison of Events for Future Planning," International Journal of Disaster Risk Reduction, Vol. 13. (2015). WELG 2012.
[21] WELG, "Lifeline Utilities Restoration Times for Metropolitan Wellington Following a Wellington Fault Earthquake," A Report to the Wellington CDEM Group Joint Committee, Wellington Engineering Lifelines Group, 2012.
[22] OECD, Good Governance. Terminologies and definitions vary, but these are also known as lifelines, critical infrastructure, or nationally significant infrastructure.

Box 1.2. What Is Critical Infrastructure?

According to a survey of 34 countries, six sectors are widely classified as being critical: energy, finance, health, information and communication, transport, and water and sanitation.[23] Other sectors that are also often prioritized include education, emergency services, justice systems, chemicals manufacturing, and fast-moving consumer goods (such as food supply). Of the countries surveyed, 90 percent have designated specific infrastructure sectors as critical.

Additionally, within a sector, some types of infrastructure assets - either because of their function, location, or connectivity - are recognized as being more important than others. For example, a telecommunications cabinet (or cables) that services a small number of connections is likely to be considered less critical than is a major telecommunications exchange point that services a much wider area. A large portion of critical infrastructure is typically owned or operated by the private sector or through PPPs. For example, in the United States, around 85 percent is privately owned.[24] In emerging and developing economies, state-owned enterprises often play an important role, particularly in the water and sanitation sector.



[23] OECD, Assessing Global Progress in the Governance of Critical Risks: OECD Reviews of Risk Management Policies (Paris: OECD Publishing, 2018), https://dx.doi.org/10.1787/9789264309272-en

[24] US Chamber of Commerce, "Critical Infrastructure Protection, Information Sharing, and Cyber Security," https://www.uschamber.com/issue-brief/critical-infrastructure-protection-information-sharing-and-cyber-security

This report uses the term critical infrastructure to refer to all the aspects required to deliver the critical services (e.g., transport, health care, energy). Six sectors are widely classified as being critical: energy, transport, water, information and communications technologies, health care, and finance. Some economies include education and critical economic and manufacturing sectors within their definitions.[25]

Importantly, the economic and social impacts from disruption to the critical infrastructure come primarily from the loss of the service they provide rather than from the cost of repairing damage to the assets themselves. For example, direct damages from disasters to power generation and to the transport infrastructure are estimated at US$18 billion a year in low- and middle-income countries globally; yet the estimated cost of the associated disruption to services (energy and transport) ranges from US$391 billion to US$647 billion (at least 20 times larger).[26] Beyond the human impacts, such costs can also strain government budgets by reducing revenues and increasing expenditures; the costs can stall investment in the economy, with knock-on impacts for long-term growth and well-being. This conclusion underscores the need to move away from a focus on the resilience of assets toward a focus on delivering critical services that are resilient.

Ensuring reliable and resilient critical infrastructure services is a growing priority and a core part of many countries' national security planning.[27] A massive investment in new critical infrastructure is expected during the coming decade. For example, the Asian Development Bank estimated that developing economies in Asia alone will need to invest US$1.7 trillion per year between 2016 and 2030 to support growth and to reduce poverty.[28] The rapid construction of infrastructure; the increase in economic interconnectedness; the concentration of people and assets in cities; the growth in reliance on global supply chains and telecommunications, on new technologies, and on changes to ways of working; and climate change, mean that social, economic, and fiscal vulnerabilities related to critical services are growing.[29]

The focus of this report is on the financial protection of critical infrastructure services. This focus complements existing, well-documented evidence and frameworks, including evidence collated by the World Bank[30], about the operational and physical protection and the resilience of critical infrastructure assets, and about best practice in incorporating resilience within PPPs in infrastructure.[31,32] The financial aspects of resilience of critical infrastructure services are not widely discussed in the existing literature, yet this is a critical component of overall resilience. A 2014 publication by the Organisation for Economic Co-operation and Development (OECD) titled Recommendations on Managing Critical Risks emphasized the role of financial preparedness in managing critical infrastructure risks to protect public finances and the fiscal position of a country. The 2018 and 2019 APEC Joint Ministerial Statements explicitly highlight the importance of quality and resilience, of the infrastructure's strengths against climate and disasters, and of the role of financial protection in this context. Figure 1.1 illustrates the interdependence of resilient infrastructure assets, services, people, economies, and wider financial resilience of the country.[33]

---

[25] OECD, Good Governance. Critical manufacturing sector can include those involved in manufacturing chemicals needed for clean water, for example.
[26] Hallegatte, Rentschler, and Rozenberg, Lifelines.
[27] OECD, Assessing Global Progress.
[28] Sungsup Ra and Zhigang Li, "Closing the Financing Gap in Asian Infrastructure," ADB South Asia Working Paper 57, Asian Development Bank, 2018, http://dx.doi.org/10.22617/WPS189402-2
[29] OECD, "Recommendations of the Council on the Governance of Critical Risks," Meeting of the OECD Council at Ministerial Level, Paris, May 6-7, 2014.
[30] Hallegatte, Rentschler, and Rozenberg, Lifelines.
[31] World Bank, Technical Brief on Resilient Infrastructure Public-Private Partnerships.
[32] World Bank, Resilient Infrastructure Public-Private Partnerships.
[33] OECD and World Bank, Fiscal Resilience to Natural Disasters: Lessons from Country Experiences (Paris: OECD Publishing, 2019).

Figure 1.1. Interdependence of Resilient Infrastructure Assets, Services, People, and Economies, Plus Wider Macro-fiscal and Financial Resilience of the Country

Source: World Bank staff, building on Stéphane Hallegatte, Jun Rentschler, and Julie Rozenberg, Lifelines: The Resilient Infrastructure Opportunity (Washington, DC: World Bank, 2019).

There are two key reasons that financial protection is important for critical infrastructure services. First, disasters can have a significant impact on public finances, affecting both sides of the balance sheet. On the expenditure side, governments often bear a significant part of the costs of response and recovery. On the revenue side, negative impacts on the productivity of firms, household incomes, and economic output can dent tax revenues. Second, a lack of financial preparedness can slow recovery and thus can increase the social and economic impacts of disasters.[34]

Infrequent but severe disasters, such as large earthquakes, can create significant macro-economic shocks and can even lower sovereign ratings in some cases.[35] For example, the Great East Japan Earthquake in 2011 is estimated to have caused losses of around 4 percent of GDP; the 2011 floods in Thailand led to economic losses, which were equivalent to more than 10 percent of GDP; and both Vietnam and Philippines have experienced events with losses of more than 3 percent of GDP in the past 20 years.[36] A recent assessment by the IMF[37] shows that those macroeconomic impacts can create a vicious cycle that lowers growth and increases debt. Frequent and smaller disruptions can reduce productivity of the real economy and can slowly drain government budgets for repairs and maintenance.

Critical infrastructure is one of the largest contributors to government losses following disasters, especially in middle- and high-income countries. Where governments own critical infrastructure assets (i.e., public assets such as schools, hospitals, and roads) or have other legal arrangements in place with the private sector such as guarantees or cost-sharing arrangements, there is an explicit contingent liability (see box 1.3) on the government for the costs of recovery and reconstruction. Recovery costs of those assets can be particularly large where insurance coverage is low. Recent work by the IMF[38] highlights the significant and often unreported contribution of public assets to a country's overall balance sheet.

Box 1.3. Contingent Liabilities from Disasters

The costs that disasters impose on governments - and ultimately on taxpayers-should be considered contingent liabilities or, when disasters lead to reductions in public revenues, contingent revenue losses. Explicit disaster-related contingent liabilities are payment obligations that are based on government contracts, laws, or clear policy commitments that could fall due in the event of disaster. Implicit disaster-related contingent liabilities are expenditures that the government makes in response to a disaster without prior formal commitments. The expectation for such payments might arise from political or moral pressure to speed up recovery in order to stimulate growth.

Given the critical importance of service continuity to citizens, even where the government does not own or operate the assets, the public sector can be left with an implicit contingent liability if those assets are underinsured. The government acts as the de facto insurer of last resort. Often, those costs are not accounted for, so a country's balance sheet likely underestimates the damage. A lack of clarity over risk ownership can also lead to poor incentives for resilience.

When faced with significant costs, governments will often draw-down on reserves (or contingency funds) and will look for opportunities to re-allocate budgets or to raise new debt. Arranging finance for response and recovery after the disaster in this way can be slower, more expensive, and unpredictable. For example, budget reallocations come

[34] Ibid.
[35] Standard & Poor's, "Storm Alert: Natural Disasters Can Damage Sovereign Creditworthiness," S&P Global Ratings, New York, 2015, https://www.spglobal.com/ratings/en/research/articles/150910-storm-alert-natural-disasters-can-damage-sovereign-creditworthiness-9327571
[36] World Bank, "Cluster 6: The Economics of Disaster Risk, Risk Management, and Risk Financing," Knowledge Note 6-3, World Bank, Washington, DC, 2012, http://documents1.worldbank.org/curated/en/175611468044671950/pdf/793950BRI0drm000Box377374B00Public0.pdf
[37] IMF (International Monetary Fund), "Building Resilience in Countries Vulnerable to Natural Disasters," presentation to IMF Executive Board, November 12, 2018.
[38] Vitor Gaspar, Jason Harris, and Alexander Tieman, "The Wealth of Nations: Governments Can Better Manage What They Own and Owe," IMFBlog, October 10, 2018, https://blogs.imf.org/2018/10/09/the-wealth-of-nations-governments-can-better-manage-what-they-own-and-owe/

with an opportunity cost in terms of diverging resources from planned productive uses. Raising new debt from creditors can be more expensive and unpredictable and often comes with a delay. Delays in financing recovery and reconstruction of critical infrastructure prolongs the disruption to critical services and so amplifies the indirect cost to the economy.

Financial protection is achieved when such risks to government balance sheets are proactively managed and when the government is financially prepared to ensure that rapid, targeted finance is available in emergencies. The process of putting in place such mechanisms defines disaster risk finance. Financial protection is a core mandate of ministries of finance. Moreover, ministries of finance are increasingly integrating those risks into their wider macro-fiscal framework, including dedicated efforts for fiscal risk management to better manage fiscal shocks from disasters.[39] In 2019, the G20 recognized that disaster risk finance and insurance can be critical ingredients for quality infrastructure investment.[40] APEC Finance Ministers have focused on disaster risk finance for public assets and infrastructure over several years and have committed to continued cooperation and knowledge exchange on this topic. For example, in 2016, APEC Finance Ministers called for the establishment of the APEC Working Group on Disaster Risk Finance and Insurance in their Joint Finance Ministerial Statement.[41,42,43]

The financial protection of critical infrastructure services requires a modified approach when compared to the financial protection of physical public assets. Chapter 2 in this report describes those key differences and their implications for a financial protection strategy. This report also proposes an operational framework for strengthening the financial preparedness of critical infrastructure through shock-responsive systems that are embedded in strong national risk management and financial preparedness. The components of this operational framework are described in detail in chapters 3 and 4. The report builds on existing principles and approaches to disaster risk finance[44], including many developed and implemented by APEC member economies in collaboration with the World Bank, as well as global experience and recommendations about managing critical infrastructure risks.[45] Chapter 5 reviews the emerging evidence about the impacts of COVID-19 on critical systems, and it draws initial conclusions for including pandemics and other risks within an operational framework. Chapter 6 then discusses the potential next steps. Examples are drawn throughout the text and are detailed as case studies in the annexes. The framework also learns from experience in working to implement financial protection for critical infrastructure in lower- and middle-income countries. For some, particularly lower-income countries, the capacities, data availability, and resources will be more constrained. As such, the framework aims to draws out actions and good practices relevant to all contexts so it can strengthen both financial protection and ideal standards.

---

[39] OECD and World Bank, Fiscal Resilience to Natural Disasters.

[40] Ministry of Finance, Japan, "Communiqué, G20 Finance Ministers and Central Bank Governors Meeting, Fukuoka, June 8-9, 2019," https://www.mof.go.jp/english/international_policy/convention/g20/communique.htm

[41] APEC (Asia-Pacific Economic Cooperation), "Joint Ministerial Statement," APEC Finance Ministers' Meeting, Port Moresby, October 17, 2018, https://www.apec.org/Meeting-Papers/Sectoral-Ministerial-Meetings/Finance/2018_finance#:~:text=1.%20We%2C%20the%20Finance%20Ministers%20of%20the%20economies,Papua%20New%20Guinea.%20Global%20and%20Regional%20Economy%202

[42] APEC, "Joint Ministerial Statement," APEC Finance Ministers' Meeting, Santiago, October 15, 2019, https://www.apec.org/Meeting-Papers/Sectoral-Ministerial-Meetings/Finance/2019_finance

[43] APEC, "Joint Ministerial Statement," APEC Finance Ministers' Meeting, Lima, October 15, 2016, https://www.apec.org/Meeting-Papers/Sectoral-Ministerial-Meetings/Finance/2016_finance.aspx

[44] World Bank, Financial Protection against Natural Disasters: An Operational Framework for Disaster Risk Financing and Insurance (Washington, DC: World Bank, 2014), https://www.gfdrr.org/sites/default/files/documents/Financial%20Protection.pdf

[45] For example, see the case studies (in annexes) and OECD, "Recommendation of the Council on the Governance of Critical Risks."

2. Planning Financial Protection and Critical Infrastructure Services

Financial protection against disasters has gained significant traction to reduce the negative fiscal impacts of disasters and to ensure that finance is available to speed recovery. Finance Ministries of APEC member economies have long been leaders in financial protection.[46] For example, many economies across the APEC region - such as the Philippines, Mexico, Peru, and Indonesia-already have some form of national financial protection strategy in place.[47] Financial protection of public assets, which is one type of infrastructure, is also advanced across the region. For example, of the 12 APEC economies surveyed in 2019, all have rules in place that clarify risk ownership related to public asset damages across government, and all use insurance to protect public assets (to a greater or lesser extent).[48] Such frameworks typically focus on the financial arrangement to enable the efficient repair, recovery, replacement, or reconstruction of assets such as schools or roads after a disaster. In 2018, APEC and the World Bank collaborated on an operational framework for catastrophe insurance programs for public assets; that framework drew on the deep experience of Australia, Colombia, Japan, Mexico, and New Zealand, among others.[49]

The financial protection of critical infrastructure services - the focus of this report - is broader in scope than public assets and requires a different approach. According to evidence gathered for this report, three important issues must be considered in this new context:

1. Financial protection of critical infrastructure services means looking at the continuity of services not just the repair and replacement of assets such as power plants and roads.

2. Governments often bear responsibility for ensuring the continuity of critical services for the safety, security, and economic prosperity of its citizens, even where the critical infrastructure is owned and operated by the private sector.

3. The contingent liabilities associated with critical infrastructure services will be larger than those related to the underlying public assets alone and need to be quantified and managed proactively.

Those three key differences are described in detail next, with examples from APEC countries. We analyze the differences on the basis of the evidence gathered, and we draw out key lessons for financial protection. This chapter concludes with a summary of the implications for a financial protection strategy.

Principle 1. Financial protection of critical infrastructure services means looking at the continuity of services not just the repair and replacement of assets, such as power plants and roads.

Ensuring the continuity of critical services in the aftermath of a disaster is a central objective of critical infrastructure resilience. Reducing the risk of disruption can significantly reduce the costs of disasters on firms, households, and government balance sheets. Any disruption to critical services, such as energy or water, can affect households and firms in many ways, both directly and indirectly (box 2.1). For example, if roads are damaged by an earthquake, then people cannot get to work, and supply chains for firms will be affected. If electricity is disrupted by wind damage to overhead transmission lines, then that disruption can force businesses to close.

[46] World Bank, "Financial Risk Management of Public Assets against Natural Disasters in APEC Economies," World Bank Technical Contribution to the APEC Finance Ministers' Process, APEC Finance Ministers' Meeting, Hoi An, Vietnam, October 2, 2017, http://mddb.apec.org/Documents/2017/MM/FMM/17_fmm_009.pdf

[47] OECD and World Bank, Fiscal Resilience to Natural Disasters.

[48] World Bank, "Financial Risk Management." | [49] World Bank, Catastrophe Insurance Programs for Public Assets: Operational Framework (Washington, DC: World Bank, 2020), https://openknowledge.worldbank.org/handle/10986/34440

Box 2.1. Impact of Critical Infrastructure Service Disruptions to Economic Activity

Critical infrastructure services can be disrupted in multiple ways, from socio-political, to natural and man made disasters, and to long-term climate change. Those events can lead to disruptions of (a) infrastructure assets, (b) supply of inputs, (c) support of infrastructure networks, and (d) availability of staff members and other human resources. The failure of infrastructure services then will further affect economic activity through three key channels. Some channels act over the short-term while others have longer-lasting impacts.

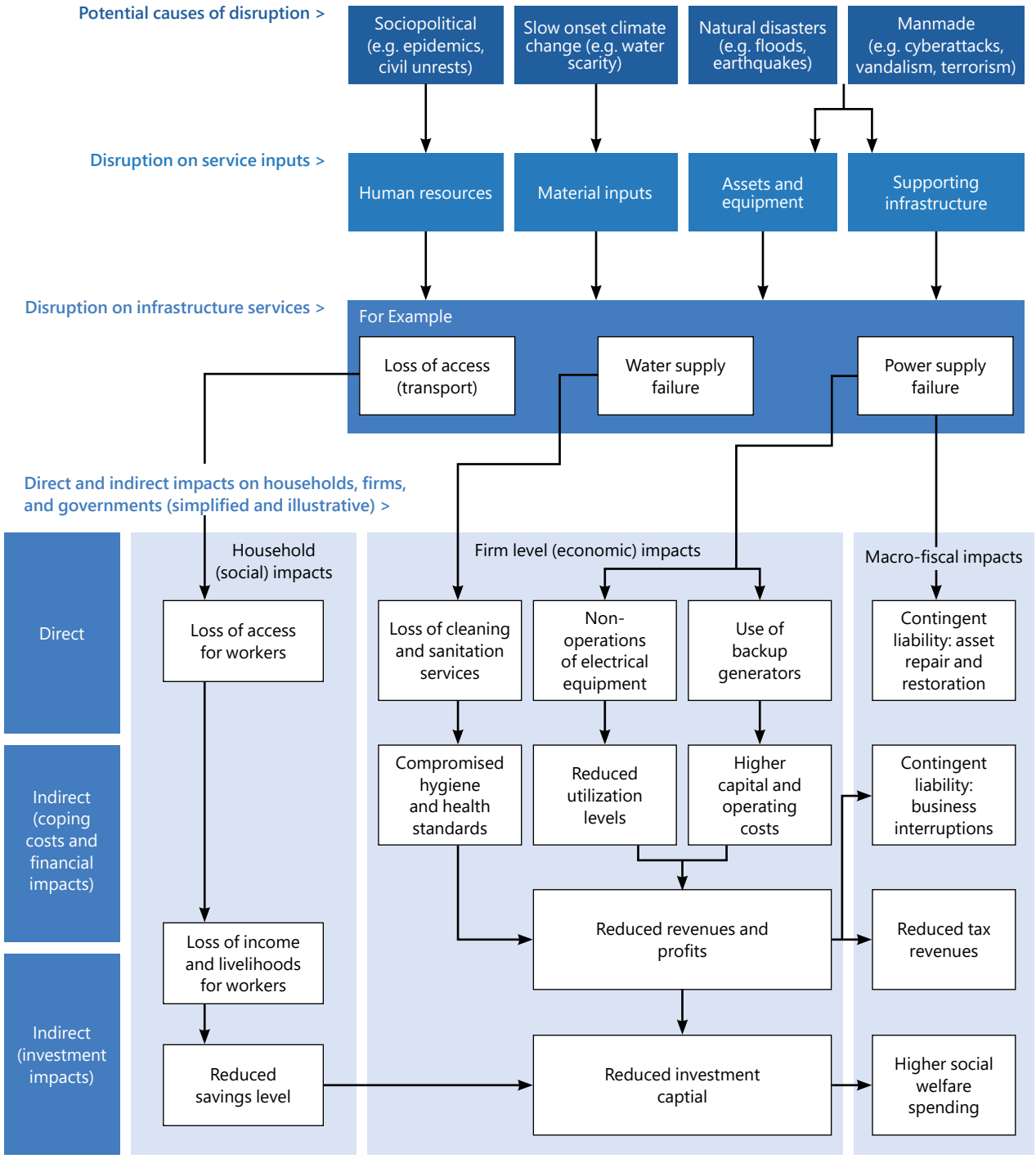
- First, direct impacts are the most visible and immediate consequences. For example, workers are unable to go to their workplace, a firm has to close its operations because it cannot operate without power or telecommunications (internet, phones), or customers are not able to access the products and services. Infrastructure owners and operators - in some cases through the involvement of governments - incur urgent repair and restoration costs.

- Second, firms and individuals absorb indirect coping costs to manage the impacts. For example, a firm has to purchase or incur costs for a backup power generator, which reduces its profits or limits its ability to invest in alternative and more productive investments. Individuals may lose income and livelihoods, and governments may need to provide financial support.

- Third, individuals, firms, and governments become more constrained on their investments and savings, either in the short- or long-term. For example, firms have less confidence to automate productions in regions with frequent electricity disruptions. In addition, foreign direct investment may be affected, with investors diverting their finances to more resilient economies.

Box figure 2.1.1 illustrates in a simplified way of how an initial shock can cascade from an infrastructure services disruption to individuals, firms, and governments. Interdependencies of some infrastructure can compound such risks.

Box Figure 2.1.1. Illustrative Pathways of Impacts of Service Disruption to Critical Infrastructure on Firms

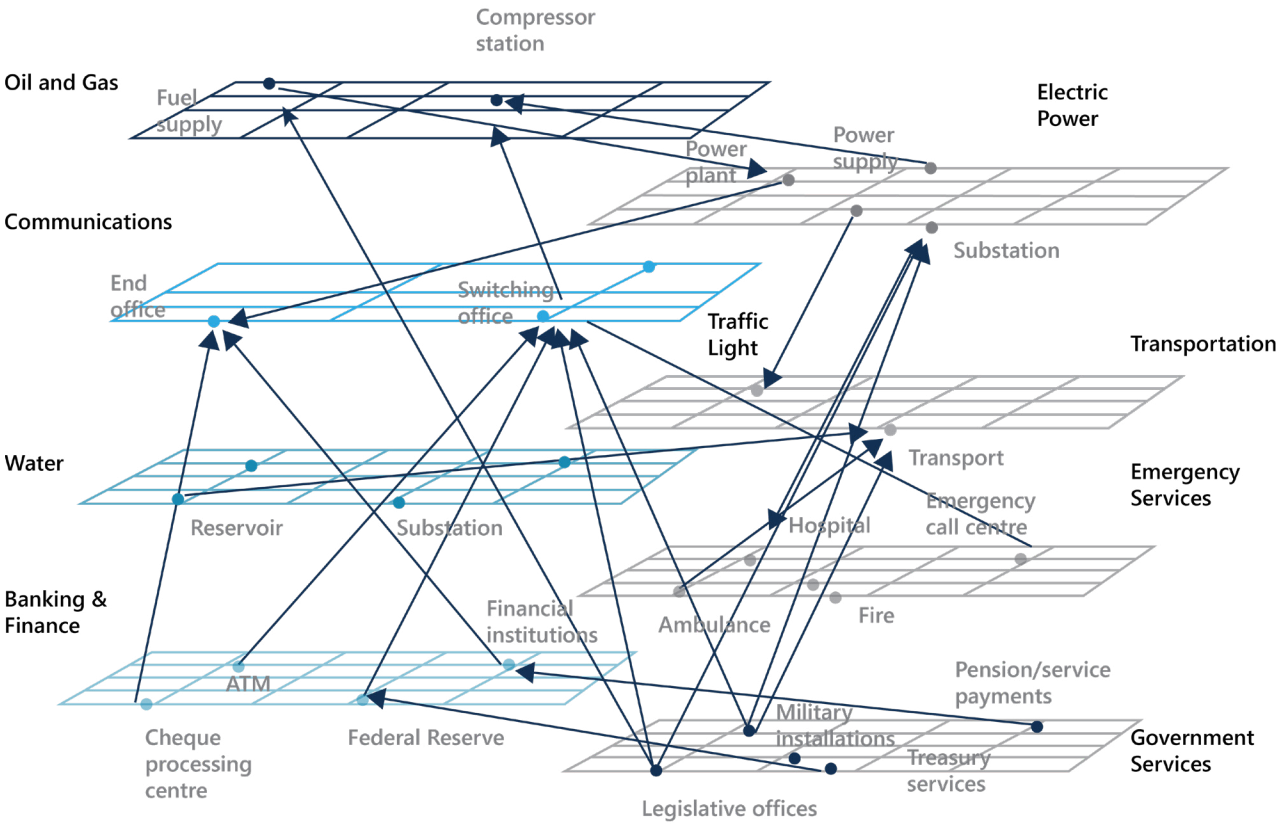


Source: World Bank staff.

Disruptions to critical services can generate significant indirect economic impacts and production losses.[50] Importantly, service disruptions can manifest well beyond the geographical area that is directly impacted by the shock, thus affecting multiple sectors. Those disruptions can quickly lead to large economic and social impacts that can persist over a longer duration. For example, damages to power lines in one area can disrupt the energy supply over a wide geographical area, but those damages can also affect other critical infrastructure systems such as transport, health, education, and even financial services (figure 2.1).[51] This approach can have a major and long-lived impact on people and the economy.

In September 2017, the Sint Maarten Airport in the **Caribbean** was devastated by Hurricane Irma, a Category 5 hurricane, which was rapidly followed by Hurricanes Jose and Maria. The airport's damage has severely affected tourism, which is the key sector for the economy and which contributed 73 percent to the country's total income from foreign exchange. Delays in financing the reconstruction slowed the recovery significantly and had knock-on tourism effects that were costly for the economy.

Figure 2.1. Illustration of Utility and Network Interdependencies



[50] Hallegatte, Rentschler, and Rozenberg, Lifelines.

[51] Institute of Public Utilities, "Utility and Network Interdependencies: What State Regulators Need to Know," Technical Assistance Brief on Critical Infrastructure Protection, US National Association of Regulatory Utility Commissioners, Washington, DC, April 2005.

