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IMPROVING RESILIENCE OF DISTRIBUTION UTILITIES

Key Threats, Leading Practices and Way Forward

November 2020

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CONTEXT AND OBJECTIVE

Providing 24x7 power is the key goal of South Asian governments. However, Distribution Companies (DISCOMs) face risk from array of threats which can cause serious power interruption and chronic undersupply. It is important to proactively plan to safeguard DISCOMs to minimize and mitigate the impact of such threats and make them resilient to such attacks in the long run.

KEY OBJECTIVES OF THE STUDY

- ✓ Identify the nature of threats faced by DISCOMs
- ✓ Understand the impact on key processes
- ✓ Develop a menu of options which can be implemented by DISCOMs to become resilient to such threats



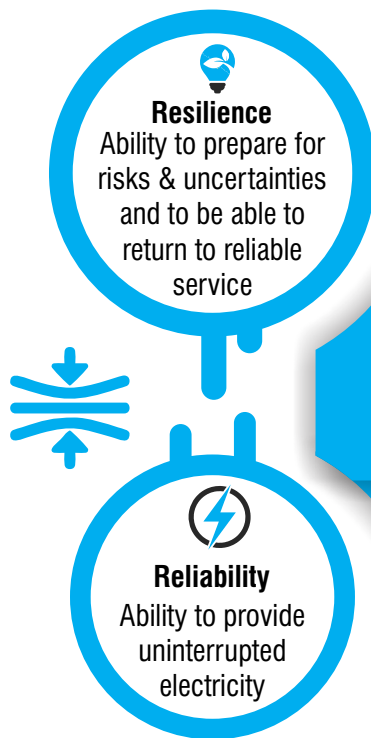
DEFINING RESILIENCE

There is no universally accepted definition of resilience. The definition varies from organization to organization.

IPCC 2012

“Strengthening the ability of a system and its component parts to anticipate, prepare for, absorb, accommodate, or recover from the effects of a hazardous event in a timely and efficient manner, including through the preservation, restoration, or improvement of its basic structures and functions”

For a DISCOM, resilience measures the ability to quickly anticipate, prepare, and adapt to changing conditions to reduce severity of risks and return to reliable service from events of high impact.



Resilience and reliability are interrelated for a DISCOM

The Business Continuity Institute

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

British Standard

“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.”

KEY THREATS TO POWER UTILITIES

OVERVIEW

Quality and reliability of electricity services is facing imminent threats from four key spheres

NATURAL ADVERSITIES

Cyclones, storms, earthquakes, wild fires, etc.

- No. of annual natural disasters in India has increased from 3 in 1965 to 11 in 2015^[1]
- 10 states in India are prone to more than 3 different types of natural adversities^[2] (Central Electricity Authority (CEA) analysis)

TECHNOLOGICAL THREATS

Unexpected failure or underperformance of an asset

- In 2012, India suffered two severe blackouts lasting as long as 15 hours affecting over 670 million people^[5]



HUMAN INDUCED THREATS

Cyber attacks, terrorist attacks, riots, etc.

- In 2018, cybercriminals hacked the billing software of one of the DISCOM in Haryana^[3]
- In 2019, a nuclear plant in Tamil Nadu faced a malware attack on one of the computers within the plant^[4]

HEALTH EMERGENCIES

Spread of local/global infectious diseases

- COVID-19 has led to nation-wide lockdown across many countries – leading to reduction in electricity demand from commercial and industrial consumers
- Outbreak of Swine Flu in the U.K. (in 2009) led to shortage of staff, which directly affected operation and maintenance (O&M) activities of utilities

SIGNIFICANT EVENTS IN RECENT YEARS

2012

Transmission Line Overload, India

- Outage affected > 650 million customers for ~15 hours^[32]

2017

Power Plant Explosion, India

- Explosion in the boiler area of a 500 MW unit of a NTPC plant impacting power supply across 9 states^[33]

2018

Kerala floods, India

- 22 sub-stations and 1,000 DTs were submerged; 30,000 kms LT line was damaged
- Outage affected > 2.6 million customers^[14]
- Total loss to KSEB > INR 850 Cr^[15]

2018

California Wildfires, U.S.

