Meeting the Challenges of Enhancing Power-Sector Resilience

EMERGING PRACTICES

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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

Short- and Long-term Resilience Concerns for Power Utilities to Be Balanced

Long-term Climate Change Concerns:
Uncertainty with long-range predictions;
Slow onset of climate change consequences;
New energy infrastructure with life span of multiple decades should be climate resilient

Short-term Concerns:
10–15 year planning horizons;
Pressing needs of providing reliable, sustainable energy services in real-time;
Lack of capacity to cope with today’s extreme weather risks proactively
Main Findings of Global Industry Survey

- **Awareness** of natural hazard exposure and risk management standards is **low**.
- Disaster **risk management practices are weak**.
- **Weak organizational capacity** is the dominant constraint to risk management.
- Failure to conduct maintenance often compromises resilience of investments.
- Needs to **prioritize design of systems and processes** rather than equipment alone.
- Relevant **datasets** are not linked and shared.

- Heavy reliance on **post-disaster financing** rather than pre-disaster mechanisms.
- Relationships with **insurance companies** are not very common.

- Recovery is more resilient when support is provided for **reconstruction planning**.
Goal

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

Resilience refers to “[t]he ability of a system and its component parts to anticipate, absorb, accommodate, or recover from the effects of a hazardous event in a timely and efficient manner, including through preservation, restoration, or improvement of its basic structures and functions.”

Intergovernmental Panel on Climate Change 2012
Integrated Disaster Risk Management Approach

Emerging Practices

1. Establish the Context
2. Pillar 1 – Identify Risks
3. Analyze and Evaluate Risks
4. Identify Risk Treatment Options
   - Pillar 2 – Risk Reduction
   - Pillar 3 – Preparedness
   - Pillar 4 – Financial Protection
   - Pillar 5 – Resilient Recovery
5. Treat Risks
Pillar 1 - Risk Identification

Outcome: By building capacity for risk assessment and analysis, risk identification improves our understanding of disaster risks.

Emerging Practices:
1. Hydro Generation Fuel-Risk Data Gathering
2. Probabilistic Modeling of Hazards and Risks
3. Medium-Range Weather Forecasting

Example: Orion Networks Risk Management Prior to 2011 Earthquake
Pillar 2 - Risk Reduction

OUTCOME: GREATER DISASTER RISK CONSIDERATION IN POLICY, INVESTMENT, ASSET DESIGN, AND MANAGEMENT AND OPERATING PROCEDURES AVOIDS CREATING NEW RISKS AND REDUCES RISKS IN SOCIETY.

Emerging Practices:

1. Real-Time Meteorological Services to Manage Renewable Energy Variability
2. Mandatory Information Transparency
3. Relocation of Assets above Flood Levels
4. Economic Valuation of Electricity Supply Reliability
5. Distribution Circuit Segregation
6. Micro-Grids
7. Local Backup Power Supplies
Pillar 3 - Preparedness

**Outcome:** Developing an institution’s disaster-management and forecasting capacity can improve its ability to manage crises.

Emerging Practices:

1. Measuring Resilience
2. Review of Supporting Infrastructure
3. External Communications Approaches
4. Live GIS Systems
5. Demand Response
6. Unmanned Vehicles
7. Virtual Power Plants
8. Artificial Intelligence in Emergency Management Exercises

Example: Online Outage Map (source www.ComEd.com)
**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
Example: Layered Risk Financing Strategy For UTE, Utility in Uruguay

Low Impact

High Impact

Low Frequency

High Frequency

Uncovered Potential Losses

Weather Risk Hedging

Contingent Financing

Energy Stabilisation Fund

Cash Reserves

Layered Financing Mechanisms

Contributors

UTE, insurance, and World Bank as intermediary

World Bank, UTE

Ministry of Finance, UTE

UTE

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Pillar 5 - Resilient Recovery

**Outcome:** Support for Reconstruction Planning leads to quicker, more resilient recovery.

Emerging Practices:

1. Mutual Aid Agreements
2. Mobile Telecommunications
3. Mobile Substations
4. Back-Up Control Centers

Example:

15/18 MVA, 110/33-22 kV Mobile Substation in Service (Transpower NZ Ltd)
# An Integrated Risk Management Strategy

**Taking into account Emerging Practices incrementally**

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**FINANCIAL PROTECTION**

- Weather Risk Hedging
- Catastrophe Bonds
- Contingent Event Reserve Funds
- Contingent Credit Financing
- Insurance Pools

**RESILIENT RECOVERY**

- Mutual Aid Agreements
- National Inter-Organisation Communication
- Mobile Telecommunications
- Mobile Substations
- Back-Up Control Centres
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.
A menu of options are available for power utilities to consider emerging practices that will be of most value to their organizations’ particular situations.

By following standard risk-management procedures, combined with cost-benefit analysis, the value propositions for individual organizations become clear.

Power utilities need to develop an integrated, cost-effective disaster risk management strategy, taking into account emerging practices and their own situations and risk tolerance.
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.

Wild and 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 degrees of severity that depend on each utility’s natural environment. Disasters that have a significant impact on power generation, transmission, distribution, or control include extreme weather events, storms, floods, droughts, and wildfires.

In the United States, a 2017 estimate from the Department of Energy showed that between 2012 and 2015, insured costs due to weather-related power outages ranged from $17 billion to $70 billion.

These figures are derived from business costs, including lost output, and include the costs of repair and renewal of power systems and facilities.

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 clear diagnosis of damage to power systems is crucial. However, damage can be difficult to assess, and the impact and extent of the resulting power outages can be limited. Disasters that involve major events in Tonga and New Zealand, however, have shown that the power authorities need to understand the human and organizational factors that play a role in the recovery efforts.

The report is based on interviews and research carried out by the authors through the ESMAP project. The findings are intended to inform policymakers and practitioners about the factors that influence the ability of power systems to recover from disasters.

What challenges were faced?
In both Tonga and New Zealand, the damage was severe.

Rangiroa, an island in the Tuamotu Archipelago of French Polynesia, was hit by a tsunami on 4 November 2013, causing significant damage to the power system. The power system in Tonga was also severely affected by the tsunami, and the power authorities worked closely with the residents to restore power as quickly as possible.

In New Zealand, the 2011 Christchurch earthquake caused widespread damage to the power system, including the loss of critical power generation and transmission equipment. The power authorities worked closely with the residents to restore power as quickly as possible.

WB Publications:
http://hdl.handle.net/10986/23634
https://www.esmap.org/node/57858

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