Importantly, disruption to critical services can emerge not only from physical damages but also from disruptions to people, inputs, or even shocks to demand. For example, pandemics such as COVID-19 can have a significant impact on critical services without damaging assets. COVID-19 has strained water utilities through increased demand, disruptions to supply chains and essential workers, and falling revenues (see chapter 5). This strain can negatively impact the government's balance sheets if fixing the effects will require public support. A focus on assets alone can mean missing important sectors such as financial services, which are often classed as critical services and are vulnerable to exogenous shocks such as disasters and pandemics. Shocks to financial services and critical economic sectors can create a large contingent liability on the government.

Investments, policies, instruments, and actions that reduce the chance, duration, or severity of disruption to critical services can achieve major reductions in economic and welfare impacts of disasters. Estimates by the World Bank show that if the average recovery and reconstruction speed is reduced by two-thirds, then global well-being losses from disasters could be reduced by 14 percent - equivalent to increasing global consumption by more than US$75 billion per year.[52]

Securing resilient critical infrastructure services requires four qualities for infrastructure systems. It involves maintaining physical resilience of assets, having good maintenance, activating repair, building in redundancy, and ensuring that mechanisms are in place to quickly deal with any disruptions and to restore services when needed:[53,54,55]

1. **Robustness (resistance and reliability)** - the ability to keep operating or to remain standing in the face of disaster through physical resilience of individual infrastructure assets.

2. **Redundancy** - the ability to keep operating and to provide services through substitute or redundant systems that can be activated or used if something important should break down or stop working.

3. **Recovery Capacity (preparedness)** - the capacity to get back to normal as quickly as possible and to minimize disruptions through effective and fast decision-making. It involves getting the right people, resources, and finances to the right places rapidly for repairing and recovering critical services.

4. **Adaptability** - the ability to absorb lessons from catastrophes and to adapt designs and plans. It involves revising plans, modifying procedures, and introducing new tools and technologies needed to improve robustness, resourcefulness, and recovery capabilities.

The appropriate balance among those qualities will depend on the case. For example, in some cases, it may be less cost-effective (or not possible) to build highly resistant infrastructure up front but more effective to build an infrastructure that can be repaired quickly (e.g., small rural roads).[56] In other cases such as major bridges and energy generation assets, it is likely to be cost-effective (and necessary, given safety requirements) to build an infrastructure that is strong enough to sustain a foreseeable shock, including design of a physical infrastructure to withstand low-probability but high-consequence events such as natural catastrophes. Some assets will be more critical to service provision than others, so the right balance will vary by asset. Importantly, it is impossible to avoid all damages; so all four qualities are important.

---

[52] Stéphane Hallegatte, Jun Rentschler, and Brian Walsh, Building Back Better: Achieving Resilience through Stronger, Faster, and More Inclusive Post-Disaster Reconstruction (Washington, DC: World Bank, 2018), https://openknowledge.worldbank.org/handle/10986/29867
It assumes no compromises in the quality of reconstruction.

[53] OECD, Future Global Shocks: Improving Risk Governance: OECD Reviews of Risk Management Policies (Paris: OECD Publishing, 2011), https://dx.doi.org/10.1787/9789264114586-en

[54] OECD, "Recommendation of the Council on the Governance of Critical Risks." | [55] OECD, Good Governance.

[56] Julie Rozenberg et al., "From a Rocky Road to Smooth Sailing: Building Transport Resilience to Natural Disasters," background paper for Lifelines, World Bank, Washington, DC, 2019, https://openknowledge.worldbank.org/handle/10986/31913

In most cases, the ability to recover both assets and services quickly after a disaster is a vital part of overall resilience; this is where financial preparedness plays an important role alongside good contingency planning and operational preparedness. A successful result depends on people and effective planning before disasters to control damages, to mitigate impacts, and to put plans and resources (people, equipment) rapidly into action for a speedy recovery. Financial preparedness is necessary both to ensure adequate funding for more frequent repair and maintenance after small events and to implement contingency plans for rapid recovery after more infrequent and larger disasters.

For example, **Vietnam** is highly exposed to natural hazards that threaten the ongoing provision of critical infrastructure services. For example, more than one-third of Vietnam's transmission grid is situated in forested areas and so is susceptible to falling trees and branches during storms. The average annual damages to energy infrastructure are estimated to be US$330 million. Flooding in 2014 caused electricity outages totaling US$670 million in lost sales for Vietnamese firms, while the outages halted production and lowered equipment-use rates causing a further US$30 million in damages. Research by the World Bank stressed the importance of investing in resilience and in risk-informed development strategies to reduce risk and to avoid future disasters, but the research recognized that disaster risk can never be fully eliminated and so stressed the importance of systemic disaster preparedness to ensure continuity of critical infrastructure services such as energy. This research includes having early-warning systems, doing emergency planning, and establishing a national financial protection strategy.[57]

By using this analysis, we can draw three lessons for financial protection of critical infrastructure services:

Lesson 1. A key objective of financial protection of critical infrastructure should be ensuring the continuity of critical services in the aftermath of a disaster.

Lesson 2. A focus on assets alone could risk missing important threats, such as pandemics, that affect critical services rather than damaging assets. That focus could also mean missing important sectors. Ministries of Finance should consider if and how those sectors should be included in a financial protection strategy.

Lesson 3. Assessments of risk should consider the criticality of services in terms of their effects on households and firms - not just on asset values - when planning resilience, response, and recovery strategies.

Principle 2. Governments often bear responsibility for ensuring the continuity of critical services for the safety, security, and economic prosperity of its citizens, even where the critical infrastructure is owned and operated by the private sector.

A large proportion of critical infrastructure is often owned or operated by the private sector. In many countries, infrastructure ownership is moving from direct government ownership (i.e., public assets) toward state-owned enterprises and privatization. This change decreases governments' direct control over the resilience of infrastructure assets and service provision and requires much greater participation of the private sector. The use of PPPs has matured significantly in parallel with well-established good practices to incentivize operational preparedness and infrastructure resilience.[58,59]

[57] Jun Rentschler et al., Resilient Shores: Vietnam's Coastal Development Between Opportunity and Disaster Risk (Washington, DC: World Bank, 2020), https://openknowledge.worldbank.org/handle/10986/34639

[58] World Bank, "PPP Best Practice," APEC Transportation Working Group, World Bank, Washington, DC, 2016.

[59] World Bank, Technical Brief on Resilient Infrastructure Public-Private Partnerships.

The role of the public sector varies between countries and across sectors. For example, in many countries, health care and education infrastructure are owned and operated mainly by the public sector. In some cases, the infrastructure may be owned by government but operated and maintained by the private sector. In many countries, the ports, the airports, and the rail infrastructure are publicly owned, but they are maintained and operated by the private sector (for example, through traditional public procurement, concessions,[60] or PPPs). In other cases, particularly in higher income countries, both the service operation and the assets themselves may be fully privatized, and the government will play the role of regulator and user. There are also many hybrid forms of ownership. For example, state-owned enterprises play some role in most countries[61] and are particularly important in many emerging economies - particularly in sectors such as water and sanitation. It is also important to consider the relative roles of central (federal), regional (including state, provincial, and municipal), and local governments. For example, the local governments often play a key role in managing local roads plus water and sanitation services.

In the **United States**, electricity is generated and delivered by nearly 3,000 utilities that consist of three main categories based on ownership type: investor-owned utilities, publicly owned utilities, and cooperatives. As of 2017, 168 investor-owned utilities were serving roughly 72 percent of all US electric customers. Publicly owned utilities include federally run, state-run, and municipally run utilities, and they service roughly 16 percent of all US electric customers. Finally, cooperatives (or co-ops) are not-for-profit, member-owned utilities. Co-ops exist in 47 states, serving a total of 12 percent of US customers.

The World Bank's Private Participation in Infrastructure Database tracked US$96.7 billion of private sector investments across 409 projects in 2019. With those investments, around 62 percent of financing originates from private sources. Commercial lenders provide for nearly half (46 percent) of infrastructure finance.[62]

Strengthening financial preparedness of critical infrastructure will therefore often involve bringing multiple stakeholders to the table and considering the roles of regulation, legislation, financing, and public policy. The varying models of ownership and operation for critical infrastructure services bring added complexity to financial preparedness when compared to, for example, public assets. The form of the legal arrangement of ownership and operation of critical infrastructure by the public and private sector affects how the government can directly influence critical service provision and resilience, as well as the explicit contingent liabilities on the government for costs associated with disasters.[63] Strengthening financial preparedness and service continuity therefore requires working with a wider community of stakeholders and a wider range of policy and regulatory tools than has been the case for financial protection of public assets. Risk ownership that is clear, credible, and enforced is a necessary foundation to financial resilience.

---

[60] A service concession, for example, is an arrangement whereby a government or other public sector body contracts with a private operator to develop, operate, and maintain the grantor's infrastructure assets such as roads, bridges, tunnels, airports, energy distribution networks, prisons, or hospitals. The grantor controls or regulates what services the operator must provide using the assets, to whom, and at what price, and it also controls any significant residual interest in the assets at the end of the term of the arrangement.

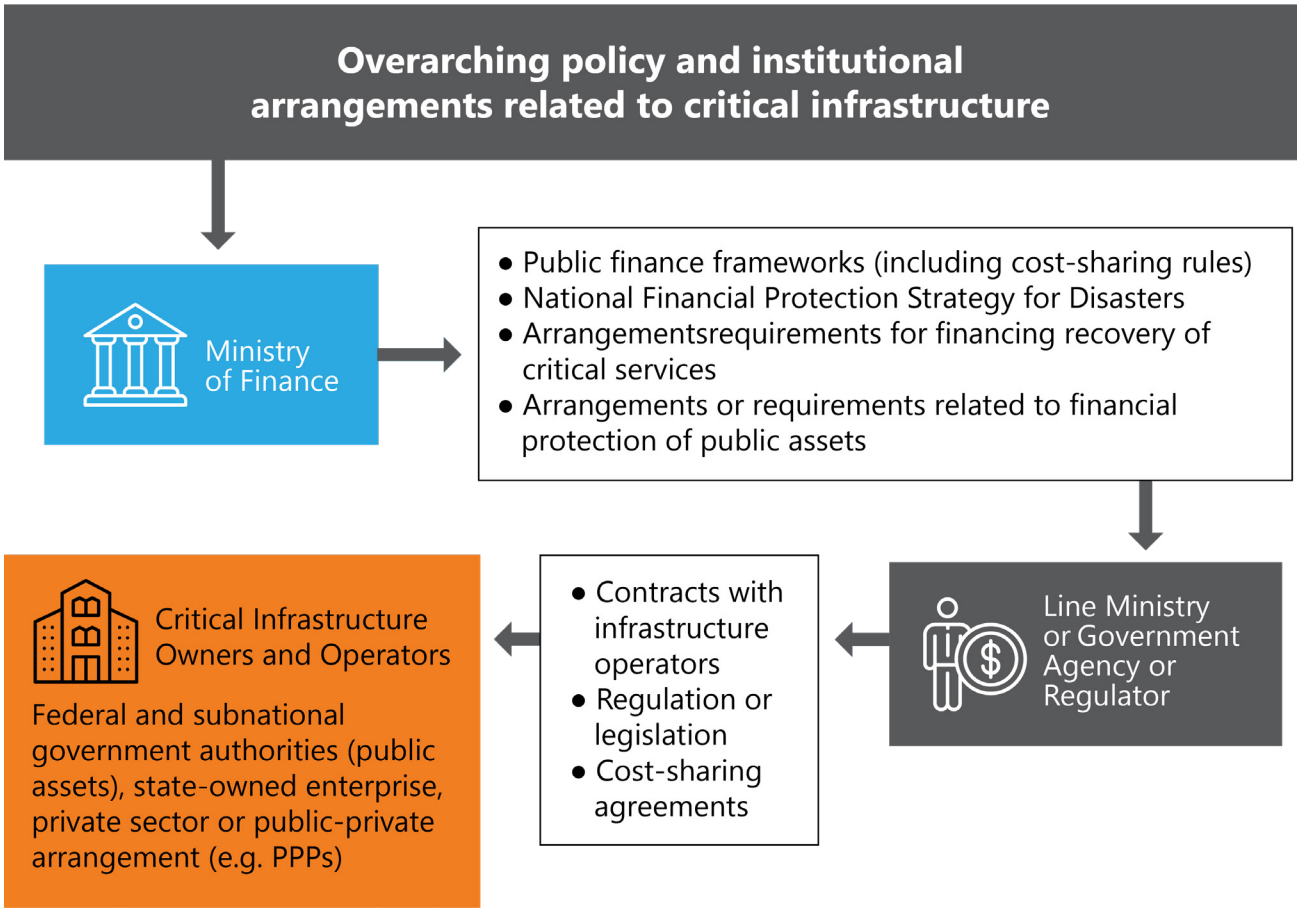
[61] OECD, "OECD Dataset on the Size and Composition of National State-Owned Enterprise Sectors," https://www.oecd.org/corporate/oecd-dataset-size-composition-soe-sectors.htm

[62] World Bank, "Private Participation in Infrastructure (PPI) 2019 Annual Report," World Bank, Washington, DC, 2019, https://ppi.worldbank.org/en/ppi

[63] OECD, Good Governance.

Governments often bear some responsibility for ensuring the continuity of critical services for the safety, security, and economic prosperity of its citizens, even where the critical infrastructure is owned and operated by the private sector. Infrastructure owners and operators bear the primary responsibility for protecting their assets and for maintaining the continuity of services they provide. But priorities and levels of risk tolerance will often be different between the public and private sector. As a policy maker, financier, and regulator, the government often plays a key role to set required levels of preparedness that will ensure acceptable levels of risk for citizens and national security.[50] Figure 2.2 illustrates the relationships between different stakeholders and the role of public policy, public finance frameworks, regulation, and procurement.

Figure 2.2. Relationships between Ministries of Finance and Critical Infrastructure Owners and Operators



In summary, the key lessons for a financial protection strategy concerning the critical infrastructure include the following:

Lesson 4. Ensuring continuity of services, as well as wider resilience, requires having clarity over risk ownership between central and local governments and the private sector. Risk allocation that is clear, credible, and enforced provides a strong and necessary foundation to resilience.

Lesson 5. Financial protection of critical infrastructure and services requires bringing multiple stakeholders to the table and adopting legislation, policies, regulations, and financing arrangements that encourage and ensure good risk management by the private sector and across levels of government.

Principle 3. The contingent liabilities associated with critical infrastructure services will be larger than those related to the underlying public assets alone and need to be quantified and managed proactively.

In addition to ensuring that finance is available to minimize disruptions, financial protection of critical infrastructure should manage the fiscal impact from any shock. Many APEC economies have made advances in financial protection of public assets. But the potential fiscal impact from disruptions to critical services is often probably not fully quantified, accounted for, or mitigated within public finance frameworks. Two additional sources of contingent liability are associated with critical services, in addition to the fiscal impacts associated with loss of revenues caused by disruptions:

- **The costs for maintaining and reinstating critical services.** This source includes government expenditures related to providing services in emergencies.

For example, in 2013, Typhoon Haiyan heavily disrupted education and health care in affected areas of the **Philippines,** and the government provided temporary health and education services to thousands of citizens, in addition to rebuilding hospitals and schools.

- **The insurer of last resort for privately owned and operated critical infrastructure systems.** Although in many countries a large part of critical infrastructure is owned or operated by the private sector, the government may still act as the insurer of last resort. For example, the government may end up paying the costs of recovery after a large disaster because that service is so critical to the population. This implicit contingent liability on the government is often not accounted for. Such unexpected expenditures can have a sizeable impact on government budgets.

In the **United States**, electric utilities are responsible for all costs associated with service continuity and restoration in disasters under normal circumstances. During president-declared emergencies, however, public utilities (which serve around 16 percent of consumers in the United States) can receive financial assistance from the federal government. Investor-owned utilities can receive other forms of federal assistance, such as tax deductions, low-interest long-term loans, and allocations to offset expenses to restore power. The state and federal government can also step in during extreme events. Following Hurricane Sandy in 2012, the Federal Disaster Management Agency **(FEMA)** approved a 100 percent cost-share for emergency power restoration work by state, local, and tribal governments and US$800 million for debris removal and infrastructure restoration. Similar responses were

seen following Hurricanes Harvey and Maria in 2017. After Hurricane **Irma**, which hit the southeastern United States in 2017, FEMA spent more than US$1 billion on infrastructure restoration including US$43 million for repairs to electric and water utilities at a 90 percent cost-share.

Key lessons for a financial protection strategy for critical infrastructure include the following:

Lesson 6. Contingent liabilities and fiscal risks that are on the government and are associated with critical infrastructure services will be larger than those related to damages to the underlying public assets alone. Not incorporating them within public finance frameworks can mean understating risks and financing gaps.

Lesson 7. Public finance frameworks need to account for the contingent liabilities associated with the recovery of critical infrastructure services, as well as creating good incentives for investment in resilience.

Conclusions for a Financial Protection of Critical Infrastructure Services

Bringing the principles and lessons together in an operational framework for financial protection of critical infrastructure should combine three interconnected parts (as illustrated in figure 2.3).

1. **Financial protection of (physical) public assets.** This protection means having finances and plans in place to rehabilitate or reconstruct critical assets after a disaster. This approach could include, for example, public assets insurance or budgetary mechanisms such as disaster funds. Such protection is not covered in this report because it is well documented in previous reports by the World Bank and APEC (for example, the 2020 operational framework for catastrophe insurance programs for public assets and the World Bank-SEADRIF knowledge series about financial protection of public assets).[64,65]

2. **Shock-responsive systems that link financial and operational preparedness to ensure rapid recovery of critical services.** This system includes having plans, finances, and systems in place to rapidly mobilize action in the event of a shock to ensure continuity or reduce the severity and duration of any disruptions to critical services. This report proposes a framework that brings together good practice from risk financing and infrastructure planning. More discussion on this framework is covered in chapter 3.

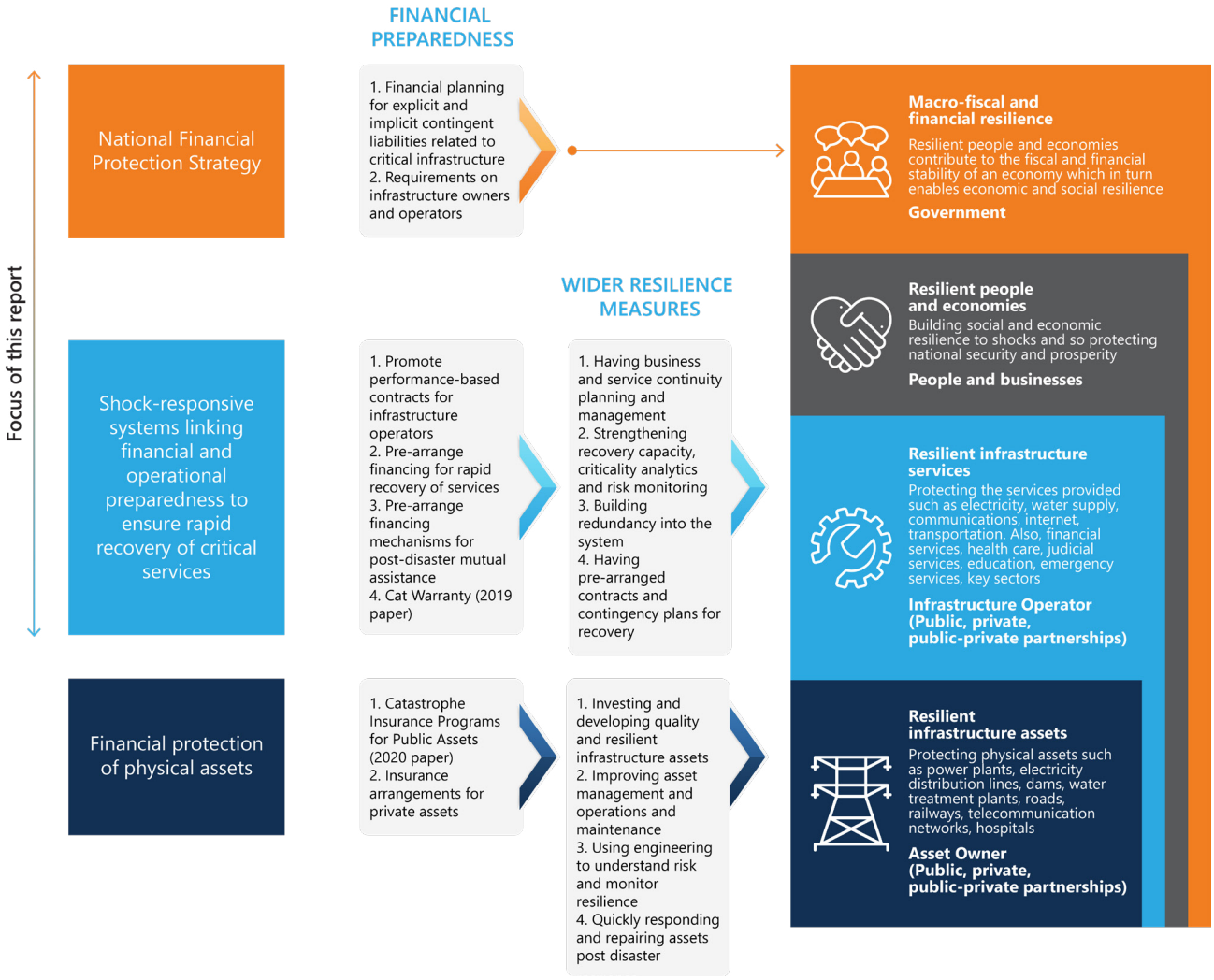
3. **A national financial protection strategy that integrates critical infrastructure to efficiently manage the contingent liabilities related to such shock-responsive systems.** Here the focus is on reducing any financial shock that negatively affects government balance sheets and that arises from the costs of recovering and reinstating critical services post-disasters. The focus is also on ensuring that timely, predictable, and cost-effective finance is available in emergencies to quickly restore services when needed. Several APEC economies already have a national financial protection strategy in place. This report considers how to include critical infrastructure appropriately within such a strategy, as well as linkages to wider approaches for managing critical risks across government. Discussions on such a strategy is covered in chapter 4.

This conclusion should complement investments in quality infrastructure, risk reduction, and adequate maintenance.

Figure 2.4 provides a decision tree to assist readers in assessing whether financial protection of critical infrastructure services is relevant to their own context and the potential next steps.

[64] World Bank, Catastrophe Insurance Programs for Public Assets.
[65] World Bank, "Financial Protection of Public Assets," SEADRIF Knowledge Series: Financial Protection of Public Assets, World Bank, Washington, DC, 2020, https://www.financialprotectionforum.org/seadrift-knowledge-series-financial-protection-of-public-assets

Figure 2.3. Interaction of Financial Resilience of Assets, Services, and Countries



Note:

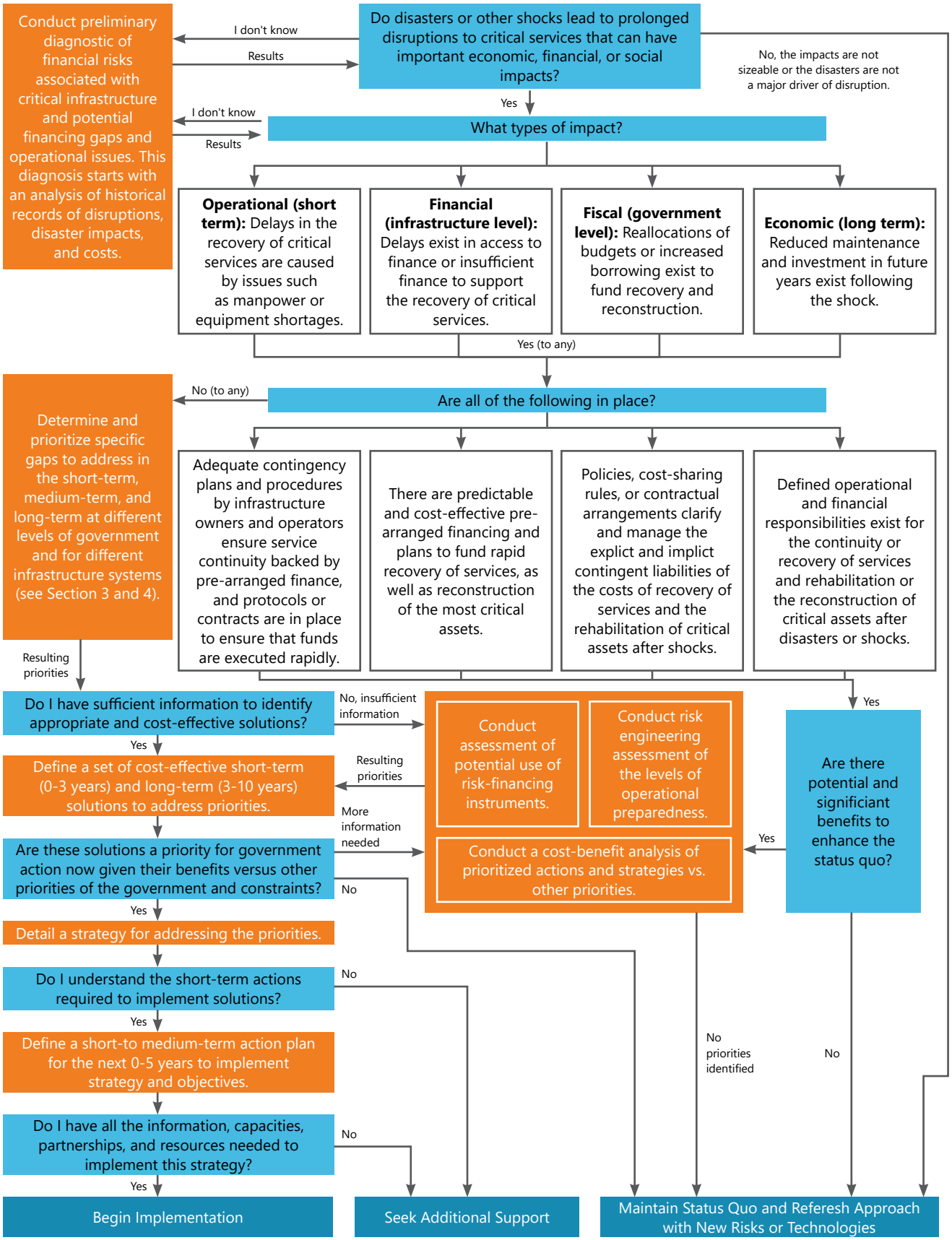
a. The schematic shows the links among critical infrastructure assets (dark blue), services (light blue), wider economic and social resilience (grey), and macro-fiscal and financial resilience (orange). The left-hand side of the schematic summarizes the three components of financial protection of critical infrastructure services and shows how they contribute to financial preparedness and resilience as well as how they link to resilience at the different levels on the right-hand side.

b. This report focuses on the additional aspects of financial preparedness related to critical infrastructure services in light blue and on the links to national financial protection strategies to strengthen macro-fiscal resilience to disasters and to safeguard the continuity of services post-disaster. Previous reports such as the following have covered aspects of infrastructure assets resilience:

(1) World Bank, "Catastrophe Infrastructure Warranty against Climate and Disaster Shocks," Draft Technical Proposal for discussion at 2019 APEC Finance Ministers Meeting and 2019 Investor Forum, 2019.
http://mddb.apec.org/Documents/2019/MM/FMM/19_fmm_007.pdf

(2) World Bank, Catastrophe Insurance Programs for Public Assets: Operational Framework (Washington, DC: World Bank, 2020).
https://openknowledge.worldbank.org/bitstream/handle/10986/34440/Catastrophe-Insurance-Programs-for-Public-Assets-Operational-Framework.pdf?sequence=1&isAllowed=y

Figure 2.4. Process to support decision makers on actions to promote financial protection of critical infrastructure services



- For a ministry of finance or governmental organization, this approach could be across a whole country of a defined region; for infrastructure owners or operators, this would be focused on infrastructure assets or services within their area of responsibility.
- Diagnostics should be proportionate to the level of risk and financial impacts. costly and long diagnostics can be inefficient. it is typically good practice to start simple and then move to in-depth if such a change is found to be necessary and cost-effective.