- 28,000 structures including Transmission and Distribution (T&D) lines and generation equipment destroyed
- Outage affected > 0.4 million customers for ~ 4 weeks^[18]

2018

Cyber Attack, Haryana, India

- Cybercriminals hacked commercial billing software and demanded extortion money in form of Bitcoins^[3]

2019

Cyclone Fani, Odisha, India

- Damaged over 84 k kms LT lines & 11 k DTs^[9] ;
- Outage affected > 0.25 million customers^[10]
- Loss to DISCOMs ~INR 250 Cr.^[11]

2020

Transmission failure, Sri Lanka

- Outage affected > 22 million customers for 7 hrs.^[43]

2020

Cyber Attack Enel, Italy

- Blockage of internal IT network causing temporary disruption to customer care activities
- Isolation of ENEL's corporate network^[27]

2020

COVID-19 Pandemic

- Working capital constraint due to low revenue collection, deferred payments and lower consumption of electricity
- Workforce unavailability impacting business continuity

2020

Cyclone Amphan, Odisha and West Bengal, India

- 280+ 33 kV stations and forty 132 kV lines tripped^[6]
- Outage affected 15 million customers^[7] ; 11 deaths due to electrocution^[8]

KEY THREATS TO POWER UTILITIES

CAUSE AND EFFECT

Business Continuity

- Workforce unavailability
- Service disruption

Outages

- Disruption in fuel supply
- Unavailability of workforce
- Asset break-down
- Customer inconvenience

Low Revenue

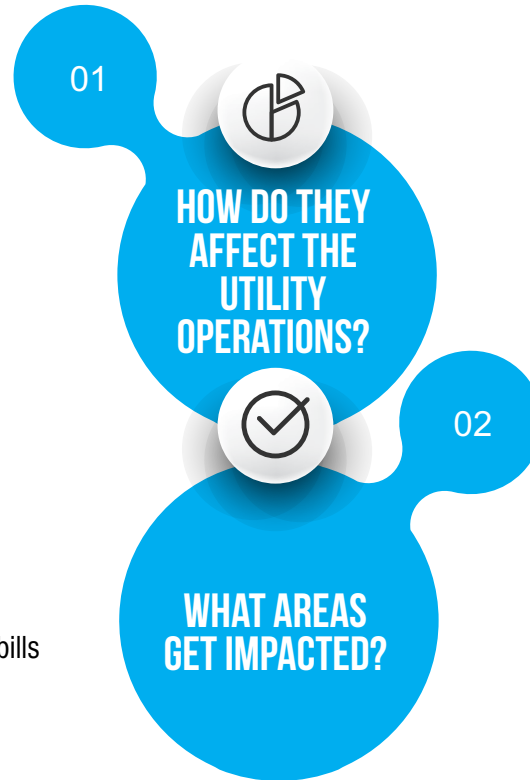
- Reduction in demand or supply
- Inability to undertake meter readings

Low Collection

- Limited accessibility of collection centers
- Manpower shortage causing delay in delivery of bills

Frozen Assets/Tools

- Loss of customer and utility data
- Damaged devices



Physical Assets

- Substations, Distribution Transformers (DTs), lines and poles, meters, etc.
- Power plants
- Storage facilities

Business Process

- O&M activities
- Metering, billing & collection services
- Workforce availability
- Fuel and power procurement
- Customer services

Information Technology (IT) Infrastructure

- Software & hardware systems
- Control room
- Communication networks
- Supervisory Control and Data Acquisition (SCADA) systems

THREAT 1

NATURAL ADVERSITIES

INDIA'S VULNERABILITY SNAPSHOT

Climate-induced natural disasters such as floods, cyclones, earthquakes, landslides

Impact on key domains

Physical assets

- Tower collapse, damage to substations, DTs, poles, power lines, meters, transformers, etc.
- Damage to coal stockpiles, fuel supply infrastructure and generation equipment

