Meeting the Challenges of Enhancing Power–Sector Resilience

EMERGING PRACTICES

WORLD BANK GROUP
Energy & Extractives

ESMAP
Energy Sector Management Assistance Program

GFDRR
Global Facility for Disaster Reduction and Recovery

AECOM

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Context

- **Reliability of power systems is weakened by increased weather-related outages and damages**.

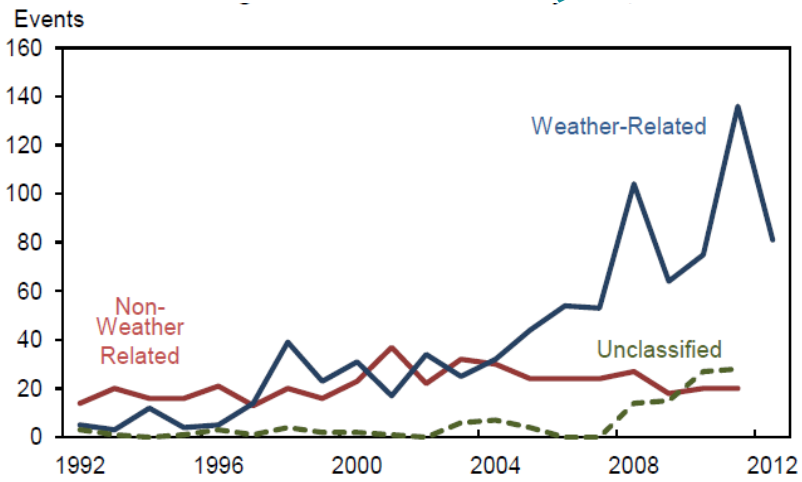
- **Economic damages to the energy sector are high**: $580 million of 2013 Yolanda in the Philippines; $280 million of 2011 floods in Thailand.

- Most utilities in developing countries treat natural disasters as an **Act of God** and rely on write-offs by donors or governments. Only 10% of them adopt appropriate disaster risk management approaches.

- Utilities in developing countries often struggle to keep up with existing standards, and lack the capacity to make decisions under such uncertainty as natural disasters; however, **weak and ageing power systems are more vulnerable to natural disasters.**

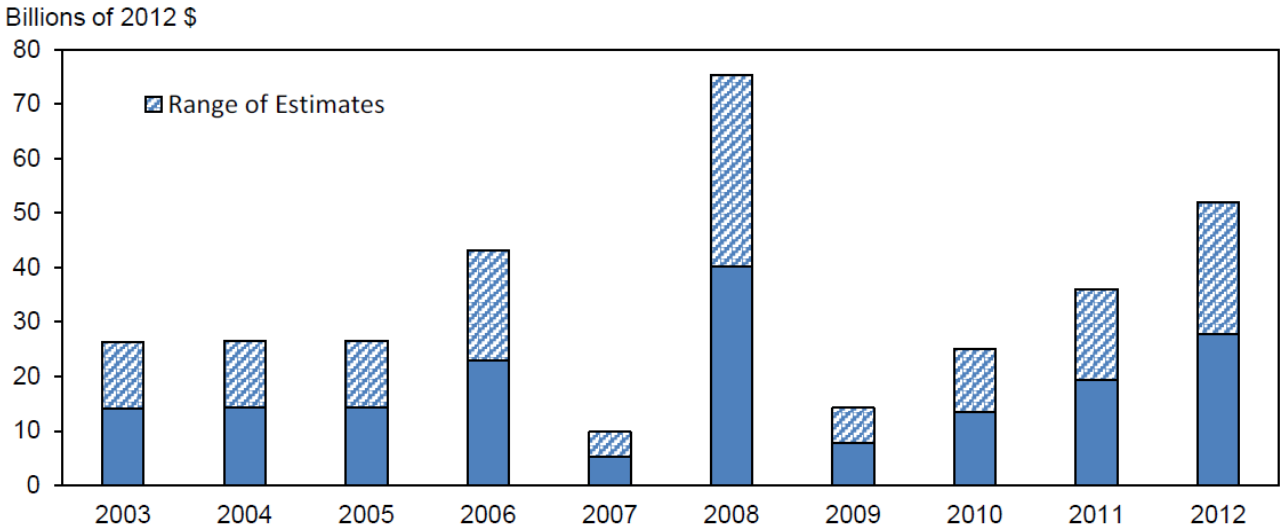
Context

Increased frequency of weather-related outages and costs of damages and losses (in the US, 2012)