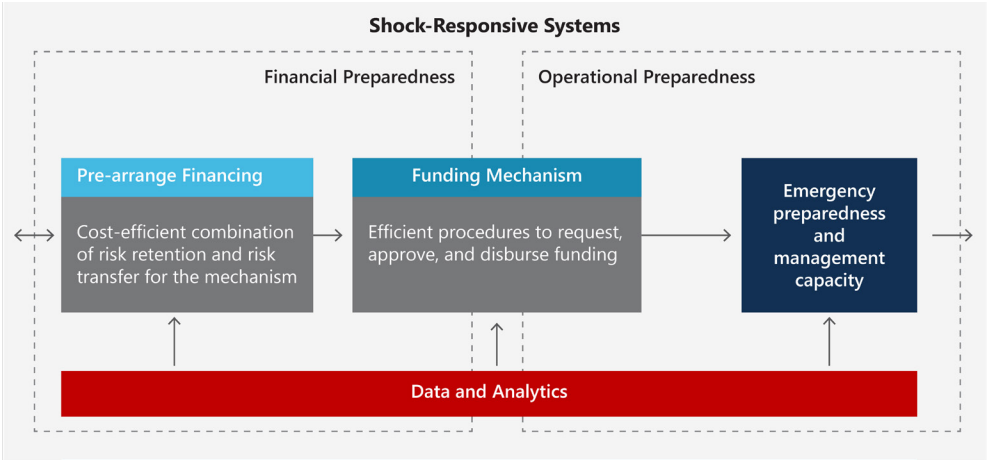
3. Combining Financial and Operational Preparedness to Ensure Continuity of Critical Services

Financial preparedness is a critical part of ensuring service continuity, both to ensure adequate funding for more frequent repair and maintenance after smaller, more frequent events and to implement contingency plans for rapid recovery after more infrequent, larger disasters. This chapter draws on the best practice principles of disaster risk financing, as well as on global experience in the maintenance and recovery of critical services. It proposes a framework to strengthen the financial preparedness of critical infrastructure systems that will enhance service continuity.

Importantly, effective financial protection of critical infrastructure services requires the integration of operational preparedness and financial preparedness (figure 3.1):

- **Operational preparedness.** The right plans, standard operating protocols, and capabilities (e.g., people, equipment, spare parts) are in place to enable quick restoration of critical services.
- **Financial preparedness.** The right mechanisms to provide and access effectively adequate and timely financing is available to implement those plans.

Figure 3.1. Three Components for Shock Responsive Systems to Protect Critical Infrastructure Services



Source: World Bank staff.

Good operational preparedness for emergencies pre-disaster - alongside good operations and maintenance and investments in physical resilience of infrastructure systems - can reduce disruptions to critical services.[66] Yet, even the best service continuity plans and good operational preparedness cannot ensure that services are restored rapidly if the required funding for labor, spare parts, or contracts is delayed or not available.

Financial preparedness can be further broken down into two aspects:

- **Mobilizing (access to) funding.** Having the right financial instruments (such as contingency budgets and insurance) in place will ensure cost-efficient access to sufficient funding for shocks of different severity, alongside sufficient funding for regular operations and maintenance (O&M).

- **Delivering funding.** Having the right funding mechanisms in place will ensure an effective flow of funds. The mechanisms include, for example, ways to transfer funds between government departments and efficient procedures to request, approve, and disburse funding. This aspect is critical because experience shows such a lack can be a major barrier to fast action.

Both components - operational and financial preparedness - need to be informed by appropriate risk data and analytics. Through well-informed risk data analytics, governments and infrastructure owners and operators can assess probable impacts, to prioritize planning, to trigger early action, and to guide recovery interventions.

This integrated approach can be described as a shock-responsive system. With such systems in place, infrastructure operators know they have the financing to put in place and implement the plans, equipment, and agreements necessary for ensuring rapid recovery. The approach also means financial planners have comfort that any allocation of funding can be executed quickly and in line with agreed objectives. The roles of government in implementing operational and financial preparedness at each stage will depend on who owns and operates the critical infrastructure assets and services. In a case of full government ownership, each of the actions would be the responsibility of government. For a fully privatized critical infrastructure sector, the actions will be the responsibility of the private sector, though the government may set standards through regulation, may provide incentives, and may provide public goods (e.g., early warning systems, coordination fora). The roles of Ministries of Finance are discussed in chapter 4.

Although this report focuses mainly on financial preparedness, it is important to recognize that operational factors can often be a major constraint to rapid recovery, particularly lower-income countries. Financial preparedness is necessary but not sufficient. Delays to recovery can stem, for example, from a lack of ability to monitor the system for quickly identifying (a) the source of a service failure; (b) a lack of contingency planning; or (c) a lack of people, spare parts, or other equipment. There can also be physical reasons that recovery is delayed (for example, debris removal after a disaster or challenges in accessing damaged infrastructure caused by blocked roads). If governments are to strengthen resilience of critical services, the first step is to assess the potential sources of bottlenecks, how often both operational and financial preparedness will need to be enhanced in parallel, and how recoveries will be closely interlinked. We refer the reader to the substantial literature about operational preparedness and resilience for detailed insights beyond the scope of this report.[67]

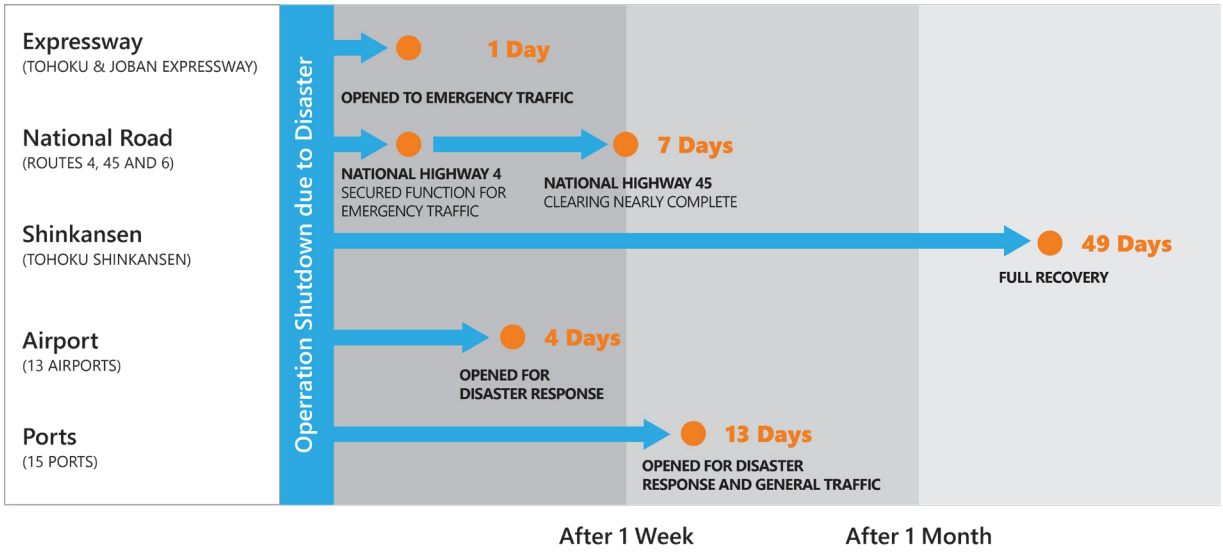
[66] Hallegatte, Rentschler, and Rozenberg, Lifelines.
[67] Ibid.

Experiences from Japan and the United States are described herein, and other examples from the Caribbean and New Zealand are detailed throughout this report. They show how financial and operational preparedness can work together to reduce service disruptions. The range of examples aims to illustrate how shock-responsive systems can work under different types of arrangements between the public and private sector, as well as the variety of roles that the government can play to ensure resilience.

In the **United States**, operational and financial preparedness for disasters in the energy sector are closely interlinked. All states are presumed to have legal authority over emergencies, with service continuity and recovery efforts falling under the purview of utilities and network coordinators. States use pre-agreed emergency and disaster plans that are based on a National Response Framework to clearly define responsibilities among different actors. Electric utilities are also required to design their own emergency response plans, which are submitted periodically to the state public utility for approval. Multiple financial and regulatory instruments are available to electric utilities to deal with the costs of response and recovery, including ex ante financing instruments (e.g., reserve accounts) and ex post instruments (e.g., securitization such as issuing bonds to pay for response costs, cost deferrals, or cost trackers, as well as approved charges on consumers).

In **Japan**, local governments have specific mechanisms to a speedy recovery for a publicly owned infrastructure. In terms of financial preparedness, local governments report their infrastructure damage to the line ministries and request a national subsidy for recovery works within days. As part of operational preparedness, they can arrange pre-disaster agreements with private companies or local industry associations to initiate recovery work in the immediate aftermath of disasters. The agreement covers information sharing, emergency inspections, debris removal, and disaster recovery. Those companies are required to begin activities upon request even before a contract is costed. Immediately after the Great East Japan Earthquake, this approach contributed to the rapid recovery of heavily damaged motorways and roads. Pre-disaster arrangements with private companies were activated to support recovery services. Assessment of priority routes were determined almost immediately, and recovery efforts began (figure 3.2 and annex III).

Figure 3.2. Great East Japan Earthquake - Transport Infrastructure Recovery



Sources: Ministry of Land, Infrastructure, Transport, and Tourism; Federica Ranghieri and Mikio Ishiwatari, Learning from Megadisasters: Lessons from the Great East Japan Earthquake (Washington, DC: World Bank, 2014).

Actions toward operational and financial preparedness can be considered at each stage of the process from (a) pre-disaster planning and policy making, (b) early warning and early action, (c) response and early recovery, and finally (d) post-disaster reconstruction (see Figure 3.3). The actions are grouped into four components, which are shown on the left-hand side of the diagram, following the four good practice principles of disaster risk finance (box 3.1): see (a) data and analytics; (b) financial preparedness to ensure timeliness of financing; (c) financial risk-layering to ensure efficiency of financing different response, recovery, and reconstruction actions; and (d) disbursement of funds, which ensures that funds are approved, disbursed, and put into use efficiently to fund action.

Figure 3.3. Components of Operational and Financial Preparedness of Critical Infrastructure Systems for Rapid Recovery

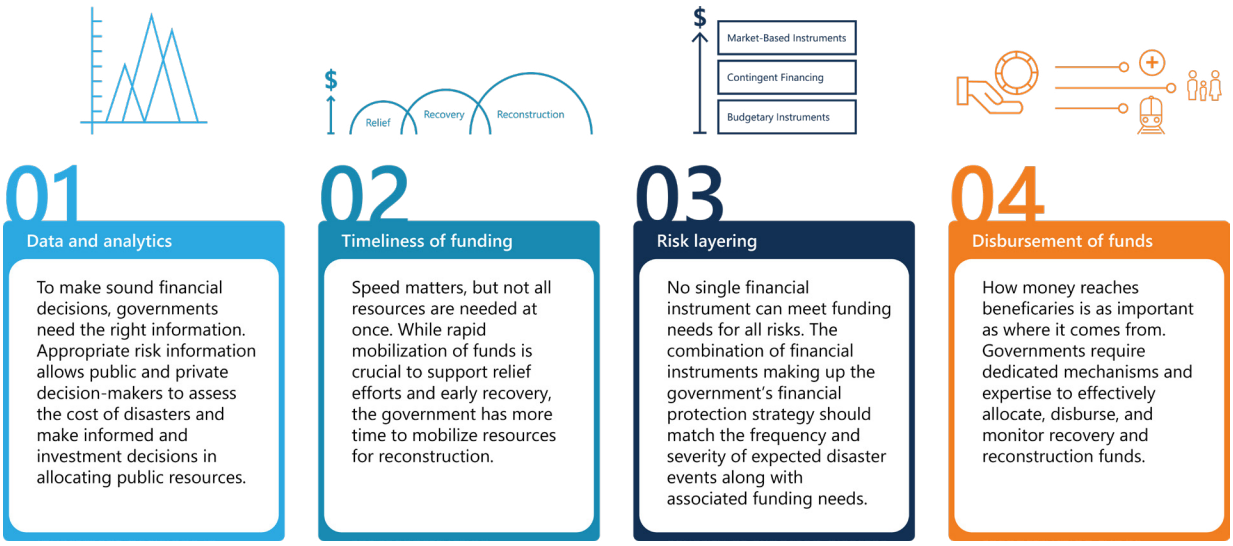
Focal Areas	Policy and Planning	Early Warning and Early Action	DISASTER EVENT	Response and Early Recovery Activities	Post-disaster Reconstruction
Data and Analytics	▸ Risk assessment, risk engineering studies, and criticality analysis of infrastructure assets and services and to inform financial preparedness and continuity and recovery strategy.	▸ Use early warning systems and real-time monitoring processes to identify, anticipate, and monitor location, types, and scale of damage and service disruption.		▸ Rapid damage assessment to enable prioritization of service recovery activities and contingent finance, or release.	▸ Rapid damage assessment to enable financing arrangements for reconstruction and any insurance or risk transfer pay-out.
Timeliness of Funding Disaster Risk-Financing Layering	▸ Put in place appropriate financing mechanisms pre-disaster to ensure finance is available when needed in an emergency. Not all finance is needed at once. ▸ Drawing on clear understanding of who owns the risk and priorities for protection, ensure a mix of financial instruments are in place to maximize coverage and minimize costs.	▸ Activate early action protocols and preparations to mobilize financing for response and recovery.		▸ Deploy early finance to support early recovery of services, as well as (if needed) business continuity support to affected firms and individuals. This could include contingency funds, reserves, contingent finance or a parametric risk transfer instrument.	▸ Reconstruction financing. This could include from indemnity insurance of the assets, other risk transfer, ex post lending, or other mechanism. Finance could be sequenced to ensure the most critical assets (e.g., in terms of critical services they provide) are recovered first.
Disbursement of Funds	▸ Contingency plans are backed by finance in place pre-disaster with clear allocation of responsibilities between operators, insurers, and local and federal governments.	▸ Activate contingency plans and arrangements for early action (e.g., measures to reduce potential damage to assets and prepare to minimise disruptions).		▸ Deployment of mechanisms (e.g., emergency contracts, mutual assistance networks) to enable infrastructure operators to resume recovery of services.	▸ Activate pre-agreed plans for building back better post-disaster.

Source: World Bank staff.

Note: The categories on the left reflect the core principles of disaster risk financing and are used here to show the linkage to the overarching operational framework for financial protection. They are not sequential. See also the next chapter and figure 3.1.

Box 3.1. Good Practice in the Design of Financial Protection Strategies against Disasters

Core principles for effective disaster risk finance are based on a decade of global experience[68].



This framework can be used as the basis of a diagnostic to identify priorities for strengthening shock-responsive systems. Often, many countries and infrastructure systems will already have some or many of the components in place. In some cases, components may be missing or could benefit from strengthening. For example, many countries have public finance mechanisms in place to allow line ministries to access additional finance in emergencies either through reallocating budgets or by requesting additional budget allocations from the Ministry of Finance. This approach can work well but often can lead to delays in financing recovery and to funds being redirected from other planned maintenance or investments, thereby reducing resilience and growth over the long-term. This framework can be used alongside data collection about past disruptions and interviews with key stakeholders to assess the critical bottlenecks-identification of which could help speed recovery and display priority actions.

Choices over the balance of policies, institutional processes, and finance at different levels of government (for example, centralized versus decentralized approaches) will depend on the political economy and situation of the country. There are advantages to ensuring that finances, protocols, and policies are as close to individual infrastructure sectors as possible (for example, contingency plans and funds held by individual government ministries, state-owned enterprises, or agencies). Yet it is also important to take a national perspective given the interconnectedness of different infrastructure sectors and risks, to assess the linkages to national-level security and resilience priorities, and to protect national government budgets. The appropriate balance will depend on country circumstances.

The following subsections describe each component of figure 3.3 and, in turn, give examples from country experiences. This framework represents the ideal that is based on good practice across several countries. For countries where capacities may be constrained, small enhancements to the status quo could lead to major improvements in service continuity. Not everything

[68] World Bank, Boosting Financial Resilience to Disaster Shocks: Good Practices and New Frontiers - World Bank Technical Contribution to the 2019 G20 Finance Ministers' and Central Bank Governors' Meeting (Washington, DC: World Bank, 2019).

is necessary to do at once. The next section draws out what those initial steps could look like, as well as outlining the latest innovations and good practices.

Data and Analytics

Accurate information and analytics are critical to inform decisions at each step from planning to triggering action to implementation. This process applies equally to operational and financial preparedness and requires in equal measure of engineering data, risk data (including early warnings), and financial data.

Availability of data can be a challenge, especially in low- and middle-income countries. The availability of adequate asset-level data has proven to be one of the most significant challenges in assessing risks to critical infrastructure systems and services. Data are required about the detailed locations of assets and their interconnectedness, resilience, and vulnerability to shocks, as well as about recovery costs. There is growing experience across the APEC region in building such databases that can be drawn on.[69] Although improving the data is an important step toward enhancing financial protection, progress can be made incrementally, and this process should not be a barrier to taking steps to advance financial protection. Other important initial information includes historical records about damages and disruptions to critical infrastructure assets and services, as well as information about historical expenditures for recovery and reconstruction.

Innovation in satellite technology and in data science is helping to make risk data more available and accessible in previously data-scarce regions.[70] This innovation opens up the potential for significant advancements in understanding risks to critical infrastructure systems and strengthened preparedness and resilience. For example, more refined and lower-cost satellite technologies are improving the granularity of earth observation data, including hazard information (flooding and tropical cyclone), as well as building information. This improvement can support both planning and recovery efforts about critical infrastructure services, as well as damage assessment, for the purpose of insurance claims or restoration planning. Machine learning and artificial intelligence are making data collation less resource intensive, and in some instances real-time data can be captured without human presence, which can be critical during severe disaster events. Open data sources and platforms about risk and socio-economic data can also help to map assets' exposure. Collaboration with the private sector can even yield important data. Such initiatives are already emerging in advanced economies and mature insurance market players. For example, a partnership between Sompo Japan, Mainmark SC, and PASCO aims to provide risk-management services for infrastructure to strengthen resilience against disasters and post-disaster insurance coverages by using advanced sensors to identify signs of infrastructure damage before a disaster occurs.[71]

If one is to understand the risks to critical infrastructure services, it is important to gather data about which infrastructure is most critical and about points of potential failure within infrastructure systems. This data gathering and analysis process is known as criticality analysis, which considers, for example, the service's dependency on particular assets, inputs, or networks. Different parts of the system will be exposed to different disaster or weather impacts. Vulnerability assessments and stress-testing can identify weak points where potential failures are likely to happen and where the potential financial impacts might occur. This type of analysis is typically completed by technical experts in consultation with local stakeholders and can involve intensive data collection on the ground. More recently, there have been innovations in the use of models and satellite data to analyze criticality and risks, with such tools becoming more openly available.

[69] World Bank, "Improving Public Assets and Insurance Data for Disaster Risk Financing and Insurance Solutions," World Bank Technical Contribution to the APEC Finance Ministers' Process, APEC Finance Ministers' Meeting, Hoi An, Vietnam, October 2017.
[70] See, for example, various articles on the Spatial Finance Initiative website, https://spatialfinanceinitiative.com/
[71] Sompo-Japan Media Release (in Japanese), 2021, https://www.sompo-japan.co.jp/~/media/SJNK/files/news/2020/20210105_2.pdf

In **Vietnam**, the World Bank worked with the government to conduct criticality analyses to help inform strategies that would strengthen the resilience of transport networks.[72,73] Vietnam, a country of around 96 million people, has estimated the annual average loss from disasters equivalent to 1.5 percent of GDP. The economic prosperity and livelihoods of a growing and rapidly urbanizing population depend on reliable transport, energy, and water systems. The analysis estimated that failures of critical road networks can result in losses of up to US$1.9 million per day, and critical railway failures can result in losses as high as US$2.6 million per day. The government's contingent liability losses that are related to public assets alone are estimated to be about US$278 million. A tool was developed to help design and prioritize resilience strategies that are based on this assessment. The tool used detailed asset data and additional information about the economic value of services they provide; then it modeled the interconnectedness between assets. This same tool can be used to identify the residual risks to be managed through financial and operational preparedness.

Flooded roads in Da Nang, Vietnam in 2018.

Catastrophe risk models are beginning to be adapted to include estimates of the financial impacts of disruptions to services and the costs associated with service continuity, but this development is a new area of innovation. Traditional catastrophe models provide information about the risks to individual assets, but the models do not consider the interconnectedness between those assets. By linking catastrophe risk models with criticality analysis as described earlier, one can estimate the probability of different levels of

[72] Jung Eun Oh et al., Addressing Climate Change in Transport: Volume 2: Pathway to Resilient Transport (Washington, DC: World Bank, September 2019), http://documents.worldbank.org/curated/en/438551568123119419/Volume-2-Pathway-to-Resilient-Transport
[73] Rentschler, et al., Resilient Shores.

service disruptions and recovery costs. The outputs of these analyses can be used to structure a financial risk-management strategy.

The World Bank is currently piloting this approach of connecting catastrophe risk models and criticality analyses as part of **Myanmar's** investments in national electrification. The model will help inform both financial and operational preparedness, as well as longer-term resilience investments. This work estimates the potential direct damages to generation infrastructure and the powerline and distribution network in Myanmar from flood, typhoons, and earthquakes; it estimates numbers of people affected in instances of systems failure. The information is used to estimate the financial risks associated with damage and disruption, as well as the recovery costs to help prioritize risk mitigation. This type of assessment can inform strategies for reducing and managing financial risks.

Development of this type of analytics is relatively nascent, particularly outside high-income countries. Further investment is required to develop approaches that are scalable and useable in lower-income countries and that deal with greater data constraints. Work to develop prototype tools and analytics is underway, including at a regional scale across Southeast Asia by the World Bank.

Timely and Reliable Finance

Appropriate financing mechanisms, if put in place before any disaster strikes, can provide timely and reliable finance when needed in emergencies. The amount of financing required for immediate recovery is typically small compared to reconstruction finance, but speed and predictability can make a big difference to ensuring service continuity.

Securing timely and reliable finance has two components: (a) the funding itself and (b) the mechanism to disburse it. Pre-arranged funding could include budgetary mechanisms, such as contingency funds and reserves, contingent credit instruments, and financial instruments. The protocols for timely approval, allocation, and transfer of funds within government are equally important. In some contexts, the lack of such protocols pose a major constraint to rapid recovery. Simple steps can be followed to put in place timely financing mechanisms.

First, dedicated institutional and budgetary arrangements can help to ensure timely approval and allocations of funds. A first step involves well-defined rules on public financial management, including pre-agreed rules and processes for approving, allocating, and transferring funds between ministries of finance, line ministries, and subnational governments that are involved in overseeing or operating critical infrastructure systems.[74] The financing mechanism itself could include, for example, a national disaster fund, an O&M fund, or a contingency budget line with pre-agreed rules in place for triggering funds and protocols to ensure rapid disbursement. An O&M fund can be established with standard operating procedures for quick approval of emergency expenditures to implementing agencies. This fund can then be backstopped with financial instruments to ensure it has enough resources to meet the needs after a disaster. As noted earlier, decisions about where funds should sit - centrally or locally - will depend on the political economy and public financial management processes of the country.

Second, financial instruments can be designed to quickly release finance in emergencies that are based on pre-agreed triggers or rules.[75] This design can include instruments with soft-triggers, which are pre-arranged with a clear threshold for release, but payouts are subject to a government's request. This approach could include contingent credit from development

[74] World Bank, "Disaster Response: A Public Financial Management Review Toolkit," World Bank, Washington, DC, November 2019, https://www.pefa.org/resources/disaster-response-public-financial-management-review-toolkit
[75] For more information on financial instruments, see World Bank, Financial Protection against Natural Disasters.

partners (such as the World Bank's Cat DDO) where rules are pre-determined for the release of funds, such as the declaration of an emergency. However, actual disbursement requires the government's decision to draw down the instrument. Instruments with hard-triggers determine payouts by an objective observation, such as windspeed or earthquake intensity or modeled loss estimates. An example is parametric insurance, where premiums are paid in advance and finance is released automatically when triggered. Being automatic, finance is typically faster and earlier than, for example, indemnity insurance products. For critical infrastructure, parametric insurance can help to overcome the difficulties in insuring horizontal infrastructure such as electricity transmission lines, which are vulnerable to weather but are difficult to insure cost-efficiently because of challenges in risk modeling.