Business Process

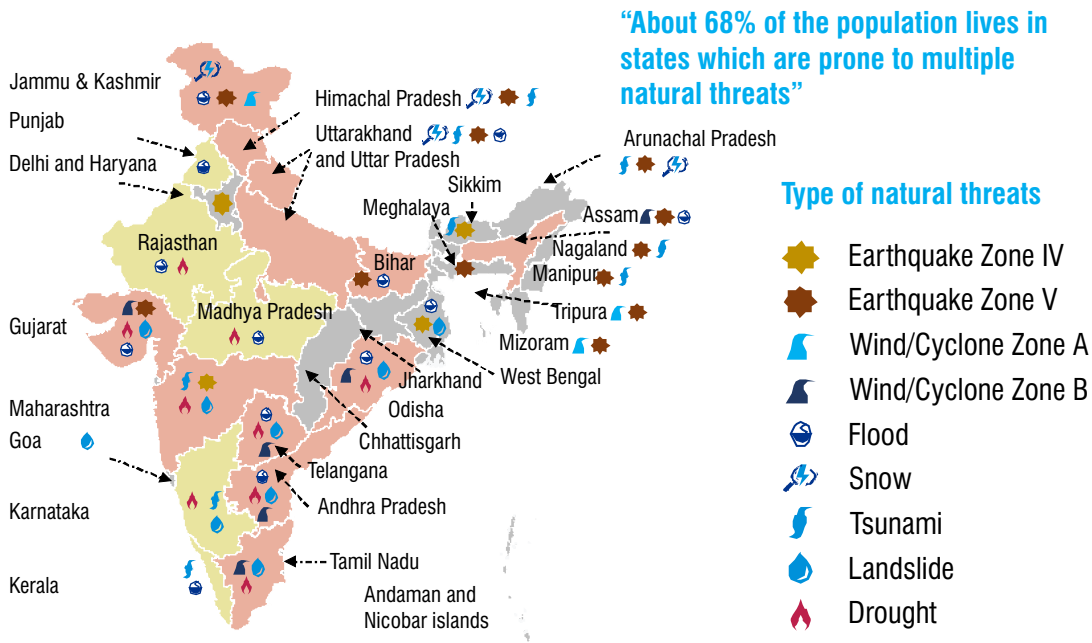
- Delay in O&M activities
- Suspension of physical meter reading
- Limited accessibility of bill payment centers
- Unavailability of workforce
- Delay in redressal of customer complaints

IT Infrastructure

- Communication network failure
- Damage to IT infrastructure components*

*including Uninterruptible Power Supply (UPS) Modems, Remote Terminal Unit (RTUs), Data Concentrator Units (DCUs), etc.

State-wise vulnerability assessment snapshot ^[2]





THREAT 1

NATURAL ADVERSITIES

EXAMPLES 1/4

2020 Odisha and WB Cyclone Amphan



Major Areas of impact

- 280+ 33 kilovolt (kV) stations affected and forty 132 kV lines tripped ^[6]
- Power outage affected 15 million customers ^[7]
- 11 deaths due to electrocution in waterlogged areas ^[8]

Initiatives undertaken [6]

- Set-up emergency restoration systems and round the clock control room
- Reduced power flow on likely affected transmission lines and introduced visualization of faults through Phasor Measurement Unit (PMU) to ensure real time monitoring
- Facilitated Emergency Restoration System (ERS) Towers/additional equipment as well as Emergency Response Teams at all critical sub-stations

2019 Odisha Cyclone Fani



Major Areas of impact

- Damaged over 84 k kms Low Tension (LT) lines & 11 k DTs ^[9]
- Power outage affected 0.25 million customers ^[10]
- Estimated revenue loss to DISCOM was INR 250 Cr. due to power outages ^[11]

Initiatives undertaken

- Established 24/7 control rooms for monitoring restoration activities ^[12]
- Mobilized man-power resources from neighboring states and central Public Sector Undertakings for immediate recovery ^[13]
- State has announced investment of INR 19,000 crore to develop resilient infrastructure in next 3 years