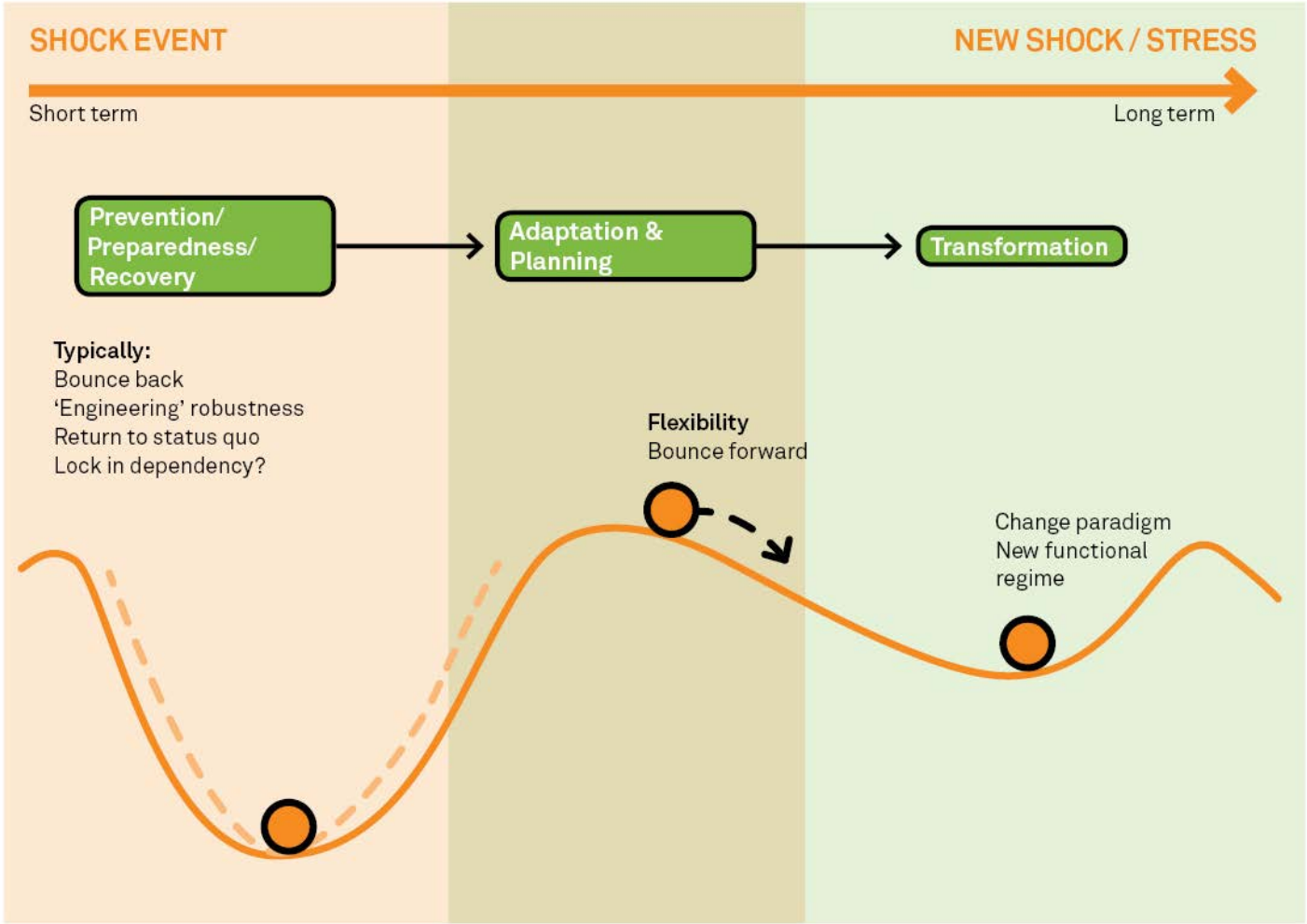
Source: Energy Information Administration

Sources: CEA estimates using data from Census Bureau, Department of Energy, Energy Information Administration; Sullivan et al. 2009



Goal

To build a more resilient power sector in developing countries that can better manage extreme weather risks across the electricity value chain

