The increasing number of natural disasters is causing irreversible societal damage to communities, and creating extremely high costs for utilities. Industry leaders are looking for ways to pro-actively invest in infrastructure to minimize exposure to threats while enhancing long term value to communities and shareholders. By understanding the five attributes of a resilient organization, utilities will be able to align resources to effectively manage risks and build a resilient organization.
Defining Resilience

Resilience has many definitions. Among the simplest is the ability to bounce back quickly from disaster or misfortune. For a utility, a more specific definition could be applied, where resilience is the ability to reduce the likelihood, severity, and velocity of risks, and return to reliable service.

Resilience should be at the heart of a utility’s mission. It enables or enhances the ability of a utility to provide reliable service.

Although resilience and reliability are distinct concepts, they are related. Reliability is being there when needed. It is the ability to provide uninterrupted electric, water, or natural gas service. Resilience is the ability to prepare for risks and uncertainties, and to be able to quickly restore reliability. The distinction is particularly important when it comes to assessing the risks that threaten utilities.

KPMG’s definition of resilience

Ability to reduce likelihood, severity and velocity of risks, and return to reliable service

“A quality within organizations [that] allows them to manage crises and disruption to operations, resist sudden shocks and adapt to changes”

*The Business Continuity Institute*

“Ability of an organization to anticipate, prepare for, and respond and adapt to incremental change and sudden disruptions in order to survive and prosper”

*ISO 22316 Organizational Resilience Standard*

“The ability of an organization to absorb and adapt in a changing environment”

*British Standard*
Risks impacting reliability and safety

Threats to reliability and safety come from four different spheres: strategic risks such as technology disruption, operational risks such as asset failures, enterprise risks such as cyber-security, and climate risks such as extreme weather. All four are on the rise.

**Strategic risks**

*Renders a utility’s business strategy ineffective and operating assumptions irrelevant (i.e. technology disruption, policy change, business model obsolescence)*

Strategic risks come in many forms. One of the most potent and pervasive in the utility industry today is the threat of technology disruption. Investment banks ranging from Citigroup and Goldman Sachs to UBS have issued reports warning about possible power sector downgrades as a result of the threat posed by distributed energy resources (DERs), particularly from the rapidly falling costs of solar panels and battery storage devices.

**Operational risks**

*Unexpected failure or under performance of an asset or disruption to the company’s routine operations (i.e. major accidents, single points of failure)*

A recent survey¹ found that nearly half of all utilities have identified risks and vulnerabilities to critical operational assets. One example is the threat that comes from underground electrical vaults. Underground vaults are pervasive. There are about 2 million in the United States, and every year there are about 2,000 events—fires or explosions—in underground vaults, resulting in property damage, injury and even fatalities.

**Enterprise risks**

*Challenges to enabling functions that help the company execute its core business (i.e. cyber security, financial crises, workforce issues)*

A report from the U.S. Department of Energy found the likelihood of cyber-attacks against utilities is increasing in both frequency and severity. Power companies and utilities around the world reported a six-fold, year-over-year increase in detected cyber incidents.² A 2015 cyber-attack in Ukraine, for instance, knocked out power to approximately 250,000 customers for six hours.

**Climate risks**

*Climate induced natural disasters that can disrupt a utility’s operations (i.e. wildfires, hurricanes and storms, earthquakes)*

Weather statistics indicate³ that the number of severe storms in the United States has risen dramatically, resulting in a steep increase in power outages. From the 1950s through the 1980s there was an average of five storms per year⁴ that caused power outages. Over the past five years, that number has soared to between 70 and 130 storms per year that have caused outages. Federal data indicates that the U.S. electrical grid now loses power almost three times more often than in the 1980s. Those outages not only disrupt a utility’s operations, but also can cause significant economic damage and can result in accidents and even fatalities in local communities.

---

² Cyber Threat and Vulnerability Analysis of the U.S. Electric Sector; Mission Support Center, Idaho National Laboratory, August 2016.
Assessing climate threats

The science is unclear on whether or not climate change will increase the number of storms, but warmer ocean temperatures and higher sea levels are expected to make their impact more severe. Despite a possible decrease in the frequency of storms, one model projects a 45% to 87% increase in the frequency of Category four and Category five hurricanes in the Atlantic Basin.

In 2017, the hurricane season was so damaging - it is estimated that Harvey, Irma, Maria and Nate caused as much $200 billion in damages - that those names were permanently retired. When Hurricane Michael made landfall on October 10, 2018 as a Category 5 hurricane, it was the strongest storm to ever hit the Florida Panhandle. The storm killed 39 people, caused more than $5 billion in economic damages, and left about 2.5 million customers in the Southeast without electricity.