The **Caribbean** regional risk pool, CCRIF SPC (Caribbean Catastrophe Risk Insurance Facility), provides parametric insurance coverage for tropical cyclones, earthquakes, excess rainfall, and the fisheries sector to 19 governments in the Caribbean and 3 governments in Central America. In October 2020, CCRIF SPC launched its newest parametric insurance product for electric utilities in the Caribbean. That product was first purchased by the **Anguilla** Electricity Company Limited and included ongoing work with electric utilities that would extend it to other Caribbean countries.

Finally, clarity of risk ownership (including between levels of government or with the private sector) - that is, for defining who pays in an emergency - is also essential. This need is particularly true for critical infrastructure where many stakeholders are often involved in the ownership of assets and operation of services. A clear risk-allocation mechanism and the ability to compensate infrastructure operators, particularly for larger-scale events, are important particularly within privately run sectors. In the short term, this approach helps maintain financial continuity of the business; in the long term, it helps to ensure the sustainability of the sector.

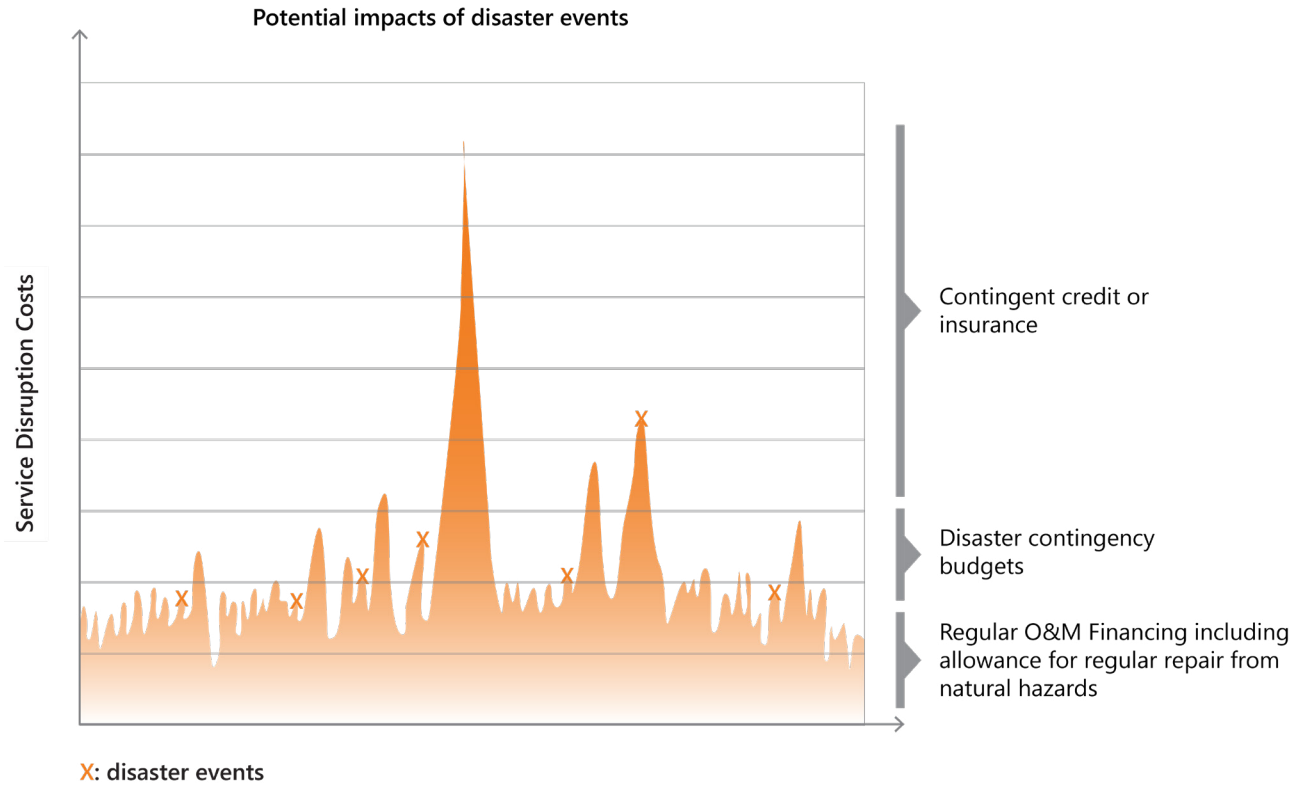
Although most electricity utilities in the **United States** are privately owned, the government plays an essential and enabling role when it clearly sets regulatory requirements for service provision by the utilities, as well as when it has pre-agreed rules that govern what risks are covered by the utilities and where the government will step in. In many countries, risk allocation is similarly and clearly defined by law or regulation (see chapter 4 for a more detailed discussion about risk ownership and allocation).

Risk Layering

Different financial instruments can be combined to help governments ensure cost-efficient and predictable access to funding for recovery of critical services during bad disaster years. This combination ensures that the overall financing mechanism can deliver the right amount of financing at the right time, without delays and without costly emergency fund raising. It also helps reduce the risk of critical infrastructure failures, as well as reducing the implicit contingent liability on the government's balance sheet (see also chapter 4).

A variety of instruments can be used to target different scales and types of disaster risks (figure 3.4). Dedicated instruments that manage (or retain) risk as part of the budget (risk retention) such as contingency budgets or disaster funds can respond to small and medium impacts and can manage funding needs for regular rehabilitation as a matter of standard financial planning. Financial instruments that transfer risk, such as insurance, can provide an additional injection of liquidity or targeted reconstruction financing for low-frequency high-impact events. For the largest catastrophes, governments typically step in to provide unplanned financial support after the event - even in well-managed systems.

Figure 3.4. Combination of Financial Instruments to Cover Cost of Service Recovery



Source: World Bank staff.

Importantly, predictable and adequate O&M financing should be the bedrock of a financing strategy for critical infrastructure. Proper O&M financing helps maintain asset resilience to the level for which that financing is designed. O&M can also respond well to smaller-scale disruptions. Without proper O&M, the quality of assets deteriorates over time, which makes assets more vulnerable to disruptions from disaster shocks and harder to repair.

Sustainable funding of regular O&M remains a challenge for many infrastructure operators. There are often trade-offs between regular O&M funding, rates faced by consumers (e.g., the price of water), and, for example, other investments to extend services.

- For concessional and privately owned critical infrastructure in many countries, regulatory and financing mechanisms (e.g., as part of PPPs) have included elements to incentivize continual O&M. Several common themes of good practices are emerging, including (a) development of a strong capability within government to prepare, plan, manage, and govern PPP projects; (b) clear and transparent procurement processes, including allocation of risks and responsibilities that cover types of risks; (c) creation of appropriate incentive (and penalty) structures for active management of different types of risks; and (d) close collaboration among the stakeholders, the regulators, and the associated supervisory agencies, private sector operators, and supporting services including insurance provision.[76,77]

[76] World Bank, "PPP Best Practice."
[77] World Bank, Technical Brief on Resilient Infrastructure Public-Private Partnerships.

In the **United Kingdom**, regulators impose penalties for failure of services on private rail operators, thus encouraging rail operators to invest in adequate O&M and to put in place effective systems that manage risks associated with poor weather. In the water sector, the England and Wales water regulator, Water Services Regulation Authority (OFWAT) requires privatized water and waste water companies to develop and report about the price, investment, expenditure, and service package they deliver. One important regulatory service requirement covers the scale of water leakages - an easily defined indicator of resilience. Poorly maintained pipes are more likely to burst during extreme weather events, and rapid repairs can limit the negative impacts caused by disruption in the localized water supply. In response, water companies have made significant progress in reducing leaks through better maintenance and quicker repairs, and leakage is reduced by about a third from its 1994-1995 high.

- Publicly owned infrastructure requires recurrent budget allocations for O&M that are based on tax revenue.[78] As a result, the allocations are not prioritized by governments in some countries, because the benefits of good O&M are less noticeable for policy makers and citizens than would be the establishment of a new infrastructure. The World Bank and APEC have been exploring how financial instruments can deliver an integrated solution for countries by combining finance for O&M with support for continuity of critical services. Under the 2019 APEC agenda, the World Bank proposed exploring a Catastrophe Warranty, which would be a new financial structure that would integrate both financing for recovery of services and regular O&M financing in one instrument to fill two common financing gaps that are experienced by countries. The design was structured so it could be financed by governments, private investors, international financial institutions, or bilateral donors (box 3.2).

England's aging underground water mains pipe are prone to leakages without regular maintenance, making pipe leakages a priority for the water regulator Ofwat.

[78] This is particularly the case for a nontariff infrastructure such as non-toll roads and bridges (which do not generate revenue) or buildings such as schools and clinics for service delivery.

Box 3.2. Innovation in Financial Protection for Infrastructure Owners and Operators - the CAT Warranty Proposal

The proposed catastrophe (CAT) infrastructure warranty[79] is a financial package that combines adequate O&M funding with pre-arranged finance for the restoration of critical infrastructure service after disasters. This package allows some cohesion between the processes for funding day-to-day service continuation under normal conditions and for financing the reinstatement and continuation of services during and after a disaster. The financial package aims to support adequate upkeep of assets during normal times and rapidly to reinstate critical services of public infrastructure, even after a disaster. The CAT infrastructure warranty could be developed for different sectors, assets, and owners. The specific warranty design and covered hazards could vary, thus reflecting different factors such as asset types, risk owners, accounting system, and revenues of infrastructure services. The following are examples of the design of the warranty.

- **O&M service providers' warranty.** Governments could purchase disaster recovery services from O&M providers by paying upfront or recurrent fees in addition to the regular O&M fees. For example, performance-based contracts, which link contracting payment to service providers' performance metrics, could include responsibility for disaster recovery as part of the key performance indicators (KPIs). Those KPIs would require, in exchange for fees, that the service providers ensure some degree of service continuity even after severe disasters (for example, providing temporary barge service after the collapse of a bridge). To provide such service, service providers should transfer disaster-related financial risks to insurance or capital markets at their own expenses in order to ensure that they can fulfil their commitment after a disaster.

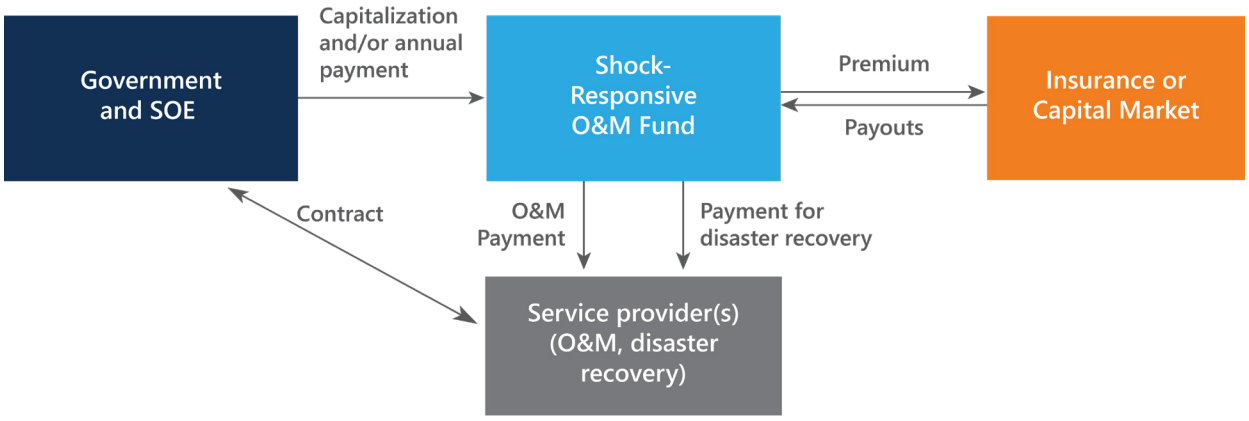
Box figure 3.2.1. O&M service providers' warranty

Key: SOE = state-owned enterprises; O&M = operations and maintenance

- **Shock-Responsive O&M:** A risk-financing product could be embedded into an existing O&M fund so that insurance payout can be used by the O&M fund to transfer additional resources to the same or other service providers for the reinstatement of the asset's services. Insurance products can be tailored by governments or state-owned enterprises to specific infrastructure assets, even for multiple years, to transfer disaster risks to insurance or capital markets. This approach could also be arranged by financing O&M through recurrent budget and by linking with contingent credit or risk-transfer instruments.

[79] World Bank, "Catastrophe Infrastructure Warranty against Climate and Disaster Shocks."

Box figure 3.2.2. Shock-Responsive O&M fund



Key: SOE = state-owned enterprises; O&M = operations and maintenance

In both cases, the CAT infrastructure warranty would ensure that finance is available for rapid recovery and would also incentivize governments to invest in risk reduction and preparedness.

Disbursement of Funds - Linking Finance to Operational Plans

Delays to the disbursement and execution of funds can also create major delays to disaster recovery. This delay can be partly about procurement of services but also about operational readiness to respond. There are various ways to address such bottlenecks, including public financial management rules for disasters, emergency accounting rules, and emergency procurement rules.

Pre-agreed emergency procurement procedures played a critical role in ensuring continuity of services during the 2009 Victoria Black Saturday bushfires in **Australia**. The Victorian Bushfire Reconstruction and Recovery Authority (VBRRA) was established and given powers to fast-track procurement. The VBRRA was able to make the decision to undertake the cleanup at the government's expense, and a contract was signed with a provider within days.

Prearranged contracting of recovery services can help to strengthen operational preparedness, to speed up recovery, and to promote preparedness. It could involve, for example, putting in place any required service level agreements, memoranda of understanding, and mutual assistance agreements with external stakeholders to ensure that appropriate services and equipment are secured in an emergency. The example of prearranged contracting for Japan noted earlier provides a good practice case. The following examples provide further good practice about where the integration of financial and operational plans has led to demonstrable success in reducing disruptions to services.

One hybrid financial and operational preparedness instrument that is available to private electric utilities in the **United States** is a mutual assistance agreement. Such mutual assistance agreements allow a utility quickly to obtain equipment and personnel in emergencies and to facilitate rapid recovery. This process is backed up by clear arrangements on the process to recoup any costs. When Hurricane Sandy left 8.5 million customers without power in New York and New Jersey, electric utilities executed mutual assistance agreements to deploy more than 70,000 workers to the affected areas, and those utilities enabled air

transportation of 229 power-restoration vehicles and 487 personnel to restore power.[80]

The **Caribbean** Electric Utility Services Corporation (CARILEC), which is a regional association of electric energy solutions providers, operates the CARILEC Disaster Assistance Program (CDAP) to enable mutual assistance (mainly human resources) for post-disaster power restoration between member utilities. Such disaster restoration assistance through the CDAP is financed by the CARILEC Disaster Fund, which is a mutual fund that receives annual contributions from member utilities and that ensures timely reimbursement to the assisting utilities. Pre-disaster, CARILEC supports utilities with preparedness planning and facilitates knowledge sharing. When a threat is imminent (early warning stage), CARILEC alerts the assisting utilities. Then during response stage, CARILEC coordinates with utilities to ensure that assistance is delivered efficiently. Currently, 27 member utilities subscribe to CDAP and, therefore, make contributions to the Disaster Fund.

Next Steps

The actions described in this section are essential to minimize disruptions to critical services from individual infrastructure systems. Governments should also take a national perspective to consider preparedness mechanisms in the wider public finance frameworks, to take a holistic view of cross-government financial-risk management of critical infrastructure, and to cushion the fiscal impacts of service disruption. This process is described in detail in the following chapter.

[80] FEMA, "Hurricane Sandy FEMA After-Action Report."

4. Integrating Critical Infrastructure in Government Financial Protection Strategies

Financial protection strategies for the government - usually championed by Finance Ministries - set out the policies and financial instruments to increase the countries' financial resilience. The purpose is to reduce the financial shock of disasters on a government's balance sheet and to ensure that predictable, timely, and cost-effective finance is available in emergencies. Such a strategy should look at ways to build financial resilience for shocks across the whole of government, as well as more broadly across society. Such financial protection strategies should ultimately include the contingent liabilities arising from disruptions to critical infrastructure services. But frequently this inclusion is not explicitly acknowledged and quantified, which can leave governments exposed. Establishing shock-responsive systems (as outlined in chapter 3) turns an implicit liability into an explicit liability that the government can properly manage by integrating it into a national strategy of financial protection.

Ministries of Finance play the key role to advance the integration of critical infrastructure services in financial planning for disasters. As both financiers and conveners across the government, Ministries of Finance are well positioned to take an integrated, national perspective about the financial risk management of critical infrastructure. Moreover, they can use public finance frameworks and regulations to align incentives across government and the private sector to strengthen resilience. This chapter proposes practical steps that finance ministries can take toward integrating critical infrastructure within a national financial protection strategy.

The inclusion of critical infrastructure services should stress two priorities:

- **Enhance the financial preparedness of the government, both to ensure that financial** arrangements are in place to cushion the fiscal impacts related to disruption of critical services and to ensure that timely finance is available for recovery.

- **Protect society by ensuring continuity of services by critical infrastructure owners and operators in line with national critical infrastructure strategies,** including through policy, regulation, and financing arrangements that align incentives among infrastructure owners and operators.

The proposed key actions to develop and implement a national financial protection strategy for critical infrastructure services are summarized in figure 4.1. This summary includes five action points for defining a set of short-, medium-, and long-term objectives and action plan (left-hand side) and a 9-point action checklist to advance financial protection against the above mentioned two priorities. Earlier publications set out more information about the steps and the particular budgetary and financial instruments, including the World Bank's Financial Protection against Natural Disasters: An Operational Framework for Disaster Risk Financing and Insurance,[81] the 2020 World Bank and APEC's Operational Framework for Catastrophe Insurance Programs for Public Assets, and the 2020 World Bank and SEADRIF's knowledge series about the financial protection of public assets.[82]

[81] World Bank, Financial Protection against Natural Disasters.
[82] World Bank, "Financial Protection of Public Assets."

Figure 4.1. Summary of Key Steps in Financial Protection of Critical Infrastructure Systems and Checklist

A. Assessing risks, identifying bottlenecks and setting objectives

1. Identify critical infrastructure assets.

2. Determine what contingent liabilities the government holds for the costs of recovery of critical infrastructure services. This can be implicit or explicit.

3. Understand risks and drivers and assess contingent liabilities. This includes understanding the drivers of historical disruptions to services and identifying key bottlenecks to be resolved.

4. Identify financing gaps. Clarify current financing arrangements and map contingent liabilities against these to identify gaps.

5. Define a set of short, medium and long-term objectives and a strategy. Prioritize problems to resolve and create a short-term action plan (0 - 5 years).

B. Government actions to enhance financial preparedness of the state

1. Clarify and enforce risk ownership Legally establish the states' liabilities for the costs of recovery and reconstruction as far as possible, including defining cost-sharing rules across national and sub-national government authorities, infrastructure owners and operators and users.

2. Develop and implement a national disaster risk financing strategy that incorporates critical infrastructure services, and link this to broader fiscal and critical risk management frameworks. Securing:

- **Immediate liquidity for budget support to ensure speedy recovery of critical services in emergencies,** including layering budgetary and financial instruments such as reserves, contingency budgets and risk transfer, and ensuring these are linked to plans and protocols to ensure rapid disbursement and execution of funds.
- **Longer-term reconstruction financing,** such as contingent credit arrangements or a public assets insurance programme.

3. Timely, effective post-disaster budget execution mechanisms so funds are approved, allocated, transferred and used effectively.

4. Ensure pre-disaster contingency planning and protocols are in place for rapid disbursement of funds, including emergency procurement procedures and pre-arranged contracts for recovery services as appropriate, and capture opportunities to build back better through building this into plans and finance in advance.

C. Government actions to protect society by ensuring continuity of services by critical infrastructure owners and operators

1. Establish requirements for data sharing and disclosure of risk information. Assess risks against national risk tolerances. Support may also include public provision of data, such as hazard information.

2. Establish regulatory/contractual requirements and/or incentives that ensure minimum financial preparedness, including e.g. minimum standards for insurance and contingency budgets as appropriate.

3. Establish regulatory/contractual requirements and/or incentives concerning operational preparedness for shocks, including minimum requirements for contingency planning and coordination in pre-disaster planning and emergency response and recovery, or fees or penalties for disruptions to critical services as appropriate.

4. Enabling provision of market-based mechanisms for financial protection, including e.g. supporting the development of robust domestic insurance markets or legislation to allow risk pooling.

5. Ensure policy and regulation builds in positive incentives for long-term risk management.

Source: World Bank staff, building on World Bank, Financial Protection against Natural Disasters: An Operational Framework for Disaster Risk Financing and Insurance (Washington, DC: World Bank, 2014)

It is important to start small and quickly with practical steps that can show tangible results. Not all governments have the capacity, data, and resources to develop all actions to a comprehensive level. But taking small steps and defining incremental, achievable policy priorities can lead to major improvements in financial resilience and service continuity. In some instances, it may be appropriate to focus on specific priority infrastructure sectors and then to expand to broader sectors over time. In others, a more cross-cutting approach led centrally will be appropriate. Different actions may be undertaken by different ministries; for example, in figure 4.1, B is often within the mandate of the ministries of finance, whereas C is often led by line ministries or other government authorities.

Ministries will also need to consider the appropriate level at which to implement different actions. For example, should contingency budgets be managed across levels of government, or should the purchase of insurance be managed centrally? The answers will depend on the political economy of the country and on the economies of scale and scope associated with rolling out a plan across multiple infrastructure assets and systems.

There are three key areas where a different approach is required for managing the contingent liabilities from critical infrastructure systems. These key areas, which are described in detail in this chapter, are:

- Assess risks and quantify contingent liabilities.
- Clarify and enforce risk ownership.
- Set requirements on infrastructure owners and operators.

Assess Risks and Quantify Contingent Liabilities

Assessing and managing disaster-related contingent liabilities from critical infrastructure in public finance frameworks is necessary both to cushion the impact of disasters on the government's balance sheet and to ensure that timely finance is available for recovery. Importantly, the contingent liabilities and fiscal risks associated with disruption to critical services are likely to be larger than the sum of damage to individual public assets from disasters. Those additional liabilities can be related to added government expenditures to recover critical services post-disaster but can also be related to implicit contingent liabilities (see chapter 2). Such fiscal risks and contingent liabilities are currently not widely or fully captured within fiscal risk frameworks.

Assessing the fiscal risks associated with service disruptions requires additional information compared to understanding risks to physical assets alone. It is important to assess contingent liabilities related to the recovery of services. But such costs may not be recorded separately in historical disaster records or as part of regular accounting by line ministries involved in infrastructure operations and maintenance. Models are beginning to be used to assess such contingent liabilities, but this assessment is relatively nascent (see chapter 3). As far as possible, it is also important to assess risks across all critical infrastructure services in an integrated and consistent way, given the interconnected nature of different infrastructure systems. This assessment includes those services with partial or full ownership by the private sector, especially given the strategic importance of those critical systems. To this end, governance mechanisms will often require risk assessment, disclosure, or information-sharing between government and infrastructure owners or operators. The government has an important role to play in managing such data, including historical loss records.

Financial decision-making tools used in public finance should take account of those risks and full costs, as well as potential losses in revenue caused by business interruptions. Once the government has a better understanding of the potential costs incurred from such service disruptions, that knowledge can inform fiscal

planning at the central level. Such risks should be assessed against the government's and society's tolerances for disruptions, which can then inform adequate resource allocation to prevent or manage service interruptions in line with government policy objectives.

This work to assess risk will take place mostly in individual line ministries but the Ministry of Finance plays an important role to assess risk in a consistent and integrated way across the whole of government and to incorporate this role into wider fiscal risk management. The steps include the following:

1. **Identify critical infrastructure assets.** Many countries have defined critical infrastructure sectors and have established an inventory of assets.[83] The most critical assets can be identified by using a set of transparent criteria (e.g., economic damages or public safety implications). The identification can be based on simple scenario analyses, on consultations with sectoral experts, or through more complex risk engineering[84] and model-based criticality analyses.

2. **Define risk ownership.** The government should aim to clarify as much as possible who is responsible for covering the costs of service restoration and rehabilitation of infrastructure systems. This clarification begins with clearly understanding current risk ownership and cost sharing. Provisions in government policy, regulation of private operators, and contract wording are critical to this end.

3. **Identify contingent liabilities of the government.** This process aims to identify the government's explicit commitments to disaster-related costs and to analyze potential implicit commitments liabilities.

.

4. **Assess risks and quantify contingent liabilities.** Once liabilities are established as far as possible, risk assessments can quantify probable losses to the government. This risk assessment brings together the liabilities from all individual programs and sectors (e.g., energy, health, ICT, and transport) and considering both the costs for each program individually and the cascading costs and impacts to the larger economy. This assessment can be approached either through analysis of historical disaster data or through modeling (see, for example, the discussion about analytics in chapter 3).

5. **Identify financing gaps.** Ministries of Finance can then map contingent liabilities for different possible events against current financing arrangements and can identify any financing gaps.

Understanding the fiscal risks from critical infrastructure services can be the basis to strong risk governance and can create incentives to promote and invest in reliable, high-quality, and resilient infrastructure.[85] For example, by quantifying implicit contingent liabilities and making them explicit, Ministries of Finance can encourage more proactive approaches to defining how such risks will be managed, including through explicit cost-sharing. Such approaches will also make it more important for governments to create incentives for infrastructure owners and operators to reduce risks.[86] In this way, progress in financial risk management can complement national programs to strengthen resilience.[87]

New Zealand provides a strong example of where critical risks and fiscal risk-management frameworks are joined up. For example, New Zealand drew its 2018 fiscal stress-testing scenarios directly from the national risk registers that support public risk-management and planning processes, including scenarios representing a severe Wellington earthquake.[88] The Public Finance Act requires disclosing all government decisions and all other circumstances that may have a material effect on the economic and fiscal

[83] OECD, Assessing Global Progress.
[84] Risk engineering refers to the application of engineering skills and methodologies to the management of risk. It involves hazard identification, risk analysis, risk evaluation, and risk treatment. Within infrastructure risk management, risk-engineering analyses and solutions include helping infrastructure owners and operators manage loss control, mitigate risk, improve safety, and reduce insurance claims. They must also look at risks before, during, and after an event.
[85] G20 Japan, "G20 Principles for Quality Infrastructure Investment,"
https://www.mof.go.jp/english/international_policy/convention/g20/annex6_1.pdf
[86] Ronnie Downes, "Budgeting for Contingent Liabilities," presentation at the Annual Meeting of OECD Senior Budget Officials, Paris, June 3-4, 2013.
[87] OECD, Assessing Global Progress.
[88] OECD, "Best Practices for Managing Fiscal Risks: Lessons from Case Studies of Selected OECD Countries and Next Steps Post COVID-19," OECD, Paris, June 2020.

outlook. The OECD in 2020 concluded that New Zealand is the only country reviewed where there is a clear link between critical risks and stress tests of public finances, and the OECD recommended that governments enhance such efforts going forward.