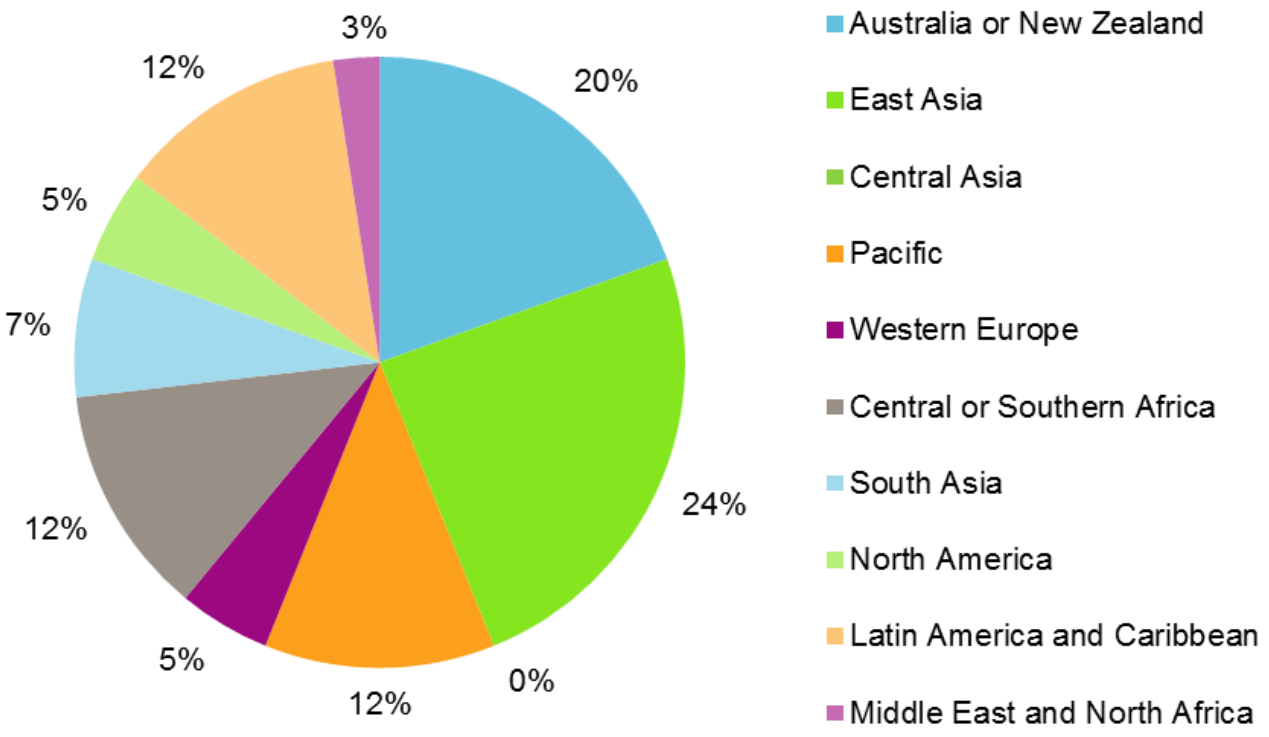


Enhancing Resilience: Emerging Practices

GLOBAL INDUSTRY SURVEY AND LITERATURE REVIEW

Extensive literature review, virtual survey, selected interviews, survey respondent interviews

196 organizations around the world contacted, 45 responded



Main Findings of Global Industry Survey

- **Awareness** of natural hazard exposure and risk management standards **is low** in developing countries.
- Disaster risk management **practices** in the power sector of developing countries **are weak**.
- The **failure to fund and conduct maintenance** often compromises the resilience capacity of the **infrastructure investments** made.
- Survey respondents recognize the **important role of educational approaches**—both public education and internal capacity building—**in reducing risk**.
- Power sector needs to assign a **higher priority to design of systems and processes** than design of equipment alone.
- Preparedness focused on **resilience strategies**, not overly prescriptive solutions, can provide better protection at lower cost against uncertain events.

Main Findings of Global Industry Survey

- **Developing countries depend heavily on post-disaster financing**, including donor assistance, while developed countries tend to rely on multiple layers of pre-disaster financing mechanisms.
- Recovery is more resilient when support is provided for **reconstruction planning**.
- **Partner relationships** dominate the level of interaction between service providers and regulators.
- **Relationships with insurance companies are much less common** among developing countries.
- While there is strong collaboration between members of the power sector, the **relationship between datasets is not established or shared**.
- **Weak organizational capacity** is the dominant constraint to risk management implementation among developing countries.