The Southeast and the Western parts of the U.S. and East and Southeast Asia are particularly vulnerable

- Indian Ocean Tsunami
  - Country most hit: India
  - Total damage: >$3 billion

- Storm Gudrun
  - Country most hit: Sweden
  - Total damage: >$2.5 billion

- Katrina + Rita
  - State most hit: Louisiana
  - No. of customers affected: >1 million
  - Natural Gas Production shut-in: >46B cf/d
  - Crude oil production shut-in: >9 cf/d

- Gustav
  - State most hit: Louisiana
  - No. of customers affected: >1 million

- Cyclone Nargis
  - Country most hit: Myanmar
  - Total damage: >$13 billion

- Ike
  - State most hit: Texas
  - No. of customers affected: >2 million

- Isaac & Sandy
  - State most hit: NE U.S., Louisiana
  - Total damage: >$73B

- Tohoku Tsunami
  - Country most hit: Japan
  - Total damage: >$360B

- Severe floods
  - Country most hit: Thailand
  - Total damage: >$45 billion

- Station Wild Fire
  - State most hit: California
  - Total acreage burned: >160,000

- Harvey, Irma, & Maria
  - Areas most hit: Puerto Rico, Costa Rica
  - Total damage: >$270B

- Hurricane Maria
  - Maria led to the largest electricity blackout in the U.S., with 3.5B customer-hours of electricity service lost
  - No. of disasters: >300
  - State with highest no. of disasters: California

- Florence
  - State most hit: Carolinas
  - Total damage: >$22B


6 The Washington Post, Hurricanes Harvey, Irma, Maria and Nate were so destructive, their names have been retired (April 12, 2018). Retrieved in 2018 from https://www.washingtonpost.com/news/capital-weather-gang/wp/2018/04/12/hurricanes-harvey-irma-maria-and-nate-were-so-destructive-their-names-have-been-retired/?noredirect=on&utm_term=.2f01b6d1b989
Climate change has also been implicated in the increasing frequency and severity of wildfires. One recent scientific study\(^7\) concluded that human-caused climate change nearly doubled the forest fire area in the western United States between 1984 and 2015. The tragic effects of greater fuel aridity linked to climate change have been particularly evident in recent years.

The 2017 wildfires were the most destructive and costly\(^8\) in California’s history, but they could be eclipsed by the wildfires of 2018. The financial damages stemming from the Camp Fire alone are estimated to exceed $10 billion.

### Wildfire losses in the U.S.

<table>
<thead>
<tr>
<th>Year</th>
<th>Insured losses</th>
<th>Overall losses</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017</td>
<td>$0</td>
<td>$10,000</td>
</tr>
<tr>
<td>2016</td>
<td>$2,000</td>
<td>$8,000</td>
</tr>
<tr>
<td>2015</td>
<td>$4,000</td>
<td>$6,000</td>
</tr>
<tr>
<td>2014</td>
<td>$6,000</td>
<td>$4,000</td>
</tr>
<tr>
<td>2013</td>
<td>$8,000</td>
<td>$2,000</td>
</tr>
<tr>
<td>2012</td>
<td>$10,000</td>
<td>$0</td>
</tr>
<tr>
<td>2011</td>
<td>$12,000</td>
<td>$2,000</td>
</tr>
<tr>
<td>2010</td>
<td>$14,000</td>
<td>$4,000</td>
</tr>
<tr>
<td>2009</td>
<td>$16,000</td>
<td>$6,000</td>
</tr>
<tr>
<td>2008</td>
<td>$18,000</td>
<td>$8,000</td>
</tr>
</tbody>
</table>

Recent storms and wildfires serve as warnings that as the effects of climate change intensify, the impact on energy infrastructure will be widely felt. Those effects range from physical damage and service disruptions to transmission and distribution equipment to lower water availability for thermoelectric generation sources, as well as lower efficiencies and power production disruptions especially for renewable and hydroelectric resources.

In most cases, the damage inflicted by major storms is caused by high winds and flooding from storm surges and heavy rains. However, storm damage can be compounded by the condition and age of the system. Most of the transmission and distribution lines in the United States were built in the 1950s and 1960s, putting them 10 or 20 years past their 50-year life expectancy. Seventy percent of power transformers and transmission lines are more than 25 years old. Sixty percent of circuit breakers are more than 30 years old.

The combination of aging infrastructure and more severe storms creates an enhanced threat to future reliability. Faced with these realities, many utilities have undertaken investments to proactively upgrade their aging infrastructure. Those investments include making physical and structural improvements to harden system components, as well as planning and modifying operations to enhance resilience.