The **United Kingdom** has taken steps to implement a framework to assess and manage contingent liabilities so it can better manage fiscal risks and improve both integrated risk governance and proactive risk management across government. This move includes assessing potential and implicit contingent liabilities that are related to shocks. In the United Kingdom, line ministries are required to go through an approval process with the HM Treasury to take on new contingent liabilities. This process enables the HM Treasury to actively monitor, manage, and mitigate contingent liabilities across the government.[89,90,91] For example, in accepting a contingent liability, the HM Treasury can set requirements on line ministries and these requirements flow down to individual infrastructure owners and operators. In only a few years, this approach has already triggered decisions about mitigation approaches for a wide range of fiscal risks.

Clarify and Enforce Risk Ownership

Clarifying risk ownership is particularly important for critical infrastructure because a large portion is often owned or operated by SOEs or the private sector. A lack of clarity over who is responsible to pay after a shock can cause delays in response and recovery, as well as lead to implicit contingent liabilities on government. It also reduces incentives to invest in quality infrastructure in the first place and in adequate maintenance over the life of the assets. Clarifying (and enforcing) risk ownership and cost-sharing requirements can reduce the overall disaster-related contingent liabilities over time.

Cost-sharing rules for compensating losses should be spelled out at all levels in advance of emergencies to the extent feasible. In some cases, such arrangements may be defined as part of a national critical infrastructure strategy or through sector-level policies. Such mechanisms need to consider issues such as (a) procedures to trigger and obtain funding from the central government, (b) processes for damage assessment, (c) proposed cost-sharing ratio of rehabilitation works, and (d) criteria about types and scales of disasters that influence the cost-sharing.

In the electric utilities sector of the **United States**, for example, risk and responsibilities for disaster response are shared among multiple stakeholders, including the electric utilities themselves, network coordinators (Regional Transmission Organization and Independent System Operators), states, and the federal government. Events of low severity (level 1 or level 2 events on a 4-level scale) are usually handled by utilities and by network coordinators, while level 3 and level 4 events often necessitate more active involvement from the state government and, in extreme circumstances, the federal government. US state regulators determine how the costs associated with disaster recovery efforts may be passed on to consumers in the form of higher tariffs, and how much will be borne by the utility and its investors. The wide variety of ex ante and ex post financial mechanisms available to electric utilities in the United States to cope with disasters is credited with reducing the contingent liabilities on the federal government as well as helping to ensure the continuity of critical services in emergencies.

In **Japan**, risk sharing in PPPs varies depending on the types of project and their risk exposure; for example, road projects that have low profitability and high public good nature tend to place stronger financial risks on governments than will airports with high operational profitability. Global evidence shows that

[89] UK Office for Budget Responsibility, "Fiscal Sustainability Analytical Paper: Public Sector Balance Sheet," UK Office for Budget Responsibility, London, July 2016, https://obr.uk/docs/dlm_uploads/FSAP_July_2016_public_sector_balance_sheet_.pdf
[90] HM Treasury, "Government as an Insurer of Last Resort: Managing Contingent Liabilities in the Public Sector," HM Treasury, London, March 2020, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/871660/06022020_Government_as_Insurer_of_Last_Resort_report__Final_clean_.pdf
[91] HM Treasury, "Contingent Liability Approval Framework: Guidance." HM Treasury, London, July 2017, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/635939/contingent_liability_approval_framework_guidance.pdf

well-designed and performance-based contracts can also improve the focus on governance and risk sharing, as well as incentivize more consistent and better service. Those contracts can provide more certainty about costs that will enable long-term fiscal planning. Nevertheless, in practice, the application of performance-based contracts has had mixed impacts. For example, reviews for road maintenance suggest that the use of performance-based contracting needs to be supported by strong fiscal management and by clearer expectations of the risk-transfer arrangements, as well as by consistent training and capacity building within the operator to maintain quality over time[92,93]. Good data are necessary for the contractor to manage the risks and for the performance to be monitored.

While risk allocation to private operators can be hard-coded through contractual obligations or regulations, it is also important to define cost-sharing rules across levels of government. Knowing the definition and rules can avoid delays in financing recovery that would result from negotiating cost-sharing post-disaster. Nine of twelve APEC member economies surveyed in 2017 have explicit post-disaster cost-sharing arrangements in place between central and local government levels.[94] Cost-sharing arrangements should aim to address the potential for moral hazard by ensuring incentives to invest in longer-term resilience.

In **Australia**, the Natural Disaster Relief and Recovery Arrangements (NDRRA) provides the legal framework for cost-sharing and financial support to subnational governments for post-disaster relief and recovery. For subnational governments, the central government reimburses up to 75 percent of eligible expenditures on relief and recovery payments. The exact percentage of the reimbursement depends on the size of the disaster-related costs that the subnational government has incurred in a given year.

Set Requirements on Infrastructure Owners and Operators

Through policy, regulation, and procurement practices, the government also has an important role to encourage adequate financial protection by all critical infrastructure owners and operators. There is substantial existing literature, good practice, and evidence in this area. As discussed in chapter 2, infrastructure owners and operators bear the primary responsibility for protecting their assets and maintaining the continuity of services they provide. Yet, the government will often have a responsibility to citizens to ensure that a minimum level of service is sustained and may bear some implicit contingent liability if services are disrupted. Although all assets owners have a strong interest to protect their capital asset and maintain the continuity of services to avoid revenue losses, the priorities and levels of risk tolerance will often be different between the public and private sector. The nature of risks, ownership, and returns on investment also varies across the infrastructure lifecycle and from design to construction, operation, and disposal. This variance can create market failures and may imply a rationale for government intervention.

The interconnectedness of critical infrastructure and the difference in who owns and who benefits from infrastructure also means a role for government in correcting market failures. There is a risk to the continuity of critical infrastructure services if minimum standards for risk tolerance and management are not in place. As a policy maker, financier, and regulator, the government plays a key role to set required levels of preparedness and to ensure acceptable levels of risk for citizens and national security[95]. This role can involve, for example, the following:[96]

- Require disclosure of information on risks.
- Ensure business continuity planning and requirements for cooperation with government entities.

[92] PPIAF (Public-Private Infrastructure Advisory Facility), "Lessons Learned in Output and Performance-Based Road Maintenance Contracts," Issue Brief, PPIAF, October 2014.
[93] Ben Gericke, Theuns Henning, and Ian Greewood, Review of Performance Based Contracting in the Road Sector (Washington, DC: World Bank, 2014).
[94] World Bank, "Financial Risk Management of Public Assets against Natural Disasters in APEC Economies."
[95] OECD, Getting Infrastructure Right: A Framework for Better Governance (Paris: OECD Publishing, 2017), https://dx.doi.org/10.1787/9789264272453-en
[96] OECD, Good Governance.

- Define risk ownership through legislation or regulation, or as part of PPPs.
- Use performance-based contracts that incentivize service continuity.
- Set minimum requirements for insurance or contingency budgets through regulations.

Many examples exist from other APEC member economies:

Australia, Mexico, Peru, the Philippines, and **Vietnam** require owners and operators of government assets to purchase a minimum level of insurance. This requirement aims to minimize the exposure of fiscal budgets to costs for reconstructing the public infrastructure. Insurance can also put a price tag on risk and can require proper O&M as a condition of coverage, further incentivizing resilience.

In **New Zealand**, the Civil Defence Emergency Management Act of 2002 incorporates legislation to ensure continuity of services for lifeline utilities. It sets out that the main duty of lifeline utilities during and after an emergency is to deliver services to the fullest extent possible. Public and private utilities are required to analyze risks, to identify critical assets, and to conduct business continuity planning, including outlining response and recovery arrangements such as pre-arranged contracts with key suppliers for spare parts and expertise. Lifeline utilities regularly review their financial risk tolerance and put in place financial mechanisms to absorb the costs of disasters and to ensure access to liquidity; such mechanisms can include contingency funds, letters of credit, and insurance. For critical infrastructure procured under public-private partnerships (PPPs) in New Zealand, the government requires private partners to procure prescribed insurance coverage.[97] The New Zealand Lifelines Council brings together lifeline utilities to coordinate and enhance resilience.

For PPPs in **Japan**, during the procurement process, tender specifications and evaluation criteria include explicit requirements about the respective responsibilities in disaster risk management, emergency recovery, and reconstruction and about how costs are shared, as well as explicit requirements for insurance, emergency recovery, and reconstruction to encourage operators to manage the disaster risks in their projects. Clear definition and understanding between the roles and responsibilities of the private and public stakeholders, the incentives, and the requirements within the contract for operators have been found effective in ensuring service continuity.

Importantly, such regulations and arrangements need to carefully balance the financial sustainability of private sector owners and operators with the fairness and affordability of costs to consumers and to long-term resilience. There can be a trade-off between providing the most affordable services for consumers and allowing investments in infrastructure that are necessary for resilience, including financial resilience such as setting aside disaster funds to ensure service continuity in emergencies. For example, after a disaster, regulators will often need to balance the need to allow utility companies to increase rates to recoup costs of repairs to infrastructure with demands from consumers for affordable services. Most regulators will have in place processes to review and approve budgets.

The public sector can also support financial protection for privately owned infrastructure owners and operators through enhancing the development of private risk-transfer markets. A lack of availability of affordable risk-transfer options can be a major barrier to financial protection. The public sector can support the development of insurance and other risk-transfer markets through, for example, providing open data and models to support risk pricing, as well as ensuring a strong regulatory and legal environment for stable and efficient markets to grow (e.g., enabling parametric insurance products).

[97] Following the Canterbury earthquake sequence, insurance pricing was volatile and the government held that if the cost of that insurance exceeded a specified indexed cost, then the New Zealand government would contribute to the premium cost.

Links to Wider Disaster Risk Management and Critical Infrastructure Strategies

Although this report focuses on financial resilience, enhanced financial protection of critical infrastructure can also deliver significant benefits for wider resilience. Global experience shows that the benefits of financial protection are not just in the early, predictable finance received after an event, but also in the greater understanding of risk, the discipline of pre-planning for disasters, and the decision-making systems that can enable wider resilience.[98] Insurance pricing and conditions can create explicit incentives and requirements for infrastructure owners and operators to reduce risks through investing in preparedness and long-term resilience and by putting in place adequate O&M.

For **Mexico**, research shows that the Natural Disaster Fund (FONDEN) delivers significant benefits for resilience. Those benefits are beyond just financial protection and actually increase the local GDP post-disaster by 2 percent to 4 percent, with a benefit-cost ratio that is estimated conservatively between 1.52 and 2.89. FONDEN was designed and based on insurance principles that support the rapid and targeted disbursement of funds for rehabilitation of public infrastructure. Research showed that the benefits were partly achieved through the processes put in place by FONDEN. The processes promoted improved planning and preparedness pre-event and clarified risk ownership, thereby helping to speed recovery.

Putting in place rules that determine who pays for what damages in the event of a disaster not only helps to manage the risks to public finances but also creates incentives so infrastructure owners and operators will invest more in building long-term resilience to disasters. Without this clarity, infrastructure operators may rely on having public sector step in during emergencies and so will have little incentive to invest themselves in better managing their risks.

In **New Zealand**, local governments are obligated to develop long-term plans and financial strategies for infrastructure, including to meet both the current and future needs of its communities. Thus, the plans create incentives for stronger up-front investments in resilience. Linking planning for financial, physical, and social resilience in this way and providing clarity about who owns the risk are important to encourage risk owners to invest in reducing risks over the long term.

A growing body of evidence shows that strengthened financial and operational preparedness for emergencies can support building back better, which is crucial for reducing impacts from disasters and adapting to climate change. Yet, in practice, there are many reasons that building back better does not happen in all cases, particularly in emerging and developing economies. Reasons can include, financial constraints, lack of information, or pressures to reconstruct critical infrastructure quickly so services are up and running as quickly as possible after a disaster.[99] As shown by Japan's experience,[100] a financial protection mechanism, when coupled with requirements for pre-disaster recovery planning, can deliver stronger opportunities to build back better after disasters:

In **Japan**, build back better is enforced even before the disaster happens. Essential systems to facilitate recovery are proactively put in place prior to a disaster. The government undertakes regular assessments, mitigation, and improvements. The government also performs failure analysis after every disaster to inform and facilitate immediate improvements in both social and physical infrastructures. Once the underlying causes of failures are identified, a significant amount of investment is put in place to correct failure and to promote improved resilience.

[98] World Bank, Financial Protection against Natural Disasters.
[99] Hallegatte, Rentschler, and Walsh, Building Back Better.
[100] For more examples, refer to chapter 6 in World Bank, Catastrophe Insurance Programs for Public Assets.

Next Steps

Integrating critical infrastructure risks into National Financial Protection Strategies is a new area with limited experiences and analytical tools to quantify the contingent liabilities. This important area needs further work to assess the potential scale of the risks and therefore to assess the implications for financial protection strategies. Further knowledge-sharing across APEC member economies can support the sharing of best practices in this area and the strengthening of approaches to risk assessment.

Many of the components needed for enhancing financial protection of critical infrastructure systems are in place across APEC member economies. A gap exists for linking those aspects together as part of a whole of government approach to risk management, as well as linking policies related to critical infrastructure management to those concerning fiscal risk management and wider disaster risk management. This is an important next step in strengthening financial protection. Chapter 5 provides a focus on the financial protection of critical services paths and the way to considering protection against other types of risk, beyond climate and disasters, including pandemics.

5. Understanding Financial Preparedness, Critical Services, and Pandemics

The COVID-19 pandemic has highlighted the threat to critical infrastructure services from many different sources of risk, and it underscores the need for more holistic planning. COVID-19 has been unprecedented but raises many important lessons about how risk is managed by societies and about the importance of financial preparedness for shocks. This chapter draws lessons from COVID-19 toward a more integrated and whole of government approach to financial protection and preparedness.

Pandemics do not damage physical assets but can severely disrupt services through their impact on people, inputs, and demand. Recently, health services have been most directly impacted, but the pandemic has also affected education, finance, water, energy, and transport systems. School closures in many countries were a shock to education services.[101] Transport systems have been interrupted, thereby negatively impacting supply chains and critical economic sectors, particularly tourism and critical manufacturing that rely on international supply chains. Demand for telecommunications, energy, water, and sanitation has increased. Health care systems are overstretched. The pandemic impacts not only the quality of the service, but also the revenues, investments, and expenses and thus the long-term viability of utility companies. For example, an April 2020 survey of 305 chief financial officers of utility companies in the United States showed that the greatest concern from COVID-19 was the financial impact on operations, liquidity, and capital.[102]

In **Singapore**, overall electricity generation and consumption in the period of April to July 2020 dropped because of the closure of factories, malls, and offices as part of the COVID-19 lockdowns. Conversely, because the majority of the population worked from home, household electricity consumption has increased, reaching a peak in June 2020 of 8.791 MWh (compared to an average of around 7.5MWh over the previous 5 years). This shift in patterns of demand has had implications for the energy mix (specifically a shift in the energy mix from fossil fuels toward more renewables) and affected the sector's profitability.[103] This has been a common trend in many countries that imposed severe movement restrictions.

In the **United States**, the energy utilities sector (which includes public and private utilities) has been impacted through changes in both revenues and costs. The significant reduction in demand from the industrial and commercial sectors (the US Energy Information Administration forecasts a total decline in US electric power generation of 6.5 percent for those sectors and 5 percent overall) is damaging to financial performance as rates (prices) are higher in the sectors. Dozens of states have also enacted a moratorium on disconnection of residential utilities resulting from nonpayment during COVID-19, with the resulting revenue losses absorbed by utilities. State utility regulators are putting in place measures to reduce the mounting financial pressures; including (in Ohio) authorizing public utilities to obtain federal loans.

[101] Saavedra, Jaime, "COVID-19 and Education: A World Bank Perspective," World Bank, Washington, DC, July 2020.
[102] PwC, "COVID-19: What It Means for the Power and Utilities Industry," https://www.pwc.com/us/en/library/covid-19/how-covid-19-is-impacting-power-and-utilities.html
[103] Authors' analyses based on information from the Singapore government's Energy Market Authority, http://www.ema.gov.sg

In **Hong Kong**, the volume of public transport passengers, including on buses and railways, decreased by 40 percent in April 2020 compared to the year before.[104] This decrease was a direct consequence of social distancing, telecommuting, and having border control measures put in place by the authorities. To keep its public transport system operational, Hong Kong successfully implemented measures including fleet sanitization, air purification, temperature screening, and responsive operations to align with passenger demand and travel pattern changes.

COVID-19 has highlighted the importance of robust and integrated operational and financial preparedness to ensure the continuity - and in places scaling up - of critical services. For example, effective government emergency procurement has been essential in health care provision.[105] The crisis has revealed many weaknesses in the preparedness of critical infrastructure to major shocks, from health equipment and care to a lack of digital technology to ensuring the continuity of education.[106]

In some cases, COVID-19 has led countries to redefine what is considered critical infrastructure (figure 5.1). The telecommunications sector has become even more critical to the economy under lockdown measures by (a) providing business-critical connectivity and resiliency, (b) facilitating work-from-home arrangements, and (c) keeping individuals and societies connected and informed. For example, the sector provides access to medical, financial, commercial, and other essential services during mandated social isolation. The financial sector is also now more widely considered a part of critical infrastructure.

In the **United States**, the critical nature of a wider scope of infrastructure - including chemicals and other critical manufacturing sectors (which are necessary, for example, to food production, health, and water purification sectors), food and agriculture, and health services - is clearly reflected in the National Infrastructure Protection plan (figure 5.1). On March 22, 2020, the Secretary of the Treasury, released a memorandum providing that the financial services sector is identified as Critical Infrastructure Sector by the Department of Homeland Security. This identification means that despite the restrictions put in place to slow the spread of COVID-19, essential workers in the financial services sector had to maintain their operations and work schedules.[107]

[104] Authors' analyses based on http://www.data.gov.hk
[105] For example, see New Zealand COVID-19 emergency procurement guidance.
[106] OECD, "Public Procurement and Infrastructure Governance: Initial Policy Responses to the Coronavirus (COVID-19) Crisis," Paris, OECD, July 30, 2020.
[107] US Department of the Treasury, "Memorandum for the Financial Services Sector: Financial Services Sector Essential Critical Infrastructure Workers," March 22, 2020, https://www.aba.com/-/media/documents/incident-response/Financial-Services-Sector-Essential-Critical-Infrastructure-Workers.pdf#_ga=2.185734497.919837796.1585000202-2141545694.1585000202

Figure 5.1. Critical Infrastructure Sectors Identified in the USA Guidance for Essential Workers during COVID-19

Source: US Cybersecurity and Infrastructure Security Agency, "ISA Guidance on Essential Critical Infrastructure Workforce," https://www.cisa.gov/critical-infrastructure-sectors

COVID-19 has highlighted the importance of financial protection of national and subnational budgets against exogeneous shocks, including pandemics and disasters. Governments have had to spend more to maintain critical services to citizens. For example, the medical response required opening additional temporary hospitals. Government-funded lines of credit and guarantees to banks have helped to maintain lending to businesses where financial services are threatened by the increased risk of nonperforming loans and changing economic conditions. This experience highlights that disruptions to critical infrastructure services caused by pandemics can have a sizeable fiscal impact, both through losses of revenue and increases in expenditure.

Recent research suggests that some subnational governments are concurrently affected by an increased demand for critical services in health and social care and in public safety and order, and lower tax revenues. On average, for subnational governments, those sectors (health, public order, and social protection services) account for 34 percent of overall expenditures.[108]

Where critical services are provided by state-owned enterprises, disruption to demand, to revenues, or to production can create a direct and substantial fiscal risk on government. State-owned enterprises (SOEs) are prevalent in critical infrastructure sectors across countries at all income levels.

[108] OECD, "COVID-19 and Fiscal Relations across Levels of Government," July 31, 2020, https://read.oecd-ilibrary.org/view/?ref=129_129940-barx72laqm&title=COVID-19-and-Fiscal-Relations-across-Levels-of-Government

Across **Africa**, SOEs account for a significant share of public sector balance sheets, with liabilities worth on average 20 percent of GDP and assets of 32 percent GDP.[109] In Africa, as in many other regions, COVID-19 posed three major challenges for water utilities (a) loss of revenues (e.g., suspension of water billing in several countries across Africa); (b) increased demand for water; and (c) reduced availability of inputs (chemicals, fuel) and essential workers, including a deferment of critical investments (e.g., in O&M).[110]

In **Brazil**, the estimated losses in terms of forgone revenues and financial risks for SOEs in the water and sanitation sector (which serves almost 60 million households) are upward of US$100 million across the sector.[111]

Increased expenditures and losses in revenues related to critical infrastructure came on top of stretched government budgets and a difficult short-term economic outlook for some countries. As of the end of October 2020, the IMF reported that governments (globally) had together spent US$12 trillion on COVID-19 response and recovery, of which around half came from budgetary sources.[112] For example, as of November 5, 2020, fiscal support measures to respond to COVID amounted to US$100 billion in Singapore, US$50 billion (4.3 percent of GDP) in Indonesia, US$12 billion (3.1 percent of GDP) in the Philippines.[113] The APEC region contracted by 3.7 percent in the first six months of 2020, a sharp reversal from the 3.4 percent growth seen in the same period in 2019; the APEC region is expected to have contracted in 2020 by 2.5 percent, which is equivalent to an output loss of around US$1.8 trillion.[114] Those compounding impacts of shocks on government balances are important to consider as part of a financial protection strategy.

Other shocks, such as cyber risks, may affect critical services in the future in similar ways. For example, airports rely on computing services. As the power grid becomes more interconnected with communication systems, the chances of cyber-induced power outages increase.

In 2019–2020, the **North American** power grid was exposed to two major cyber events, which took several days to resolve.[115] In California, for example, a cyber event lasted more than three days, with the risk of potentially affecting the adequacy and reliability of the electric system.[116] Such risks, particularly where they directly impact a government-owned or government-operated infrastructure, pose a significant contingent liability on the government that is often not assessed or understood.

A national financial protection strategy can be a mechanism to support comprehensive financial management of such risks. Most countries did not plan for the fiscal implications of a COVID-19-type pandemic. Some countries explicitly captured the risk of a pandemic within national risk assessments and preparedness plans, yet such plans still did not translate to financial preparedness. Governments, in effect, operated as insurers of last resort to limit the long-term economic impact from the pandemic. Such implicit contingent liabilities are difficult to quantify but are a significant fiscal risk to the government.

---

[109] Jason Harris et al., "Government Support to State-Owned Enterprises: Options for Sub-Saharan Africa," IMF Fiscal Affairs Special Series on COVID-19, June 15, 2020.
[110] World Bank, "Supporting Water Utilities during COVID-19," June 30, 2020, https://www.worldbank.org/en/news/feature/2020/06/30/supporting-water-utilities-during-covid-19
[111] Rafael Muñoz Moreno, "Keeping the Lights on, the Water Running and People Moving," World Bank, Washington, DC, July 10, 2020, https://www.worldbank.org/en/news/opinion/2020/07/10/brazil-covid-19-coronavirus-pandemic-impact-water-utilities-transport-energy
[112] Phillip Inman, "IMF Urges Government to Borrow to Fight Impact of Covid-19," The Guardian, October 14, 2020, https://www.theguardian.com/business/2020/oct/14/imf-urges-governments-to-borrow-to-fight-impact-of-covid-19
[113] IMF, "Policy Responses to COVID-19," Policy Tracker, https://www.imf.org/en/Topics/imf-and-covid19/Policy-Responses-to-COVID-19
[114] APEC, "APEC Regional Trends Analysis: New Virus, Old Challenges, and Rebuilding a Better Asia-Pacific; APEC Amid COVID-19: Navigating Risks and Opportunities toward Resilience," APEC, Singapore, November 2020, https://www.apec.org/Publications/2020/11/APEC-Regional-Trends-Analysis---November-2020
[115] Authors' analysis based on data about cyber-attacks obtained from http://www.eia.gov
[116] North American Electric Reliability Corporation, "Lesson Learned: Risks Posed by Firewall Firmware Vulnerabilities," NERC Lessons Learned, North American Electric Reliability Corporation, Atlanta, GA, 2019.

Understanding past and potential future fiscal risks (and contingent liabilities), as well as proactively managing those risks within public finance frameworks, will be crucial for increasing the resilience of public finance and for creating incentives to reduce risks. This understanding is even more important in a fiscally constrained environment.

Pandemics were already considered in fiscal stress tests in **New Zealand**.[117] In 2006, New Zealand modeled the impact of a pandemic on the macroeconomy, and that model was used to inform the Treasury's preparedness during the 2009 H1N1 crisis.

Recent work in the **United Kingdom** by the HM Treasury explicitly considered the role of the government as an insurer of last resort.[118] The rationale was outlined as follows: "[The government] takes on risk that others cannot both to protect the population and provide stability when unforeseen events occur. By taking on these risks the government acts as insurer of last resort in a range of domains such as flood risk and supporting lending to small businesses. This can help improve the market for insurance and provide protection against risks where the private sector is unable to provide full insurance cover without some degree of government intervention." This report in particular addressed implicit contingent liabilities where there is no formal legal obligation for government to cover the costs but where the risk adversely affects the general public and is not covered by the private sector. The July 2020 Fiscal Sustainability Report by the United Kingdom's Office of Budget Responsibility[119] noted that Government opted to take on a large portion of the risk itself (valued at £142 billion in 2020–2021), because had it not done so, an even larger and long-lasting economic and social impact would have materialized.