An Integrated Risk Management Strategy

Taking into account Emerging Practices incrementally

Based on the results of the literature review and industry survey, along with a comparative analysis of their application in developed and developed countries, the study identified a set of emerging and potential practices.

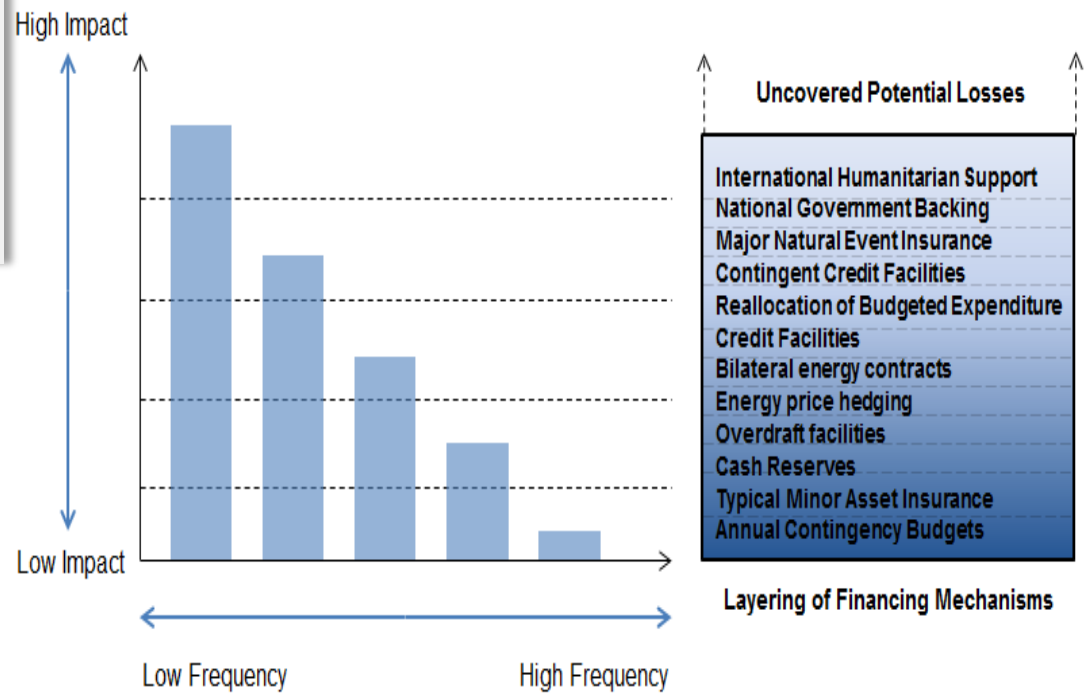
Pillar 4 – Financial Protection

Outcome: Financial Protection Strategies Increase the Resilience of Governments, Utilities, the Private Sector, and Households.

Emerging Practices:

1. **Weather Risk Hedging**
2. **Catastrophe Bonds**
3. **Contingent Event Reserve Funds**
4. **Contingent Credit Financing**
5. **Beneficiary Insurance Pools**

Example:
High Electricity Cost Contingent Event Fund
-
Financial Protection Layering against High Energy Cost



Challenges to Implementation

- Need to raise awareness of power-sector organizations on integrated risk-management practices.
- Need to broaden resilience responses from a primarily technical engineering focus to those encompassing an **organizational and financial focus**.
  - ✓ Equipment design is not enough to prevent supply disruption.
  - ✓ Good organizational resilience—including effective leadership and inspiration—provide the best support framework for recovery and rebuilding.
- Need to coordinate disaster risk management plan for the power sector with a **nationwide plan since natural disasters impact other critical infrastructure**.
- Need to strengthen the implementation capacity of utilities, policy makers, regulators, and private sector to take adaptive, resilience-enhancing actions.

BELIZE: Energy Resilience for Climate Adaptation Project (ERCAP)

enhance resilience of energy system to adverse weather & climate change impacts

Enhance System Resilience

Planning & Operations

Long-Term Energy Planning**
- At national level integrating climate adaptation

System Segmentation + Protections*
- Installation of breakers
- Installation of insulators

Diversification of Power Generation Mix*
- Expansion of biomass to offset hydro volatility (pilot)

Improve Load Dispatch through better Meteorological Data Collection*
- Installation of additional real-time weather stations
- VHF link BEL to Hydromet