By one estimate\(^9\), Texas utilities could spend as much as $520 million to repair damage for wires and equipment in the wake of Hurricane Harvey. In the wake of Superstorm Sandy in 2012, Public Service Electric & Gas (PSE&G) in New Jersey launched Energy Strong I. The $1.2 billion program, approved by regulators in 2014, is designed to improve reliability and enhance resiliency by repairing or replacing twenty-nine PSE&G switching stations and substations that were flooded by Sandy.

Sandy was a wake-up call for many MidAtlantic utilities on how vulnerable they are to the triple threat of more severe storms, rising sea levels, and aging infrastructure. In its ongoing efforts, PSE&G is proposing to spend as much as $17 billion in the five-year period that ends in 2023 in what the company’s CEO called, “the most significant investment program\(^10\)” in PSE&G’s history. The spending program includes $6 billion to upgrade aging transmission lines and $2.5 billion for its Energy Strong II program.
U.S. utilities have undertaken investments to combat aging infrastructure

The President’s proposed $11.7 Billion FY 2019 budget for Department of the Interior includes legislation to strengthen infrastructure and address deferred maintenance. The budget also focuses on economic growth, responsible energy development and rebuilding for the next 100 years.

Texas utilities: $520 million for Hurricane Harvey
Public Services Electric and Gas: $17 billion by 2023
Energy Strong I: $1.2 billion for Superstorm Sandy
FirstEnergy: $100 million to replace aging transmission lines

Average infrastructure life expectancy is 50 years

Current distribution and transmission lines are 10–20 years past their life expectancy

70% Of power transformers and transmission lines are more than 25 years old

60% Of circuit breakers are more than 30 years old

Annual electric distribution system costs for major U.S. utilities

Billion dollars (2017)

Capital investment
Customer expenses
Operations and maintenance

The rationale behind PSE&G’s Energy Strong II program is to have “the greatest impact on system-wide hardening and resiliency” while anticipating potential equipment failure rather than waiting for it to occur.11

So, while the Energy Strong I program addressed substations that were directly affected by Sandy, the Energy Strong II program is taking preemptive action by raising substations not directly affected by recent storm events that are at risk under flood elevations designated by FEMA. Risk analysis performed for PSE&G estimates that the Energy Strong II program will reduce substation failure by more than 20%.12

In New York, Sandy was the largest storm ever to strike Consolidated Edison’s (ConEd’s) service territory. It caused over 1 million customers to lose power. After Sandy, ConEd invested about $1 billion from 2013 and 2016 to make its infrastructure more resilient. ConEd estimates that its storm hardening investments prevented 370,000 customer outages.13

In Ohio, FirstEnergy spent about $100 million to replace and upgrade aging transmission lines and substations. The utility says its investment resulted in a 37% reduction in equipment-related outages.

11 Direct testimony of William D. Williams, associate vice president, asset management practice of Black & Veatch, for PSE&G before the New Jersey Board of Public Utilities, June 8, 2018.
12 Direct testimony of Edward F. Gray, director of transmission and distribution engineering for PSE&G, before the New Jersey Board of Public Utilities, June 8, 2018.
What is Disruptive Risk?

Disruptive risks are those that have a significant, severe, and often sudden effect on a company’s revenue, profitability, competitive position, and/or reputation. These risks have the potential to change industry structure or operating conditions, make existing business models obsolete, derail growth, or otherwise pose a fundamental threat to the long-term strategy of the organization.


For management faced with managing risks, that raises questions about the correct level of investment needed to ensure resilience. With storm related damages in the hundreds of millions of dollars, one response could be to spend commensurate sums to protect against any and all contingencies. That approach is not likely to meet the metrics of effective or prudent investment.

It is important, nevertheless, that investment and budgetary considerations be included in any complete approach to risk and resilience. A risk-informed budget allocation should incorporate an assessment of funds to mitigate the impacts of events with a low probability of occurrence and a high potential for adverse consequences. That assessment should also be multi-dimensional and should include scenarios in which risk compounds or cascades as a result of the confluence of multiple events as well as due to “single points of failure.”
Attributes of resilience

The practices of leading organizations can provide a template for building resilience and improving reliability and safety. That template comprises the building blocks that any utility can use to manage risk more effectively and build resilience. The process starts by (1) aligning the preparations needed to respond to risks and uncertainties with a wider vision that encompasses the organization’s strategy, mission, and values. Those preparations can be put in place by (2) developing formal structures such as reporting lines and committees specifically charged with implementing resiliency strategies.