Although it is challenging to quantify all contingent liabilities associated with such risks, those contingent liabilities associated with disruptions (or scale-up) to critical infrastructure services could be quantified and more proactively managed, thus easing pressure on government balance sheets and creating incentives for resilience. Potential contingent liabilities related to critical infrastructure services in many sectors are clearly defined (for example, those to SOEs in the energy and water sectors). Where the private sector is involved, public interventions such as regulation and contracts could also ensure that infrastructure owners and operators assess and disclose risks and put in place adequate financial protection. For other critical infrastructure sectors such as financial services, it is more difficult to estimate the risks, yet core principles of financial preparedness (chapter 4) still apply. For example, the UK July 2020 OBR report concluded the following: It seems implausible that the financial sector could ever be totally resilient to extreme events such as a major pandemic, so the need for the state to act as an 'insurer of last resort' will remain. The Government's future fiscal strategy will need to take account of this risk."[97] A first step is to learn the lessons from COVID-19, including collecting data to help assess future liabilities.

Governments around the world are starting to explore new ways to better manage such liabilities. For example, many countries including France, Germany, the United Kingdom, and the United States are exploring new financial arrangements to better manage such contingent liabilities and to avert future fiscal shocks from pandemics. This exploration includes public-private partnerships to strengthen the market for pandemic insurance.[120] Disaster risk finance and insurance could also support measures to manage such risks arising from the continuity of

[117] OECD, "Best Practices."
[118] HM Treasury, "Government as an Insurer of Last Resort."
[119] UK Office for Budget Responsibility, Fiscal Sustainability Report (London: HM Stationery Office), July 2020," https://obr.uk/fsr/fiscal-sustainability-report-july-2020/
[120] OECD, "Responding to the COVID-19 and Pandemic Protection Gap in Insurance," September 9, 2020. https://read.oecd-ilibrary.org/view/?ref=133_133327-3tdsqdiu7y&title=Responding-to-the-COVID-19-and-pandemic-protection-gap-in-insurance

critical services. The World Bank is supporting utilities in several countries (including Ethiopia, Ghana, and Zambia) with expertise and tools to assess their financial risks from the pandemic.[121]

In conclusion, investing in financial resilience is critical to enable stronger preparedness across society, especially for new and unexpected risks. To be better prepared for future shocks, strengthening financial preparedness should be a core part of post-COVID recovery.[122] Financial protection of critical infrastructure is even more important in a post-COVID context when countries face fiscal constraints and when households and firms are less economically secure.

[121] World Bank, "Supporting Water Utilities during COVID-19."
[122] Mahul and Signer, "The Perfect Storm."

6. Next Steps

This report proposes a preliminary operational framework to enhance financial resilience of critical infrastructure services. This framework complements ongoing World Bank work with APEC economies to improve financial protection of public assets (for example, with Indonesia, Mexico, Peru, the Philippines, and Vietnam). It aims to support countries to more proactively manage a larger portion of contingent liabilities associated with disaster shocks. However, this is a new area and few international benchmarks exist. The report puts forward initial thinking that is based on existing practice about the design of financial protection programs for critical infrastructure services, and it aims to highlight the importance of this agenda and to advance discussion. The report can serve as a basis for policy design, diagnostic analyses, and strategy development.

Moreover, the report demonstrates that financial risk management plays an important role in ensuring high-quality, reliable, and resilient services for critical infrastructures. Such services are vital for sustainable economic growth. Global experiences clearly show that the benefits of financial protection are not just in the early, predictable finance received after an event, but are also in the greater understanding of risk, the discipline of pre-planning for disasters, and the decision-making systems that can enable wider resilience.[123] Together, the recommendations of this report can help reduce disruption to critical services from disasters and thus can avoid the significant social and economic impacts experienced today.

In this way, a national financial protection strategy can be a lever for implementing the national infrastructure security and the national risk management agendas. For example, it can help set risk tolerance levels through risk-management requirements for infrastructure owners, including risk-transfer arrangements where it is appropriate to do so. Strengthening financial preparedness is particularly important in a post-COVID context, when most countries face fiscal constraints and when households and firms are less economically secure. A focus on critical services also provides an opportunity to consider wider risks in a practical way, including risks from pandemics.

Including critical infrastructure services as part of national financial protection strategies is an important step for managing fiscal risks and protecting the economy and population. The fiscal risks and contingent liabilities related to critical service disruptions are currently not widely captured within fiscal-risk frameworks. Indeed, few research studies even quantify those risks, and so there is a scarcity of evidence on the scale of the contingent liabilities and financing gaps. The World Bank is exploring new tools and analytics to close this gap, including through research as part of the Japan-World Bank Program for Mainstreaming Disaster Risk Management in Developing Countries.

This more comprehensive approach to risk within public finance frameworks could form an important part of a wider shift toward a whole-of-government integrated approach to risk management. Experience from COVID-19 has highlighted more strongly than ever the need for such an integrated and forward-looking approach to planning. Such an approach has been adopted, for example, in Singapore to manage risks in an integrated manner.[124] New Zealand is similarly moving toward an all-of-government risk-financing strategy. The World Development Report 2014[125] recommended that countries establish a national risk board to support coordination of management of critical risks across government. In many countries, this approach is already practiced to some extent, typically with cabinet offices or equivalent institutional bodies holding responsibilities for monitoring and managing national critical risks. A national risk board could bring together a set of critical infrastructure objectives, a

[123] World Bank, Financial Protection against Natural Disasters.
[124] World Economic Forum, "Global Risks 2007: A Global Risk Network Report," World Economic Forum, Geneva, January 2007, http://www3.weforum.org/docs/WEF_Global_Risks_Report_2007.pdf
[125] World Bank, World Development Report 2014: Risk and Opportunity - Managing Risk for Development (Washington, DC: World Bank, 2013), https://openknowledge.worldbank.org/handle/10986/16092

national risk assessment, a system of national financial protection planning, and a much wider and integrated way of fiscal risk management, thereby driving a whole-of-government approach.

Existing practices can be further enhanced with more explicit allocation of roles and resources. For example, such practices can include assigning a dedicated senior official role and a risk-management team (similar to the chief risk officer roles in many corporate institutions). The risk management team could have explicit and direct linkages to different line ministries and could provide consistent, coherent advice and guidance, as well as coordinate the risk dependencies and interfaces across different ministries. Clear lines of risk-reporting frameworks and escalation procedures, complemented with regular long-term risk planning and scenario stress-testing exercises, can all help to establish greater risk awareness and a risk-management culture across different government departments. Linking such an entity to financial and fiscal risk management and focusing on critical risks (including critical infrastructure services) can significantly enhance risk management.

APEC finance ministers could promote priority policy actions to strengthen financial resilience of critical infrastructure services against shocks as part of such an integrated approach. Specifically, APEC finance ministers could promote activities in the following areas: (a) assess the potential fiscal impact from disruptions to critical services, (b) strengthen the integration of operational and financial preparedness planning, (c) integrate the contingent liability from critical service interruptions in national risk-financing frameworks, (d) sharing of knowledge about incorporating such risks within public finance frameworks, and (e) promoting comprehensive risk management during recovery from the COVID-19 pandemic.

The World Bank is exploring projects to embed financial protection against disasters into critical infrastructure investment in the highest risk countries. Although such projects are at an early stage, lessons are beginning to emerge. For example, the absence of asset-level data is a key constraint to understanding risk and to designing strategies, particularly in lower-income countries. The World Bank and others are exploring ways to close such data gaps by using new technologies, satellite data, and models. Early work suggests that even where there are constraints, significant opportunities exist to strengthen financial preparedness. A key challenge is the operational preparedness to execute those funds effectively.

APEC Finance Ministers could consider the following next steps:

- Organize further technical work and knowledge-sharing about quantifying risks and contingent liabilities that are associated with critical infrastructure services and their inclusion within public finance frameworks. This knowledge-sharing should include reflecting on lessons learned from COVID-19 and should consider opportunities to incorporate risks beyond just disasters, including pandemics.

- Convene a knowledge exchange among APEC member economies about financial and operational preparedness of critical infrastructure services to promote resilience. The knowledge exchange needs to draw on expertise from the private sector to explore opportunities for financial solutions.

- Highlight the benefits of whole-of-government integrated approaches to risk management, as well as the linkages to public finance and critical infrastructure risks. Support continued knowledge exchange and capability development, including analyses, guidance, and training.

Support from international partners is available to further strengthen financial resilience of critical services. For example, the Japan-World Bank Program for Mainstreaming Disaster Risk Management in Developing Countries helps bring Japanese and global lessons to vulnerable countries around the world. The Global Risk Financing Facility has more than US$200 million in financial support from Germany and the United Kingdom, and it provides grants to pilot shock responsive systems that are integrated in World Bank projects.

Annex I. Critical National Infrastructure: APEC Resilience Strategies

Country	Definition of Critical Infrastructure	Resilience Strategy	Lead Institution in Charge
Australia	Jan 2017. 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 well being of the nation or affect Australia's ability to conduct national defence and ensure national security. Updated in Dec 2020. The Security Legislation Amendment (Critical Infrastructure) Bill 2020 sought to expand critical infrastructure entities in a wider range of sectors including: communications; financial services and markets; data storage or processing; defence industry; higher education and research; energy; food and grocery; health care and medical; space technology; transport; and water and sewerage.	Critical Infrastructure Resilience Strategy (2015) https://cicentre.gov.au/document/P50S010	Attorney-General's Department and Critical Infrastructure Centre
Canada	Critical infrastructure refers to processes, systems, facilities, technologies, networks, assets and services essential to the health, safety, security or economic well-being of Canadians and the effective functioning of government.	National Strategy for Critical Infrastructure www.publicsafety.gc.ca/cnt/ntnl-scrt/crtcl-nfrstrctr/index-en.aspx	Public Safety Canada

South Korea	National infrastructure implies that the facilities are deemed necessary to be continuously managed to protect the national infrastructure, according to the following standards, 1. Ripple effects on other infrastructure, systems; 2. Necessity for at least two central administrative agencies to jointly respond to disasters; 3. The scale and scope of damage that is caused by any disaster to the national security, the economy, and the society; 4. The possibility that a disaster can occur and the easiness of recovering from such disaster	National Infrastructure Protection Plan https://opengov.seoul.go.kr/sanction/10812531	Ministry of the Interior and Safety
New Zealand	Critical infrastructure, also referred to as nationally significant infrastructure, can be broadly defined as the systems, assets, facilities, and networks that provide essential services and are necessary for the national security, economic security, prosperity, and health and safety of the nation.	The Thirty-Year New Zealand Infrastructure Plan 2015 Civil Defence Emergency Management Act 2002 and secondary legislations (e.g., the National Civil Defence Emergency Management Plan Order 2015 and Guidance)	National Emergency Management Agency
United States	Critical infrastructure represents systems and assets, whether physical or virtual, that are so vital to the United States that the incapacity or destruction of such systems and assets would have a debilitating impact on security, national economic security, national public health or safety, or any combination of those matters.	NIPP 2013: Partnering for Critical Infrastructure Security and Resilience; also 2015 Sector-Specific Plans, https://www.dhs.gov/2015-sector-specific-plans	Department of Homeland Security

Sources: Websites as listed; OECD, Good Governance for Critical Infrastructure Resilience: OECD Reviews of Risk Management Policies (Paris: OECD Publishing, 2019), https://doi.org/10.1787/02f0e5a0-en

Annex II. New Zealand Lifelines Utilities: Integrating Operational and Financial Preparedness

New Zealanders face regular, disruptive, and costly natural hazards, including flooding, earthquakes, tsunamis, and volcanic eruptions. Climate change and increasing urbanization are likely to exacerbate this risk exposure over time, with potential for socio-economic losses resulting in critical damage and disruption, including from a lifeline infrastructure such as energy (electricity, gas, and petroleum), transportation (road, rail, ports, and airports), water and telecommunications, and broadcasting. Given the importance of lifeline services, managing the risk of failure of those services for any reason is incorporated into national strategic risk-management systems through an underpinning 4 R's framework (reduction, readiness, response, and recovery).

This case study summarizes the systems approach to natural-disaster risk management by lifelines and utilities in New Zealand. It covers (a) the relevant central government governance and leadership, (b) the specific legislative and regulatory framework, and (c) the operational and financial practices used by utilities to prepare for and respond efficiently and effectively to natural disasters.

Central Government Governance, Legislative, and Regulatory Framework

In New Zealand, there is a clear link between governance of critical risks, central government fiscal risk management and sector-level policies, regulations and plans, as illustrated in figure AII.1.

The Civil Defence Emergency Management (CDEM) Act 2002 and supporting regulations form the key legislative and policy backdrop to an integrated approach to disaster risk management.[i]

Key CDEM Act principles underlying the role of lifeline utilities are as follows:

- Identify and understand the full range of hazards or risks, and implement reduction strategies.
- Prioritize the continuity of operations and supply of services in accordance with response priorities set by the local controller, group controller, or national controller.
- Plan co-operatively with local authorities, CDEM groups, emergency services, and other utilities.
- Establish emergency procedures for communication with government agencies, CDEM groups, emergency services, and other lifeline utilities.
- Develop common and effective approaches to the 4 Rs, including financial preparedness mechanisms.
- Coordinate with other lifeline utilities to promote service restoration following an emergency.
- Provide information about the status of networks to the Emergency Operations Centre and National Crisis Management Centre.

[i] The National Civil Defence Emergency Management Plan is available at https://www.civildefence.govt.nz/cdem-sector/plans-and-strategies/national-civil-defence-emergency-management-plan/

Financial and Operational Preparedness of Individual Infrastructure Owners and Operators

Lifeline utility entities undertake several operational preparedness activities designed (a) to comply with CDEM Act requirements and shareholder expectations and (b) to mitigate the impacts on service delivery and to maintain a competitive advantage where they operate in competitive markets. Key operational preparedness activities commonly undertaken by lifeline utilities can be categorized into three types: (a) planning and governance; (b) risk identification, analysis, and evaluation; and (c) risk treatments.

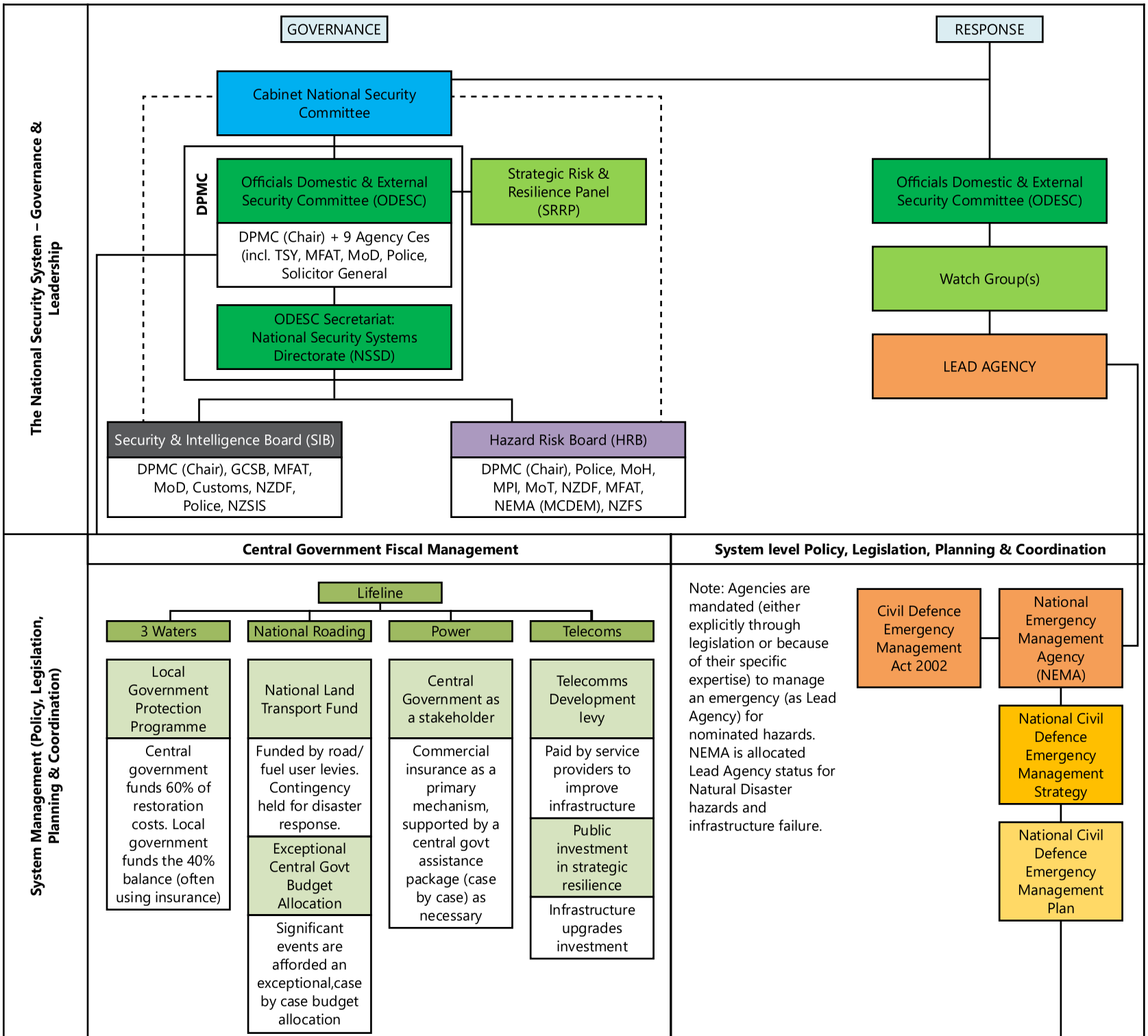
General themes inherent in the financial preparedness of lifeline utilities include these:

- **Risk layering.** The risk-financing program is a mix of layered instruments and takes into account balancing the dependency on any single instrument, the relative cost of each layer, and the capacity of risk-transfer markets to accept risk.

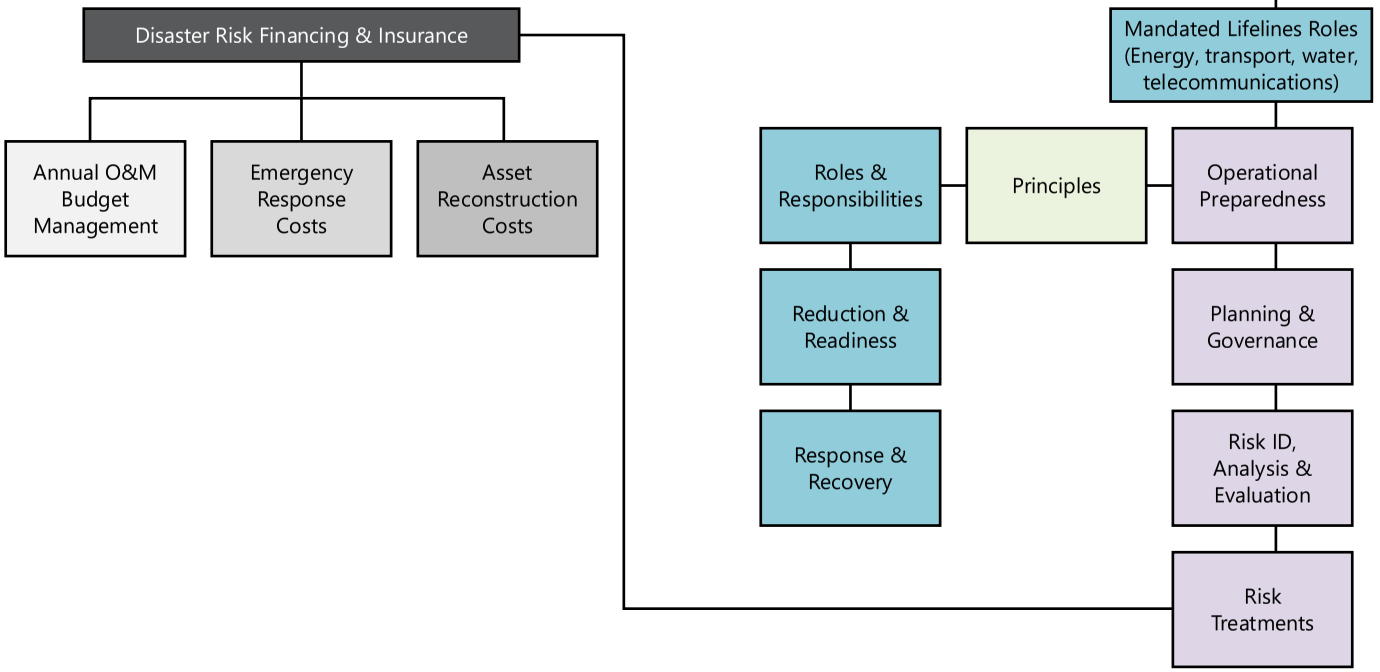
- **Risk retention and risk transfer.** Natural disaster insurance is not cheap in New Zealand, especially since the recent earthquake activity. Large, complex organizations, such as lifeline utilities, have sought to mitigate the costs of the risk-financing program by balancing risk retention with risk transfer, thereby accepting sizeable retentions (ranging from tens of millions to hundreds of millions of dollars).

- **Annual budgets.** At the project level, annual asset management budgets incorporate contingency finance, such as corporate and central government budget contingencies. The costs and risk ownership are allocated to the party best positioned to manage it.

A National Systemic Approach to Lifelines Disaster Risk Management



Lifelines Disaster Risk Management



Electricity Industry Structure

The electricity industry in New Zealand has four (4) main components: 1) Generation, 2) Transmission, 3) Distribution, 4) Retail.

Generation: Five (5) major generating companies make up in excess of 90% of the generating capacity. Three (3) of those companies have a mixed ownership model in which government holds a major stake. Two (2) are private sector companies.

Transmission: Transpower, a State Owned Enterprise, has the monopoly remit to manage the transmission network.

Distribution: Managed via twenty seven (27) electricity lines companies. These companies are trust owned or publicly registered companies.

Retail: In New Zealand there is a high degree of vertical integration between generation and retail. The five (5) main retail companies are also the main generating companies.

Abbreviations:
DPMC – Dept of Prime Minister & Cabinet
GCSB – Govt Communications Security Bureau
MCDEM – Min. of Civil Defence & Emergency Mgmt
MFAT – Min. of Foreign Affairs & Trade
MoD – Min. of Defence
DPMC
MoH – Min. of Health
MoT – Min. of Transport
MPI – Min. for Primary Industries
NZDF – NZ Defence Force
NZFS – NZ Fire Service
NZSIS – NZ Security Intelligence Service
TSY – The Treasury

Annex III. Japan: Improving Disaster Preparedness and Restoring Critical Infrastructure Services after Disasters through Partnership with the Private Sector

Japan is highly exposed to a range of natural disaster risks such as earthquakes, tsunamis, cyclones, floods, landslides, and volcanic eruptions. In the past decade, Japan has been commissioning and operating infrastructure through public-private partnership (PPP) arrangements. Japan offers useful lessons about approaches to improve disaster resilience in infrastructure under this context. Drawing on experience within a PPP framework, the Japanese have used a number of approaches to incentivize disaster resilience from the private infrastructure operators during the contracting and procurement process. The approaches include these [i,ii,iii] :

- **Clear definition of disaster subtypes, scale, and respective responsibilities.** In Japan, PPP contracts have a reasonably clear definition of natural disaster and a distinction between public and private responsibilities and risk sharing during a natural disaster event-whether by type or the scale of the disaster. By doing so, there is an alignment of expectations and understanding and the avoidance of doubt and dispute when a disaster happens. This approach incentivizes private operators both to integrate disaster-resilience measures into the operation and to improve response time.

- **Risk-transfer mechanisms that vary by project characteristics.** In early public procurement and first-generation PPP projects across Japan, the costs of force majeure risks were largely borne by the public sector. Modern PPPs involve a transfer of reasonable disaster risks to the private sector by learning through experiences, and now risk-sharing considers the different characteristics of each project. For example, the local government bears a higher proportion of financial risks in road projects with low profitability and high public nature when compared to airport projects that are likely to generate adequate revenue. Such risk tolerance of private operators is taken into account.

- **Procurement tender specifications and evaluation criteria.** There are explicit requirements in the contracts for disaster risk management, insurance provisions, emergency recovery and reconstruction, and in some cases resilience-linked payment mechanisms to encourage private operators to manage the disaster risks in their projects. The bidders' proposals for meeting those requirements are evaluated during a tender process. For example, the private operator may be required to meet a payment reduction mechanism that is based on

[i] World Bank, Resilient Infrastructure Public-Private Partnerships.
[ii] Masaaki Nagamura, "The Role of Insurance Industry to Strengthen Resilience of Infrastructure Assets - Experience in Japan," APEC Document 2019/FMP/DRFI/SEM/009, October 14, 2019.
[iii] Federica Ranghieri and Mikio Ishiwatari, Learning from Megadisasters: Lessons from the Great East Japan Earthquake (Washington, DC: World Bank, 2014).

performance and quality of the infrastructure asset during both the construction and operation and maintenance (O&M) phases. Additional requirements include preparation of business continuity plans (BCPs), disaster risk management plans, and additional insurance (see next point).

- **Use of Insurance or Alternative Risk-Transfer Measures.** Approach varies about the use of financial risk-transfer mechanisms. In Japan, where there is a high risk of earthquakes, some private operators may be required to add an earthquake rider to the fire insurance for the O&M period. However, requirements to take out the earthquake rider vary across regions and types of projects. Alternative risk-transfer methods, such as Cat bonds, weather derivatives, and use of captive insurance companies, have yet to be popular for PPP projects in Japan.

Local governments also have specific mechanisms to speedy recovery for a publicly owned infrastructure. For example, local governments report their infrastructure damage to the line ministries, usually within 10 days of occurrence, and then the governments request a national subsidy for recovery works.[iv] They can also arrange pre-disaster agreements with private companies or local industry associations to initiate relief and recovery work in the immediate aftermath of disasters. The agreement covers information-sharing, emergency inspections, debris removal, and disaster recovery. Those companies are required to begin relief or recovery activities upon request even before a contract is costed. In return, their participation is positively evaluated during future evaluations of competitive procurement.

Immediately after the Great East Japan Earthquake (GEJE), this approach contributed to the rapid recovery of heavily damaged motorways and roads, which in turn offered critical access for other emergency services to relief and recovery operations. Pre-disaster arrangements with private companies were activated to support recovery services. Assessment of priority routes were determined almost immediately, and recovery efforts began. An important element of the speed of mobilization also relates to the clarity of who would bear the cost. In the case of Japan, the cost of the reconstruction project is two-third funded by the national government, and much of the local government's share is covered by national tax revenues. The share of cost borne by the local government decreases as the severity of the disaster increases. In the case of the GEJE, the severity of the impacts meant that the local government share was minimal.