System Strengthening

Transmission & Distribution System Strengthening*

- **Transmission**
  - Pilot alternative poles
  - Change/install repeaters
- **Distribution**
  - Replace deficient poles
  - Additional lightning arrestors
  - Stub suspect poles

Strengthening Selected Substations *
- Improvements to control building to better withstand adverse weather
- Relocation of DC battery bank

Rapid Response & Recovery

Emergency Response

Improve Emergency Response Plan **
- Develop storm preparedness plan

Enhance Rapid Repair Capability*
- Mobile control unit

Improved Access to repair Energy Infrastructure **
- Vegetation management plan for areas surrounding infrastructure

Emergency Communication*
- Enhance VHF network
- Mobile repeaters
- Increase number of relays

Damage Recovery

Improve Emergency Recovery Plan **
- Develop a recovery plan
- Identify Rapid-response capabilities

Quicker Recovery of Power Sector Infrastructure*
Spares for rapid recovery of power system
- Transformers
- Breakers
- Protection equipment

* indicates investment ** indicates technical assistance

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A KNOWLEDGE NOTE SERIES FOR THE ENERGY & EXTRACTIVES GLOBAL PRACTICE

THE BOTTOM LINE

Given the increasing frequency and severity of extreme weather events, it is useful to understand the lessons learned from recent natural disasters in Ha'apai, Tonga, and Christchurch, New Zealand. Despite vastly different circumstances, the two experiences demonstrate that power outages can be shortened through access to adequate human resources, immediate and frequent communication with the public, good pre-disaster maintenance, and standardized equipment. By attending to these factors, utilities can become more resilient and help communities recover more quickly.

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Are Power Utilities in Tonga and New Zealand Resilient? Human and Organizational Factors in Disaster Response

Why is this issue important?

Natural disasters are increasingly frequent, costly, and disruptive

Natural disasters have become more frequent over the past 20 years, and the costs of the damages and losses associated with them are rising. At the same time, the world is increasingly reliant on electricity, and the population expects reliable, stable, and secure services.

Natural disasters affect power utilities with varying levels of severity that depend on each utility's natural environment. Disasters that can have a major impact on power generation, transmission, distribution, or control include earthquakes, tsunamis, volcanoes, cold spells, heat waves, storms, tropical cyclones, heavy snowfalls, floods, droughts, and wildfires.

In the United States, a 2012 estimate from the Department of Energy showed that between 2008 and 2012, annual costs due to weather-related power outages ranged from $25 billion to $70 billion. These figures are derived from business costs associated with lost output, residential customers' willingness to pay to avoid outages, and other types of lost economic output. Hurricane Sandy alone cost the U.S. economy between $14 and $26 billion.

In Thailand, the 2011 floods cost the power sector $285 million in damages and losses and another $180 million to recover and reconstruct.

In most disasters, a certain degree of damage to power system components is unavoidable; however, steps can be taken to reduce the impact and length of the resulting power outages. Here we look at how major disasters in Tonga and New Zealand affected power systems and what the power authorities learned about the human and organizational factors that played a part in the recovery efforts. This brief is based on interviews and research carried out by the authors for a global study (to be published in February 2016) of how the power sector can be made more resilient to weather and geological risks.

Of course, the expectations and requirements of a largely rural, remote island community in a developing nation with a small power system and those of a major, interconnected city in a developed country with a much larger power system are different. The response to Tonga's Cyclone Ian, which damaged most of the electricity network of the Ha'apai Islands in January 2014, was quite different from the recovery efforts surrounding the February 2011 earthquake in Christchurch, New Zealand. Despite the differences, however, the human and organizational factors of resilience affecting post-disaster management are similar.

What challenges were faced?

In both Tonga and New Zealand the damage was severe

Tonga. On January 10, 2014, Tropical Cyclone Ian hit the Ha'apai Islands of Tonga—home to approximately 7,000 people—with wind gusts of 287 km/h. The category five cyclone destroyed 82 percent of all buildings and 95 percent of power lines, damaging the only power station and requiring it to undergo major refurbishment.

A lack of functioning communications facilities after the event hampered efforts to organize transportation and logistics and to understand the level of assistance required of authorities and staff based on Tonga's main island. Even when response staff arrived

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http://hdl.handle.net/10986/23634
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ENHANCING POWER-SECTOR RESILIENCE:
EMERGING PRACTICES TO MANAGE WEATHER AND GEOLOGICAL RISKS

EXECUTIVE SUMMARY

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Example: Layered Risk Financing Strategy For UTE, Utility in Uruguay