As part of the process of implementing their resiliency strategies, leading organizations (3) utilize data to identify and evaluate various risks and uncertainties. Part of that process is to look outside the organization’s immediate sphere of operations in order to (4) develop a wider view of resilience and an effective crises management plan which identifies and analyzes risks before they occur.

The last key attribute involves (5) investment planning. The ability to demonstrate the value of investments, including enhancements to controls and mitigations can ensure that capital can be deployed in a time sensitive manner that can reduce the frequency of risks and mitigate their effects when they do occur. Together, these five attributes are key to building a resilient organization.

The five key attributes of a resilient organization

1. Prepare
   - Strategy
   - Create an integrated risk framework with a clear definition and alignment of enterprise strategy, capital and operations and maintenance investments, and asset management philosophy

2. Prevent
   - Governance
   - Coordinate responsibilities across Enterprise Risk Management, Compliance, Internal Audit, and Lines of Business to ensure risk management and compliance as part of the operating culture

3. Protect
   - Operations
   - Understand operational risk at various levels - frequency, severity, and velocity of risks to develop appropriate controls and mitigations

4. Practice
   - Crises management
   - Implement crisis management best practices to effectively respond to risk by identifying, analyzing, and having a plan to address the risk before it occurs

5. Pivot
   - Investment planning
   - Monitor the effectiveness of investments in controls and mitigations to reduce the frequency of risks and contain their effects when they do occur
Building these key resiliency attributes into an organization requires a process that begins with (1) a survey of the landscape to identify critical short- and long-term risks to resilience. Mapping out that landscape allows (2) a strategy to be put in place that identifies key collaborators and partnerships that can aid in execution - internal to the utility and externally with third parties. The process of creating a resilient organization is not complete until (3) metrics to assess performance are put in place. It is critical that those metrics (4) take into consideration the long-term value to stakeholders in multiple spheres, from the world of finance, investment, and politics to the world of government and regulatory stakeholders, and the customer.

All utilities face rising threat levels, but the scope and scale of the threats are specific and unique for each utility. There are, however, common principles that can help guide investments. Resilient infrastructure, for instance, can do more than one thing well. Likewise, a resilience investment should pay for itself and create value for ratepayers, even when it is not being used. When in place, the practices and procedures that build resilience, will allow a utility to better withstand the rising threats of the 21st Century.

The risks to utility resilience are real. They are pervasive, and they are on the rise. Utilities that do not act now will most likely have to react, after the fact. Experience shows that being prepared by building a resilient organization not only mitigates the severity when disaster strikes, but over the longer term, improves utility performance.
About the authors

Arun Mani
A Principal in KPMG’s Advisory group, Arun is the U.S. power and utilities strategy and transformation leader in KPMG’s Strategy practice. Arun operates at the intersection of risk, regulation, and response in the power and utilities sector to advise industry leaders worldwide on a variety of topics. With more than two decades of experience, he has helped numerous power and utilities organizations transform their risk management practices and become resilient. Most recently Arun has been advising utilities on some of the most significant and highly visible “extreme risks” that the industry has seen in a long time ranging from wildfires to natural gas incidents.

Jonathan White
A Managing Director in KPMG’s power and utilities practice, Jonathan has over fifteen years of experience in strategy consulting and in the power and utilities sector. Jonathan has focused on business and operating model strategies and has leveraged this experience to help utilities to understand their resilience risks and translate those into operational improvements. Most recently, Jonathan has been working with U.S. west coast utilities on Enterprise Risk Management (ERM) assessments and design, enhanced vegetation management design, system hardening prioritization, and enhanced asset inspection and repair design strategies.
For more information, contact:

Arun Mani  
*Principal, Corporate Strategy*  
832-648-8513  
arunmani@kpmg.com

Jonathan White  
*Managing Director, Corporate Strategy*  
415-635-5149  
jdwhite@kpmg.com

**About KPMG’s Global Strategy Group**

KPMG’s Global Strategy Group works with private, public and not-for-profit organizations to develop and implement strategy from “innovation to results” helping clients achieve their goals and objectives. KPMG Global Strategy professionals develop insights and ideas to address organizational challenges such as growth, operating strategy, cost, deals and transformation.

**About the KPMG Global Energy Institute**

Launched in 2007, the KPMG Global Energy Institute (GEI) is a worldwide knowledge-sharing forum on current issues and emerging trends within the Power & Utilities and Oil & Gas industries. GEI membership is free and an effective way for energy executives to gather the latest information on trends affecting the industry as well as meet their continuing education requirements. Members receive early alerts and invitations to valuable thought leadership, studies, events and webcasts about key industry topic. Register today. To become a member, visit kpmgglobalenergyinstitute.com and register today.