Lessons Learned

Appropriate disaster risk sharing between public and private has been developed by learning through experiences. Incentive and partnership mechanisms are built into contracts and procurement processes including use of financial risk-transfer solutions, and allocation of financial responsibilities between the infrastructure operator, local and central governments. To enhance the speed of service recovery of critical infrastructure systems after disasters, the private sector can play a significant role. In Japan, for PPP infrastructures in which the private sector is responsible for the operation, the private operating entity will lead the process of restoring the infrastructure services with support from government entities. To enable quick service recovery, governments have found that the most-effective process is a clear definition and understanding of the roles and responsibilities between the private and public stakeholders, of incentives and requirements within the contract for operators' preparedness actions and investments (such as business continuity plans), and of insurance or alternative risk-transfer measures. Governments need to consider the type of infrastructure and the degree of risk exposure

[iv] Ranghieri and Ishiwatari, Learning from Megadisasters.

to set the level and form of their risk-sharing with the private sector so the risks are proportionate and commercially viable for the private sector to accept.

Publicly owned and operated infrastructure systems can enhance the speed of asset and associated service recovery by partnering with the private sector as first responders to post-disaster service recovery. Experience of Japan has shown that establishment of pre-arranged agreements with private firms to mobilize preparatory and early recovery activities, coupled with financial mechanisms to ensure reimbursement, can significantly reduce the service disruption time of critical infrastructure systems such as arterial roads that need to be re-established for urgent response efforts.

Annex IV. Sint Maarten: Reconstruction of Sint Maarten Airport after Hurricane Irma

Princess Juliana International Airport Operating Company N.V. (PJIAE) is a private corporation that operates the Princess Juliana International Airport, which is the major commercial airport on the island of Sint Maarten/Saint Martin and serves as a hub for connecting traffic to nearby Caribbean islands. In September 2017, the airport was devastated by Hurricane Irma as a Category 5 hurricane, which was rapidly followed by Hurricanes Jose and Maria. The roof was blown off the terminal, the jetways were damaged, and there was a significant amount of sand and flooding on the runway. The airport's damage has severely affected tourism, which is the key sector for the economy and which contributed 73 percent to the country's total foreign exchange income.

Because of damages to the airport, operations were limited mainly to nonscheduled flights for humanitarian and reconstruction purposes. The airport reopened for commercial flights on October 10, 2017, while using temporary facilities after a suspension of services of more than a month. Commercial operations for airlines were serviced from tents on the airfield for more than a year. Only in December 2018 were temporary arrival and departure facilities opened within the first level of the terminal building. The entire upper floor of the terminal and the four jet-bridges remain temporarily out of commission.

When basic services were resumed, efforts were also made to restore the airport. Those efforts were financed through a range of sources. The government of Sint Maarten provided emergency financing cash transfers of US$5 million and an additional US$15 million for a fully committed facility to cover operating expenditures during reconstruction of the airport. Bilateral aid came from the Dutch government through the Sint Maarten Recovery, Reconstruction, and Resilience Trust Fund (SXM TF), which was established in April 2018 as a tripartite undertaking of the Government of the Netherlands, the Government of Sint Maarten and the World Bank. In December 2019, the SXM TF provided the Government of Sint Maarten with a US$72 million grant for the Sint Maarten Airport Terminal Reconstruction Project, which aims to restore full service at the Princess Juliana International Airport. The project is a tripartite initiative that includes the US$72 million grant managed by the World Bank, US$50 million from the European Investment Bank, and US$7 million from the PIJAE.

The significant delays to secure the required financing is in part related to delayed insurance payouts. The airport holds a commercial all-risk insurance policy and business interruption extension, which is handled by National General Insurance Corp N.V. (NAGICO), a major privately owned general and life insurance carrier in the Caribbean. NAGICO is in turn backed by a suite of global major reinsurers including Swiss Re, Hannover Re, Munich Re, Partner Re, Peak Re, and a number of Lloyds' Syndicates.

The airport filed a claim worth more than US$100 million under its all-risk insurance policy and about US$10 million under its business interruption extension for 2017 alone. NAGICO disputed the level of damage sustained by the airport, which, it said, was based on estimates and not on real invoices and tenders. Its own calculations estimated that damages should be to the tune of US$37 million, including profit loss. NAGICO had paid out only US$25 million in advances, which led PJIA to file an injunction in

May 2018. In a judgment of July 30, 2018, the Sint Maarten Court of First Instance ordered NAGICO to pay Princess Juliana International Airport (PJIA) a further advance of US$33 million to continue restoring the airport. Only in August 2019 did the arbitration panel that had been set up for the case rule for a payment of US$72 million (including advances already made) from NAGICO to PJIA.

Although basic flight services were resumed rapidly and the airport was able to operate close to full capacity over time, the airport had endured prolonged periods of sourcing adequate reconstruction finance, which limited its speed of recovery.

Annex V. United States: Disaster Recovery in Privately Owned Electric Utilities

Overview of Operational Response to Emergencies in the United States

In the United States, all states have legal authority for general disasters, including any utility-related emergencies.[i] The National Response Framework (NRF) provides guidelines to states (a) to create emergency and disaster plans that serve as blueprints for emergency response operations and (b) to define responsibilities among state agencies and state and local jurisdictions. The National Incident Management System (NIMS) provides guidelines to electric utilities to design their own emergency response plans (ERPs), which must be submitted periodically to state public utility commissions for approval. Both the NRF and NIMS establish common terminology and concepts to facilitate communication and coordination, to define and standardize the hierarchical structure of temporary operational systems[ii] so they are active during a disaster response, and to implement standard procedures for all responding organizations to use. Those measures facilitate the sharing of resources and information, plus the integration of operational teams and maintenance crew across utilities, local jurisdictions, and states.[iii]

Risk and Responsibility Allocation

The National Association of State Energy Officials has a 4-level severity scale to classify disaster events. Depending on the severity, the risks and responsibilities for disaster response are shared between the electric utilities, network coordinators such as Regional Transmission Organizations (RTOs) and Independent System Operators (ISOs), states, and the federal government. Level 1 and 2 events are handled by utilities and by network coordinators, while level 3 and 4 events often necessitate more active involvement from the state and, in extreme circumstances, the federal government.

Utilities are responsible for monitoring potential threats, planning for emergencies, and declaring utility-level emergencies (ERP events). They are also responsible for alerting network coordinators and state authorities about the evolution of the disaster event, as well as managing resources needed for disaster response. The utilities have financial and operational responsibility for recovery and restoration efforts, and they play a major role with network coordinators to

[i] In this report, we use the terms "disaster" and "emergency" interchangeably. This is done because different stakeholders involved in the response and recovery process prefer different terms: while utilities and system operators (RTOs/ISOs) prefer the term "emergency," some mutual assistance groups and government agencies prefer the term "disaster." By using both terms, we can better portray how different stakeholders describe these events.
[ii] These include Incident Command System, Emergency Operations Center Structures, and Multiagency Coordination Groups. These systems, activated in case of a disaster, are staffed by regular employees of an organization, and remain active only for as long as the disaster response last.
[iii] The definition of "disaster event" used in this report is adapted from the "State Energy Assurance Guidelines" issued by the National Association of State Energy Officials. Disaster events can be broadly divided into four groups: deliberate attacks caused by people (e.g., terrorists, criminals, hackers, delinquents, employees); natural disasters (e.g., hurricanes, tornadoes, floods, wildfires, earthquakes); accidents caused by technological failure (e.g., pipeline rupture, levee breaches, chemical spills, power outages, nuclear or biological contamination); and systemic disasters caused by the physical inability of energy delivery systems to meet demand. See NASEO (National Association of State Energy Officials), State Energy Assurance Guidelines (Arlington, VA: NASEO, December 2009), 9, https://www.naseo.org/Data/Sites/1/documents/energyassurance/eaguidelines/State_Energy_Assurance_Guidelines_Version_3.1.pdf

ensure service continuity through restoration priority guidelines and the identification of critical facilities before an emergency event.

Network coordinators (RTOs and ISOs) help to monitor and detect a power situation that could limit or prevent the system from operating safely and reliably under normal protocols. In such cases, it will declare a system emergency and will send notices to market participants and stakeholders such as state emergency response agencies. A system emergency is an operational procedure that allows RTOs and ISOs to implement temporary measures such as limiting outside sales of power, increasing power imports, reducing voltage, asking some customers to reduce their load, and implementing rotating interruptions of service.[iv] Power generators would also respond by increasing generation.

Individual states in the USA have legal authority over general emergencies by supporting utilities and network coordinators. States have no authority over RTO or ISOs, but state public utility commissions regulate individual utilities that are members of an RTO or ISO in terms of rates, cost recovery, and safety and reliability. State public utility commissions ensure that individual utilities comply with the requests from the RTO or ISO during a system emergency, and those commissions regulate how the financial burden of the disasters are shared, whether they are recouped through higher tariffs, or if they are borne by the utility and its investors.

The federal government plays a limited role in most disaster-response emergencies as it monitors the situation and provides guidelines (such as the NRF and the NIMS) to standardize disaster response procedures and to facilitate cooperation. When the US president declares a national emergency, the federal government steps in to provide financial and direct assistance to affected individuals and to certain private and public entities. The federal government may support utilities' recovery and restoration efforts through the Department of Energy, but its financial assistance[v] does not extend to private, investor-owned utilities. Moreover, utilities still maintain operational control over restoration efforts.

Financing Structures and Cost Recovery Instruments

Multiple financial and regulatory instruments are available to electric utilities to deal with cost recovery related to disaster response efforts. Those tools can be divided into pre-event instruments, hybrid instruments, during-event instruments, and post-event instruments:

- **Pre-event instruments.** Reserve accounts are cash accounts or liquidity provisions that are earmarked for restoring service and rebuilding the infrastructure following a weather event.

- **Hybrid instruments.** Mutual assistance agreements are between utilities and borrow or lend resources such as equipment and trained personnel during an emergency event.

- **During-event instruments.** Charge cards are credit cards given to employees and contractors during an emergency event to pay for small-cost personal gear, lodging, and meals without the need to go through the traditional authorization process.

- **Post-event instruments.** Securitization is the issuance of bonds by utilities to pay for the costs of emergency response efforts. Cost trackers are special authorizations granted by state public utility commissions that allow utilities to recover certain expenses through a per unit or fixed charge on customers' bills outside the period of regular rate review. Cost deferral is when a utility is allowed to

[iv] RTOs and ISOs establish contractual arrangements with individual utilities to ensure that they are legally authorized to enact supply-side measures (such as discontinuing outside sales of power) during system emergencies. In addition, RTOs and ISOs work with state regulators to make sure they are allowed to pursue demand-side measures (such as asking select customers to reduce load or implementing rotating interruptions of service) during system emergencies as well.

[v] The Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act) was signed into law November 23, 1988, as an amendment to the Disaster Relief Act of 1974. This act constitutes the statutory authority for most federal natural disaster-response activities, especially as they pertain to FEMA and the FEMA programs.

defer a certain cost to its balance sheet, then can recover the cost through base rates as a regulatory asset over multiple years like a capital investment.

Lessons Learned

The US experience offers the following six key lessons:

- **Standardize operational procedures for disaster response across utilities.** In the United States, the Incident Command System ensures that all utilities operate with the same hierarchical structure and the same procedures during a disaster event. This approach increases the response effectiveness, minimizes the potential for miscommunication, and facilitates the management of disaster response resources and the sharing of resources and information across utilities and jurisdictions. It is inexpensive yet highly effective, and it can be implemented in all types of utilities.

- **Strengthen regional cooperation for risk and resource sharing.** Mutual assistance agreements provide utilities with access to both expert crew assistance and specialized equipment during emergencies without increasing their fixed costs. Mutual assistance helps maximize the use of available resources across utilities, which is particularly important in countries with limited disaster-response resources. This approach is effective in large countries (where disaster events tend to negatively impact some but not all parts of a country) and in small neighboring nations (where regional cooperation is typically common). Mutual assistance groups need a minimum viable size to be effective. During Hurricane Sandy, multiple small Northeastern Regional Mutual Assistance Groups were affected at the same time and therefore were unable to share resources effectively. Following Sandy in September 2013, the Mid-Atlantic Mutual Assistance, the New York Mutual Assistance Group, and the Northeast Mutual Assistance Group were merged into the North Atlantic Mutual Assistance Group, which includes 21 companies across 13 states, 1 district, and 4 Canadian provinces,[vi] with an improved ability to share resources more effectively during major events.

- **Use risk-layering and complementary instruments to increase flexibility and response effectiveness while reducing costs.** US utilities use the principle of risk-layering in their disaster response strategy; they combine different instruments to protect against events of different frequency and severity. Utilities first access their own more liquid resources (such as reserve accounts) and their partners' resources (through mutual assistance agreements) to fund the equipment and crew needed. More costly instruments, such as federal assistance or cost trackers, are used only in more severe circumstances. Utilities also incorporate flexibility in their mutual assistance network arrangements. Depending on the event, a utility can choose to request support from the more flexible regional mutual assistance groups, or the standardized, national Emergency Management Assistance Compact. Mutual assistance arrangements at different levels (for example, flexible regional agreements and more standardized national mutual assistance schemes) can help increase overall responsiveness to different types of events.

- **Adopt a multi-instrument approach to disaster recovery to improve timeliness and effective disbursement of funds.** Utilities obtain immediate liquidity through reserve accounts for early response operations, and they access other instruments such as cost trackers, cost deferrals, or securitization for larger expenses involving long-term disaster recovery. As a result of having multiple instruments, the US government, states,

[vi] EEI (Edison Electric Institute), "Understanding the Electric Power Industry's Response and Restoration Process," EEI, Washington, DC, 2016, 5, https://www.eei.org/issuesandpolicy/electricreliability/mutualassistance/Documents/MA_101FINAL.pdf

and regulators do not face pressure for immediate release of funds. Tax-payer money is spent or regulated tariffs are raised only when strictly necessary. Utilities are expected to front those costs through available financing instruments, rather than by being bailed out by government or by passing all those costs to consumers.

- **All Instruments are Important; some are essential.** Reserve accounts and cost-trackers help US utilities manage liquidity and cost recovery. Reserve accounts can be set up by any utility, regardless of ownership structure, and they are easy to implement because they rely only on internal funding. Regulatory frameworks that encourage the use of this instrument can help provide domestic utilities with immediate liquidity when dealing with the costs of disaster response and recovery.

- **Real-time network data monitoring and analytics enables effective resource allocation and quick response and recovery.** Over the past decade, US utilities have made significant investments in technologies such as smart meters, which are now present in more than half of all US homes. This investment has helped improve disaster response by enabling utilities to monitor outages continuously and by responding to them in real time and more effectively rather than relying on projections. Increased use of real-time data monitoring of disaster events may allow governments and utilities to more effectively allocate their limited response resources during major disaster events.

Annex VI. The CARILEC Disaster Assistance Program

The Caribbean is the second most hazard-prone region in the world. Most islands sit on a hurricane belt, and seismic activity is common in the area. A cumulative average of six hurricanes per year hit the region between 1966 and 2009.[i] More than 1,200 earthquakes are recorded in the region each year.[ii] Annual disaster losses in the region are estimated at US$3 billion.[iii] Between 1950 and 2016, the economic cost of those disasters exceeded US$22 billion (2009 constant dollars).[iv] Against this context, disaster risk management is a key priority for Caribbean governments, and a sum of more than US$60 million was directed toward enhancing disaster-management policy and promoting preparedness training between 2007 and 2012.[v]

Most island nations have their respective national disaster-management agencies to set and operationalize disaster-management policy, but policy makers in different nation states have progressively adopted a collaborative approach. Regional platforms have been invaluable in coordinating collaborative responses, including the establishment of the Pan Caribbean Disaster Preparedness and Prevention Project (PCDPPP) in 1981.[vi] The PCDPPP focused on standardizing procedures, establishing early-warning systems, and creating emergency telecommunications. In 1991, the Caribbean Disaster Emergency Response Agency (CDERA) replaced PCDPPP. CDERA focused on intergovernmental cooperation in disaster-management arrangements and interagency cooperation in support of disaster preparedness and response. CDERA recognized the link between disaster management and development, which placed risk management in the broader context of decision-making in the region.[vii]

In 1989, Caribbean Electric Utility Services Corporation (CARILEC) emerged as an association of power utilities, Independent Power Producers (IPPs),[viii] and energy solutions companies[ix] that were operating in the region. CARILEC has also become the largest platform for disaster response among utilities in the region.[x] The CARILEC Disaster Assistance Program (CDAP) was established so that CARILEC utilities could provide joint manpower assistance to each other after a disaster event occurs. CDAP was also created to exchange knowledge and best practices for managing disasters. Assistance is based on the impact that a disaster has on a member utility's generation, transmission, and distribution infrastructure.[xi] As a result of COVID-19, CDAP is considering including pandemics as well, though this inclusion is a long-term goal.[xii]

---

[i] National Hurricane Center and Central Pacific Hurricane Center, "Tropical Cyclone Climatology," https://www.nhc.noaa.gov/climo/#bac
[ii] University of the West Indies, Seismic Research Center, "Earthquakes: Frequently Asked Questions," http://uwiseismic.com/General.aspx?id=85
[iii] CDEMA (Central Defence Emergency Management Agency), "Regional Comprehensive Disaster Management (CDM) Strategy and Programming Framework, 2014–2024," CDEMA, St. Michael, Barbados, 2014, https://www.preventionweb.net/publications/view/39126
[iv] IMF, "Bracing for the Storm."
[v] Jeremy Collymore, "Disaster Management in the Caribbean: Perspectives on Institutional Capacity Reform and Development," Environmental Hazards 10, no. 1 (2011): 6–22, https://doi.org/10.3763/ehaz.2011.0002
[vi] Ibid. | [vii] Ibid.
[viii] Member IPPs include EGEHAINA in Dominican Republic and Jamaica Energy Partners.
[ix] Energy solutions companies include Aggreko and Marubeni.
[x] CARILEC, "Members," 2020, https://www.carilec.org/members/#associate-members
[xi] Qualitative data collected during CARILEC interview with the World Bank.
[xii] Qualitative data gathered with questionnaire sent by the World Bank.

Since its launch in 1998, CDAP has provided joint restoration assistance on more than 20 occasions and has helped several utility members rebuild and repair damaged infrastructure. Currently, 26 out of the 33 CARILEC member utilities and 1 IPP subscribe to CDAP. CDAP has two main components. The first component coordinates regional efforts to respond to requests for assistance from disaster-stricken member utilities.

The second component involves the management of CDAP's disaster fund. Through CDAP, CARILEC coordinates regional disaster preparedness and response in the following three phases:

- **Preparedness planning (normal conditions.**This phase takes place when no disaster is imminent, usually outside of the Atlantic Basin's hurricane season.[xiii] During this phase, CARILEC holds a disaster round table to address the organization's disaster management policy. CARILEC member utilities also review and update the CARILEC Disaster Response and Restoration Manual, which is based on their previous experience preparing and responding to disasters.

- **Preparedness planning (when a threat is imminent).** This phase takes place when a disaster at a member utility is imminent. During this phase, CARILEC maintains constant communication with the utility that will likely be affected, and it alerts potential assisting utilities.

- **Restorations assistance (post-disaster).** This phase takes place after a disaster strikes a member utility. During this phase, CARILEC forms a liaison with the utilities to ensure that assistance is provided safely and efficiently. If requested, CARILEC will also coordinate and deploy nonstandard assistance such as humanitarian aid, logistical support, heavy-duty equipment, and mobile diesel power generators. In turn, the assisting utilities dispatch crews to the affected utility to support service restoration works.

Short-term liquidity assistance to most Caribbean nation states is provided by the Caribbean Catastrophe Risk Insurance Facility (CCRIF SPC), which is a segregated portfolio company that provides earthquake, hurricane, and excess rainfall catastrophe coverage at low pricing.[xiv] CARILEC has recently embarked on a partnership with CCRIF to allow member utilities to take advantage of their catastrophe risk insurance.

- **Risk and responsibility allocation.** CARILEC and member utilities share responsibilities for disaster preparedness and response. In general, CARILEC has management and coordination responsibilities throughout the three phases. Utilities are responsible for updating their own emergency response plans, maintaining emergency inventories, and deploying assistance crews, among others. When a threat is imminent, responsibilities of member utilities are divided into either affected utilities - those likely to be impacted by disaster - or assisting utilities - those best placed to help the affected utility. In general, member utilities should be prepared to exchange responsibilities in an event, if needed.

- **Financing structures and cost-recovery instruments: CDAP's disaster fund.** Member utilities that are subscribed to CDAP make annual contributions to the disaster fund, which CARILEC uses to reimburse the general expenses that utilities incur while assisting the affected utility. Any CARILEC member can subscribe to CDAP and can benefit from the disaster fund. However, member utilities that do not subscribe to the fund will not receive restoration assistance in the event of being affected by a disaster. Currently, 27 member utilities subscribe to CDAP and, therefore, make contributions to the disaster fund.

[xiii] According to the US National Hurricane Center, the hurricane season for the Atlantic Basin takes place from June 1 to November 30.
[xiv] CCRIF SPC, "Company Overview,"
https://www.ccrif.org/about-us

- **Emerging issues: Responding and recovering from the COVID-19 pandemic.** The pandemic did not trigger CDAP's assistance, because triggers are impact driven and relate exclusively to damage to a member utility's transmission and distribution infrastructure. CDAP is considering including pandemics in its framework as a long-term goal. Nevertheless, when the pandemic hit member states, CARILEC documented and disseminated best practice measures to ensure that customers' needs continue to be served. For example, according to CARILEC, most member utilities such as the Jamaica Public Service Company Limited adopted response practices that include (a) stopping disconnections resulting from late payments, (b) waiving late fees, and (c) creating flexible payment plans. In general, CARILEC became a key resource to guide utilities in ensuring an uninterrupted power supply during the pandemic.

- **Lessons learned and recommendations.** The CARILEC CDAP demonstrates that mutual, regional disaster assistance can offer support for utilities in small, developing island nations that are susceptible to disasters on a regular basis. Support for such disasters are otherwise difficult to obtain because of the islands' relative smaller scale of operations. CDAP helps restore electricity supply significantly faster than could be done otherwise, which speeds up the disaster-recovery process in all other sectors of the economy. Some lessons that can be drawn for other regions are the following:

  - **Regional disaster policy coordination is key.** Regional platforms, such as CARILEC, have been essential in developing a common understanding of disaster risks and for informing national policies to minimize impact. Developing one language and approach to disaster management allowed the region to respond and recover more efficiently. Beyond streamlining processes and approaches, those platforms help foster regional knowledge transfer and shared experiences between sectors, which has numerous benefits for regional planning and sector development.

  - **After a disaster that affects electricity infrastructure, in-kind assistance is ideal to recover service quickly.** Since the launch of CDAP in 1998, CARILEC has provided joint manpower restoration assistance on more than 20 occasions. This type of in-kind assistance has been beneficial to CDAP's subscribing utilities. Power utilities in the Caribbean need substantial manpower when repairing and rebuilding electricity infrastructure damaged by disasters, particularly hurricanes. Electricity must be restored as quickly as possible for affected areas to restore other essential services such as water supply, transportation, and medical services. However, CARILEC utilities do not have sufficient staff members to meet this need on their own in the aftermath of a disaster. Therefore, assistance from supporting crews from other CARILEC utilities is usually what affected utilities need most urgently after an emergency.

  - **In-kind assistance should be coupled with financial assistance to fully restore service faster.** CDAP's in-kind assistance model is crucial to the region, but it is limited to the availability of financial resources that an affected utility can access after an emergency. Having a mechanism to finance the rapid recovery works needed to restore service could make CDAP's efforts more effective and efficient.

- **The linemen's occupational health and safety must be a priority.** CDAP considers the linemen's physical and mental health as a priority when deploying them to a disaster-stricken area. This consideration is reflected in the multilayered approach to disaster preparedness that CDAP has adopted. This approach consists in assessing the linemen's personal and family circumstances and the potential impact of disasters on their lives before deployment. This assessment helps ensure that the individuals, their families, and their community will support the linemen's deployment to an affected utility.

- **The establishment of the disaster fund has been pivotal to the implementation of CDAP.** Reimbursing utilities for expenses incurred while aiding others promotes mutual assistance. In addition, participation of CDAP subscribing utilities through shared funds fosters a shared ownership of the program and highlights the spirit of mutual assistance of CDAP.

- **CDAP's flexible mechanism of governance has allowed the fund to evolve as needed to provide timely support.** The board of directors of CARILEC reviews CDAP's lifecycle disaster management annually and makes adjustments based on recent performance. The board also reviews the fund's applications and terms during its quarterly meetings each year. This reviewing allows for flexible adjustment of membership fees, of the fund's floors and ceilings, and of the withdrawal cap.

- **Pandemics could be included as a disaster in CDAP.** Mutual assistance does not need to be exclusively physical. CDAP could formalize its knowledge sharing, its remote technical assistance, and the best practice development so CARILEC members are uniformly guided during this type of disaster.

Annex VII. Australia: Defining Risk Ownership for Rapid Recovery

Australia has a history of natural hazards, climate variability and extreme weather events including tropical cyclone, flood, earthquake, and bushfire. The social and economic cost of past events has been considerable in Australia; estimates of average annual economic cost of natural disasters in Australia came to US$18.2 billion per year between 2007 and 2016, equivalent to 1.2 percent of average gross domestic product (GDP).[i]

Because of its history of natural disaster exposure, Australia's federal government has natural disaster funding arrangements to support disaster recoveries. Cost-sharing arrangements of reconstruction and relief between federal and state governments are well articulated and regularly updated.

Risk Allocation of Disaster-Related Contingent Liabilities

To enhance the financial resilience of subnational governments against disaster risk, the Australian government both provides subnational governments with financial assistance and encourages them to reduce their disaster risk. Through the Natural Disaster Relief and Recovery Arrangements (NDRRA), the Commonwealth formalizes conditions of financial assistance to subnational entities.

A comprehensive legal framework gives the Australian government a clear role in providing financial support for post-disaster relief and recovery. For subnational governments, the central government provides financial assistance under the NDRRA and reimburses up to 75 percent of eligible expenditures on relief and recovery payments. The exact percentage of the reimbursement depends on the size of the disaster-related costs that the subnational government has incurred in a given year. Expenditure thresholds are established to calculate the level of financial support; those thresholds consider the capacity of individual states to fund relief and recovery assistance. As the cost to the subnational government increases, so too does the assistance provided by the central government.

In exceptional circumstances, regional government can access an additional ex post disaster-assistance subject, which is an implicit contingent liability. In the past, this category of assistance was used for exceptional costs, such as the dredging of a port after the 2010-2011 Queensland floods, and it was meant to provide the government with the necessary flexibility to support unforeseen recovery and reconstruction needs. There has been a concerted effort across levels of government to ensure that such payments do not raise unrealistic expectations with regard to future levels of central government assistance. For example, the assistance is provided only after the details of the disaster's impact have been assessed, and it is subject to authorization from the prime minister.

Quantification of Disaster-Related Contingent Liabilities

Across all levels of government, Australia has recognized the need to assess disaster-related contingent liabilities as part of budget planning and fiscal-risk considerations. The central and subnational governments in Australia carry out regular inventories of past disaster-related expenditures and of expected

[i] Australian Business Roundtable for Disaster Resilience and Safer Communities and Deloitte Access Economics, The Economic Cost of the Social Impact of Natural Disasters (Sydney: Deloitte Access Economies, 2016), http://australianbusinessroundtable.com.au/assets/documents/Report%20-%20Social%20costs/Report%20-%20The%20economic%20cost%20of%20the%20social%20impact%20of%20natural%20disasters.pdf

future expenditures arising from past incidents. The assessments include an examination of spending at the subnational level; the examination is based on data provided in NDRRA reimbursement requests and on public accounts of subnational governments. The process is jointly managed by the Australian Attorney-General's Department, the Treasury, and the Department of Finance.

The government discloses information about its explicit disaster-related contingent liabilities in the Statement of Risks in its budget papers, specifically Budget Paper 1. Future disasters are recognized as an unquantifiable contingent liability in the budget documents. Since 2014, the formal Statement of Risks has explicitly acknowledged disaster-related contingent liabilities, which are defined as potential costs to the central government arising outside its control [ii]. Budget estimates include expected NDRRA expenditures for eligible costs not yet incurred for recovery and reconstruction from past events, although estimates do not include a forecast of expenditures caused by potential future events that might entail NDRRA expenditures. The main reason is that NDRRA expenditures have varied significantly from year to year, making it difficult to forecast expenditures with any level of accuracy.

To mitigate the fiscal impact of disaster-related contingent liabilities and other fiscal risks, a non-appropriated contingency reserve is included in the budget. Under the NDRRA, no provision is made for future disasters, but the annual Budget Paper 3 outlines expected payments to subnational governments for disasters in the previous fiscal year [iii]. The government conducts exercises to develop longer-term projections of the cost of future disasters.

The central government also holds a qualitative discussion to evaluate the potential fiscal impacts of disasters. There are no standard procedures to evaluate a macro-fiscal scenario that follows a combination of extreme events. Instead of projecting the coincident occurrence of such events, the government instead has had to learn from actual experiences such as the 2010–2011 Queensland floods, which occurred when Australia's economy was negatively impacted by the global financial crisis.

Insurance of Public Assets

State governments develop insurance funds to provide standardized insurance coverage for public assets and access to international reinsurance capacity. State governments are also required to undertake independent assessments of their insurance arrangements every three years and to submit the results to the Commonwealth for review. Most states have developed a self-insurance system, such as government-owned captive insurers and mutual insurance pools for critical state-owned assets. According to an assessment conducted by Australia's Department of Finance and Deregulation[iv], most states have abundant and cost-effective insurance arrangements for nonroad assets, which meet the NDRRA's obligations. Some local governments insure non-road assets through a mutual pool arrangement or commercial insurance.

The public assets of more than 160 Australian government entities (including all departments of state) are insured through Comcover, the Australian government's general insurance fund.[v] Comcover handles only those entities that are within the general government sector and are subject to the Public Governance, Performance and Accountability Act 2013 (i.e., fund members). Managed by the Department of Finance, Comcover keeps a register of insured public assets that are declared by each fund member, and it provides cover for all general insurable risks including natural hazards (but excluding workers' compensation,

[ii] OECD and World Bank, Fiscal Resilience to Natural Disasters, chapter 2.
[iii] Treasurer of the Commonwealth of Australia and Minister for Finance of the Commonwealth of Australia, Federal Financial Relations Budget Paper No. 3, 2016–17. Sydney: Commonwealth of Australia, 2016.
[iv] Australian Department of Finance and Deregulation, "Review of the Insurance Arrangements of State and Territory Governments under the Natural Disaster Relief and Recovery Arrangements Determination 2011," Commonwealth of Australia, Sydney, 2011.
[v] Comcover website at https://www.finance.gov.au/government/comcover

which is the responsibility of Comcare). Comcover seeks information from fund members about assets to be covered by the fund, and it charges property premiums that are based on the sum insured and past claims experience, while taking into account the value of the property premium pool for the entire fund.

Building Back Better

NDRRA generally provides funds to return assets to their pre-disaster state. State and territory governments are expected to consider any need to relocate assets or to build in additional resilience during reconstruction, although the Commonwealth government currently has few (if any) tools to encourage state and territorial governments to build back better. The states and territories are able to seek reimbursement for some costs related to investments that improve resilience, although such requests are not very frequent. There is an ongoing discussion of increasing the NDRRA funding support for such investments.

Abbreviations

APEC	Asia-Pacific Economic Cooperation
BCPs	Business Continuity Plans
CARILEC	Caribbean Electric Utility Services Corporation
CAT	Catastrophe
CAT DDO	Catastrophe Deferred Drawdown Option
CCRIF SPC	Caribbean Catastrophe Risk Insurance Facility Segregated Portfolio Company
CDAP	Carilec Disaster Assistance Program
CDEM	Civil Defence Emergency Management
CDERA	Caribbean Disaster Emergency Response Agency
DRFIP	Disaster Risk Financing and Insurance Program
EOC	Emergency Operations Centre
EMAC	Emergency Management Assistance Compact
ERPs	Emergency Response Plans
FMCG	Fast-Moving Consumer Goods
FEMA	Federal Disaster Management Agency
FONDEN	Natural Disaster Fund
GEJE	Great East Japan Earthquake
GDP	Gross Domestic Product
GFDRR	Global Facility for Disaster Reduction and Recovery
GRiF	Global Risk Financing Facility
ICT	Information and Communications Technologies
ICS	Incident Command System
IFIs	International Financial Institutions

IMF	International Monetary Fund
IPPs	Independent Power Producers
ISO	Independent System Operator
KPIs	Key Performance Indicators
NAGWICO	National General Insurance Corp N.V
NCMC	National Crisis Management Centre
NDRRA	Natural Disaster Relief and Recovery Arrangements
NIMS	National Incident Management
NRF	National Response Framework
O&M	Operations and Maintenance
OBR	United Kingdom's Office of Budget Responsibility
OECD	Organisation for Economic Co-Operation and Development
OFWAT	UK England and Wales Water Regulator Water Services Regulation Authority
PCDPPP	Pan Caribbean Disaster Preparedness and Prevention Project
PJIA	Princess Juliana International Airport
PJIAE	Princess Juliana International Airport Operating Company N.v.
PPI	Private Participation in Infrastructure
PPIAF	Public-Private Infrastructure Advisory Facility
PPPs	Public-Private Partnerships
RTO	Regional Transmission Organization
SEADRIF	Southeast Asia Disaster Risk Insurance Facility
SOEs	State-Owned Enterprises
SXM TF	Sint Maarten Recovery, Reconstruction, and Resilience Trust Fund
VBRRA	Victorian Bushfire Reconstruction and Recovery Authority

References

APEC (Asia-Pacific Economic Cooperation). "APEC Regional Trends Analysis: New Virus, Old Challenges, and Rebuilding a Better Asia-Pacific; APEC Amid COVID-19: Navigating Risks and Opportunities toward Resilience." APEC, Singapore, November 2020, https://www.apec.org/Publications/2020/11/APEC-Regional-Trends-Analysis---November-2020

APEC. "Joint Ministerial Statement." APEC Finance Ministers' Meeting, Lima, October 15, 2016. https://www.apec.org/Meeting-Papers/Sectoral-Ministerial-Meetings/Finance/2016_finance.aspx

APEC. "Joint Ministerial Statement." APEC Finance Ministers' Meeting, Port Moresby, October 17, 2018. https://www.apec.org/Meeting-Papers/Sectoral-Ministerial-Meetings/Finance/2018_finance#:~:text=1.%20We%2C%20the%20Finance%20Ministers%20of%20the%20economies,Papua%20New%20Guinea.%20Global%20and%20Regional%20Economy%202

APEC. "Joint Ministerial Statement," APEC Finance Ministers' Meeting, Santiago, October 15, 2019. https://www.apec.org/Meeting-Papers/Sectoral-Ministerial-Meetings/Finance/2019_finance

Australian Business Roundtable for Disaster Resilience and Safer Communities and Deloitte Access Economics. The Economic Cost of the Social Impact of Natural Disasters. Sydney: Deloitte Access Economies, 2016. http://australianbusinessroundtable.com.au/assets/documents/Report%20-%20Social%20costs/Report%20-%20The%20economic%20cost%20of%20the%20social%20impact%20of%20natural%20disasters.pdf

Australian Department of Finance and Deregulation. "Review of the Insurance Arrangements of State and Territory Governments under the Natural Disaster Relief and Recovery Arrangements Determination 2011." Commonwealth of Australia, Sydney, 2011.

Cantelmo, Alessandro, Giovanni Melina, and Chris Papageorgiou. "Macroeconomic Outcomes in Disaster-Prone Countries." IMF Working Paper 19/217, International Monetary Fund, Washington, DC, 2019.

CDEMA (Central Defence Emergency Management Agency). "Regional Comprehensive Disaster Management (CDM) Strategy and Programming Framework, 2014-2024." CDEMA, St. Michael, Barbados, 2014. https://www.preventionweb.net/publications/view/39126

Collymore, Jeremy. "Disaster Management in the Caribbean: Perspectives on Institutional Capacity Reform and Development." Environmental Hazards 10, no. 1 (2011): 6-22. https://doi.org/10.3763/ehaz.2011.0002

Downes, Ronnie. "Budgeting for Contingent Liabilities." Presentation at the Annual Meeting of OECD Senior Budget Officials, Paris, June 3-4, 2013.

EEI (Edison Electric Institute). "Understanding the Electric Power Industry's Response and Restoration Process," EEI, Washington, DC, 2016. https://www.eei.org/issuesandpolicy/electricreliability/mutualassistance/Documents/MA_101FINAL.pdf

FEMA (Federal Emergency Management Agency). "Hurricane Sandy FEMA After-Action Report." U.S. Department of Homeland Security, Washington, DC, 2013, https://www.alnap.org/help-library/hurricane-sandy-fema-afteraction-report

Gaspar, Vitor, Jason Harris, and Alexander Tieman. "The Wealth of Nations: Governments Can Better Manage What They Own and Owe." IMFBlog, October 10, 2018. https://blogs.imf.org/2018/10/09/the-wealth-of-nations-governments-can-better-manage-what-they-own-and-owe/

Gericke, Ben, Theuns Henning, and Ian Greewood. Review of Performance Based Contracting in the Road Sector. Washington, DC: World Bank, 2014.

G20 Japan. "G20 Principles for Quality Infrastructure Investment." https://www.mof.go.jp/english/international_policy/convention/g20/annex6_1.pdf

Hallegatte, Stéphane, Mook Bangalore, Laura Bonzanigo, Marianne Fay, Tamaro Kane, Ulf Narloch, Julie Rozenberg, David Treguer, and Adrien Vogt-Schilb. Shock Waves: Managing the Impacts of Climate Change on Poverty.Washington, DC: World Bank, 2016.

Hallegatte, Stéphane, Jun Rentschler, and Julie Rozenberg. Adaptation Principles: A Guide for Designing Strategies for Climate Change Adaptation and Resilience. Washington, DC: World Bank, 2020.

Hallegatte, Stéphane, Jun Rentschler, and Julie Rozenberg. Lifelines: The Resilient Infrastructure Opportunity. Washington, DC: World Bank, 2019.

Hallegatte, Stéphane, Jun Rentschler, and Brian Walsh. Building Back Better: Achieving Resilience through Stronger, Faster, and More Inclusive Post-Disaster Reconstruction. Washington, DC: World Bank, 2018. https://openknowledge.worldbank.org/handle/10986/29867

Harris, Jason, Bruno Imbert, Paulo Medas, John Ralyea, and Ashni Singh. "Government Support to State-Owned Enterprises: Options for Sub-Saharan Africa." IMF Fiscal Affairs Special Series on COVID-19, June 15, 2020.

HM Treasury. "Contingent Liability Approval Framework: Guidance." HM Treasury, London, July 2017. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/635939/contingent_liability_approval_framework_guidance.pdf

HM Treasury. "Government as an Insurer of Last Resort: Managing Contingent Liabilities in the Public Sector." HM Treasury, London, March 2020. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/871660/06022020_Government_as_Insurer_of_Last_Resort_report__Final_clean_.pdf

IMF (International Monetary Fund), "Bracing for the Storm," 2018, https://www.imf.org/external/pubs/ft/fandd/2018/03/otker.htm

IMF. "Building Resilience in Countries Vulnerable to Natural Disasters." Presentation to IMF Executive Board, November 12, 2018.

IMF. "Policy Responses to COVID-19." Policy Tracker. https://www.imf.org/en/Topics/imf-and-covid19/Policy-Responses-to-COVID-19

Inman, Phillip. "IMF Urges Government to Borrow to Fight Impact of Covid-19." The Guardian, October 14, 2020. https://www.theguardian.com/business/2020/oct/14/imf-urges-governments-to-borrow-to-fight-impact-of covid-19

Institute of Public Utilities. "Utility and Network Interdependencies: What State Regulators Need to Know." Technical Assistance Brief on Critical Infrastructure Protection, US National Association of Regulatory Utility Commissioners, Washington, DC, April 2005.

Mahul Olivier, and Benedikt Signer. "The Perfect Storm: How to Prepare against Climate Risk and Disaster Shocks in the Time of COVID-19." One Earth 2, No. 6 (2020): 500-502.

Ministry of Finance, Japan. "Communiqué, G20 Finance Ministers and Central Bank Governors Meeting, Fukuoka, June 8-9, 2019." https://www.mof.go.jp/english/international_policy/convention/g20/communique.htm

Moreno, Rafael Muñoz. "Keeping the Lights on, the Water Running and People Moving." World Bank, Washington, DC, July 10, 2020. https://www.worldbank.org/en/news/opinion/2020/07/10/brazil-covid-19-coronavirus-pandemic-impact-water-utilities-transport-energy

Nagamura, Masaaki. "The Role of Insurance Industry to Strengthen Resilience of Infrastructure Assets-Experience in Japan." APEC Document 2019/FMP/DRFI/SEM/009, October 14, 2019.

NASEO (National Association of State Energy Officials). State Energy Assurance Guidelines. Arlington, VA: NASEO, December 2009 https://www.naseo.org/Data/Sites/1/documents/energyassurance/eaguidelines/State_Energy_Assurance_Guidelines_Version_3.1.pdf

National Hurricane Center and Central Pacific Hurricane Center. "Tropical Cyclone Climatology." https://www.nhc.noaa.gov/climo/#bac

North American Electric Reliability Corporation. "Lesson Learned: Risks Posed by Firewall Firmware Vulnerabilities."NERC Lessons Learned, North American Electric Reliability Corporation, Atlanta, GA, 2019.

OECD (Organisation for Economic Co-operation and Development). Assessing Global Progress in the Governance of Critical Risks: OECD Reviews of Risk Management Policies. Paris: OECD Publishing, 2018. https://dx.doi.org/10.1787/9789264309272-en

OECD. "Best Practices for Managing Fiscal Risks: Lessons from Case Studies of Selected OECD Countries and Next Steps Post COVID-19." OECD, Paris, June 2020.

OECD. "COVID-19 and Fiscal Relations across Levels of Government." July 31, 2020. https://read.oecd-ilibrary.org/view/?ref=129_129940-barx72laqm&title=COVID-19-and-Fiscal-Relations-across-Levels-of-Government

OECD. Future Global Shocks: Improving Risk Governance: OECD Reviews of Risk Management Policies. Paris: OECD Publishing, 2011. https://dx.doi.org/10.1787/9789264114586-en

OECD. Getting Infrastructure Right: A Framework for Better Governance. Paris: OECD Publishing. https://dx.doi.org/10.1787/9789264272453-en

OECD. Good Governance for Critical Infrastructure Resilience: OECD Reviews of Risk Management Policies. Paris: OECD. Publishing, 2019. https://doi.org/10.1787/02f0e5a0-en

OECD. "OECD Dataset on the Size and Composition of National State-Owned Enterprise Sectors." https://www.oecd.org/corporate/oecd-dataset-size-composition-soe-sectors.htm

OECD. "Public Procurement and Infrastructure Governance: Initial Policy Responses to the Coronavirus (COVID-19) Crisis." Paris, OECD, July 30, 2020.

OECD. "Recommendation of the Council on the Governance of Critical Risks." Meeting of the OECD Council at Ministerial Level, Paris, May 6–7, 2014. http://www.oecd.org/gov/risk/Critical-Risks-Recommendation.pdf

OECD. "Responding to the COVID-19 and Pandemic Protection Gap in Insurance." September 9, 2020. https://read.oecd-ilibrary.org/view/?ref=133_133327-3tdsqdiu7y&title=Responding-to-the-COVID-19-andpandemic-protection-gap-in-insurance

OECD (Organisation for Co-operation and Development) and World Bank. Fiscal Resilience to Natural Disasters: Lessons from Country Experiences. Paris: OECD Publishing, 2019

Oh, Jung Eun, Xavier Espinet Alegre, Raghav Pant, Elco E. Koks, Tom Russell, Roald Schoenmakers, and Jim W. Hall. Addressing Climate Change in Transport: Volume 2: Pathway to Resilient Transport. Washington, DC: World Bank, September 2019). http://documents.worldbank.org/curated/en/438551568123119419/Volume-2-Pathway-to-Resilient-Transport

PPIAF (Public-Private Infrastructure Advisory Facility). "Lessons Learned in Output and Performance-Based Road Maintenance Contracts." Issue Brief, PPIAF, October 2014.

PwC. "COVID-19: What It Means for the Power and Utilities Industry." https://www.pwc.com/us/en/library/covid-19/how-covid-19-is-impacting-power-and-utilities.html

Ra, Sungsup, and Zhigang Li. "Closing the Financing Gap in Asian Infrastructure." ADB South Asia Working Paper 57, Asian Development Bank, 2018. http://dx.doi.org/10.22617/WPS189402-2

Ranghieri, Federica, and Mikio Ishiwatari. Learning from Megadisasters: Lessons from the Great East Japan Earthquake. Washington, DC: World Bank, 2014.

Rentschler, Jun, Sophie de Vries Robbé, Johannes Braese, Dzung Huy Nguyen, Mathijs van Ledden, and Beatriz Pozueta Mayo. Resilient Shores: Vietnam's Coastal Development Between Opportunity and Disaster Risk. Washington, DC: World Bank, 2020. https://openknowledge.worldbank.org/handle/10986/34639

Rozenberg, Julie, Xavier Espinet Alegre, Paolo Avner, Charles Fox, Stéphane Hallegatte, Elco Koks, Jun Rentschler, and Mersedeh Tariverdi. "From a Rocky Road to Smooth Sailing: Building Transport Resilience to Natural Disasters."Background paper for Lifelines, World Bank, Washington, DC, 2019, https://openknowledge.worldbank.org/handle/10986/31913

Saavedra, Jaime. "COVID-19 and Education: A World Bank Perspective." World Bank, Washington, DC, July 2020.

Standard & Poor's. "Storm Alert: Natural Disasters Can Damage Sovereign Creditworthiness." S&P Global Ratings, New York, 2015. https://www.spglobal.com/ratings/en/research/articles/150910-storm-alert-natural-disasters-can-damage-sovereign-creditworthiness-9327571

Treasurer of the Commonwealth of Australia and Minister for Finance of the Commonwealth of Australia. Federal Financial Relations Budget Paper No. 3, 2016-17. Sydney: Commonwealth of Australia, 2016.

UK Office for Budget Responsibility. "Fiscal Sustainability Analytical Paper: Public Sector Balance Sheet." UK Office for Budget Responsibility, London, July 2016, https://obr.uk/docs/dlm_uploads/FSAP_July_2016_public_sector_balance_sheet_.pdf

UK Office for Budget Responsibility. Fiscal Sustainability Report. https://obr.uk/fsr/fiscal-sustainability-report-july-2020/

UN-ESCAP (United Nations Economic and Social Commission). The Disaster Riskscape across Asia-Pacific: Pathways for Resilience, Inclusion and Empowerment. Bangkok: UN-ESCAP, 2019. https://www.unescap.org/sites/default/files/APDRR%20_draft_15%20August%202019_latest%20Delhi.pdf

University of the West Indies, Seismic Research Center. "Earthquakes: Frequently Asked Questions." http://uwiseismic.com/General.aspx?id=85

US Chamber of Commerce. "Critical Infrastructure Protection, Information Sharing, and Cyber Security." https://www.uschamber.com/issue-brief/critical-infrastructure-protection-information-sharing-and-cyber-security

US Cybersecurity and Infrastructure Security Agency. "ISA Guidance on Essential Critical Infrastructure Workforce,"https://www.cisa.gov/critical-infrastructure-sectors

US Department of the Treasury. "Memorandum for the Financial Services Sector: Financial Services Sector Essential Critical Infrastructure Workers." March 22, 2020. https://www.aba.com/-/media/documents/incident-response/Financial-Services-Sector-Essential-Critical-Infrastructure-Workers.pdf#_ga=2.185734497.919837796.1585000202-2141545694.1585000202

WELG (Wellington Engineering Lifelines Group), "Lifeline Utilities Restoration Times for Metropolitan Wellington Following a Wellington Fault Earthquake," A Report to the Wellington CDEM Group Joint Committee, Wellington Engineering Lifelines Group, 2012.

WELG. "Restoring Wellington's Transport Links after a Major Earthquake." WELG Project Report, Wellington, 2013.

World Bank. "Catastrophe Infrastructure Warranty against Climate and Disaster Shocks." Draft Technical Proposal for discussion at 2019 APEC Finance Ministers Meeting and 2019 Investor Forum. http://mddb.apec.org/Documents/2019/MM/FMM/19_fmm_007.pdf

World Bank. Catastrophe Insurance Programs for Public Assets: Operational Framework. Washington, DC: World Bank, 2020. https://openknowledge.worldbank.org/handle/10986/33423

World Bank. Climate Change in APEC: Assessing Risks, Preparing Financial Markets, and Mobilizing Institutional Investors. Washington, DC: World Bank, 2020. https://openknowledge.worldbank.org/handle/10986/33423

World Bank. "Cluster 6: The Economics of Disaster Risk, Risk Management, and Risk Financing." Knowledge Note 6-3, World Bank, Washington, DC, 2012. http://documents1.worldbank.org/curated/en/175611468044671950/pdf/793950BRI0drm000Box377374B00Public0.pdf

World Bank. "Disaster Response: A Public Financial Management Review Toolkit." World Bank, Washington, DC, November 2019. https://www.pefa.org/resources/disaster-response-public-financial-management-review-toolkit

World Bank. Financial Protection against Natural Disasters: An Operational Framework for Disaster Risk Financing and Insurance. Washington, DC: World Bank, 2014. https://www.gfdrr.org/sites/default/files/documents/Financial%20Protection.pdf

World Bank. "Financial Protection of Public Assets." SEADRIF Knowledge Series: Financial Protection of Public Assets, World Bank, Washington, DC, 2020. https://www.financialprotectionforum.org/seadrif-knowledge-series-financial-protection-of-public-assets

World Bank. "Financial Risk Management of Public Assets against Natural Disasters in APEC Economies." World Bank Technical Contribution to the APEC Finance Ministers' Process, APEC Finance Ministers' Meeting, Hoi An, Vietnam, October 2017. http://mddb.apec.org/Documents/2017/MM/FMM/17_fmm_009.pdf

World Bank. "Improving Public Assets and Insurance Data for Disaster Risk Financing and Insurance Solutions."World Bank Technical Contribution to the APEC Finance Ministers' Process, APEC Finance Ministers' Meeting, Hoi An, Vietnam, October 2017.

World Bank. "Keeping the Lights on, the Water Running and People Moving," Rafael Muñoz Moreno, July 2020, accessed January 2021. (https://www.worldbank.org/en/news/opinion/2020/07/10/brazil-covid-19-coronavirus-pandemic-impact-water-utilities-transport-energy)

World Bank. "PPP Best Practice." APEC Transportation Working Group, World Bank, Washington, DC, 2016.

World Bank, "Private Participation in Infrastructure (PPI) 2019 Annual Report." World Bank, Washington, DC, 2019, https://ppi.worldbank.org/en/ppi

World Bank. Resilient Infrastructure Public-Private Partnerships (PPPs): Contracts and Procurement - The Case of Japan. Washington, DC: World Bank, 2017.

World Bank. "Supporting Water Utilities during COVID-19."June 30, 2020. https://www.worldbank.org/en/news/feature/2020/06/30/supporting-water-utilities-during-covid-19

World Bank. 2019. Technical Brief on Resilient Infrastructure Public-Private Partnerships: Policy, Contracting, and Finance. Washington, DC: World Bank.

World Bank, World Development Report 2014: Risk and Opportunity-Managing Risk for Development. Washington, DC: World Bank, 2013. https://openknowledge.worldbank.org/handle/10986/16092

World Economic Forum. "Global Risks 2007: A Global Risk Network Report." World Economic Forum, Geneva, January 2007. http://www3.weforum.org/docs/WEF_Global_Risks_Report_2007.pdf


APEC
Asia-Pacific
Economic Cooperation


APEC 2020
MALAYSIA


THE WORLD BANK
IBRD • IDA | WORLD BANK GROUP