2018 Kerala floods



Major Areas of impact

- Power outage affected 2.6 million people
- 22 sub-stations and 1,000 DTs were submerged; 30,000 kms LT line was damaged ^[14]
- Total loss to KSEB INR 850 Cr. (incl. revenue loss of INR 430 Cr.) ^[15]

Initiatives undertaken

- Kerala State Electricity Board (KSEB) switched off power lines as a precautionary measure; standby transformers were arranged from neighboring states for quick restoration ^[16]
- Established flood prediction system & climate proof DTs
- Estimated cost for repair and maintenance of generating stations (~INR 81 Cr.) was allowed by the regulator as a one-time expense ^[17]

2018 California Wildfires

Major Areas of impact ^[18]

- 28,000 structures including above ground T&D lines and generation equipment were destroyed
- Around 0.4 million customers were left without power for nearly four weeks

Initiatives undertaken ^[18]

- The regulatory agency directed to switch off power lines as a precautionary measure & ensured dissemination of real-time outage information
- Suspended disconnection against non-payment of bills
- Initiated partnerships between policymakers, industry and experts to mitigate the impact of future outbreaks



THREAT 1

NATURAL ADVERSITIES

EXAMPLES 3/4

2018 Cyclone Mekunu Oman



Major Areas of impact ^[19]

- Shut down of select generation facilities
- Damaged overhead lines and underground lines due to heavy rainfall and flooding
- Power outage affected 5 million customers

Initiatives undertaken ^[19]

- Activated disaster response plan to restore power supply in affected areas
- Utilities collaborated with local municipalities and army
- Dispatch of generators and sufficient quantities of fuel through helicopters in remote areas
- Constituted Emergency Committee to ensure availability of spare parts and machineries for restoration

2017 Puerto Rico Hurricanes



Major Areas of impact ^[20]

- Damaged about 100 transmission line segments, 600+ poles and conductors
- Disruption in fuel supply due to port closure
- Power outage affected 3 million customers

Initiatives undertaken ^[20]

- The power authority issued a grant of USD 4.7 million to repair generation facilities
- Facilitated temporary transmission poles and allowed use of alternate methods of power generation (small gasoline and diesel generators)
- Installed new residential PV systems with batteries promoting use of microgrids



THREAT 1

NATURAL ADVERSITIES

EXAMPLES 4/4

2016 Colombia El Niño



Major Areas of impact ^[21]

- 60-70% reduction in water levels in hydropower dams as compared to previous years; Cumulative shortage ~200 MW
- Increase in spot prices to USD 400 per Megawatt Hour (MWh) (from USD 30-50) due to reduction in hydropower generation

Initiatives undertaken ^[21]

- Introduced price cap on spot markets (at later stages)
- Launched an energy saving campaign which led to 5% reduction in consumption and avoided blackouts
- Addition of two new thermal power plants in 2018 along with focus on Renewable Energy (RE) diversification as long-term measures

2011 Japan Tsunami



Major Areas of impact ^[22]

- 8% of total installed capacity (33 GW) was shutdown (mainly nuclear plants)
- Power outages affected 8.5 million customers

Initiatives undertaken

- Set-up emergency service stations and scheduled phased blackouts across the country
- Provided budgetary support of ~USD 43.7 billion for building resilient infrastructure
- Shifted focus from nuclear plants to RE-based power plants; incentivizing micro-grids, solar PV and battery storage technologies in the affected areas ^[23]



THREAT 2

HUMAN-INDUCED

IMPACT ON UTILITIES

Cyber attacks, terrorist attacks, riots, workforce issues, etc.

Impact on key domains

Physical assets

- Damage to generation facilities including equipment
- Impact on operations of load dispatch centers
- Impact on equipment performance and ability to recover
- Disconnection of substations, DTs, poles, etc. from the grid

Business Process

- Delay in routine O&M activities
- Suspension of physical meter reading
- Limited accessibility of payment centers
- Unavailability of workforce
- Delay in redressal of customer complaints

IT Infrastructure

- Communication network failure
- Damage to IT infrastructure components
- Loss of sensitive customer data and threat to customer privacy
- Loss of files stored on servers and workstations
- Disconnection of Supervisory Control And Data Acquisition (SCADA) systems

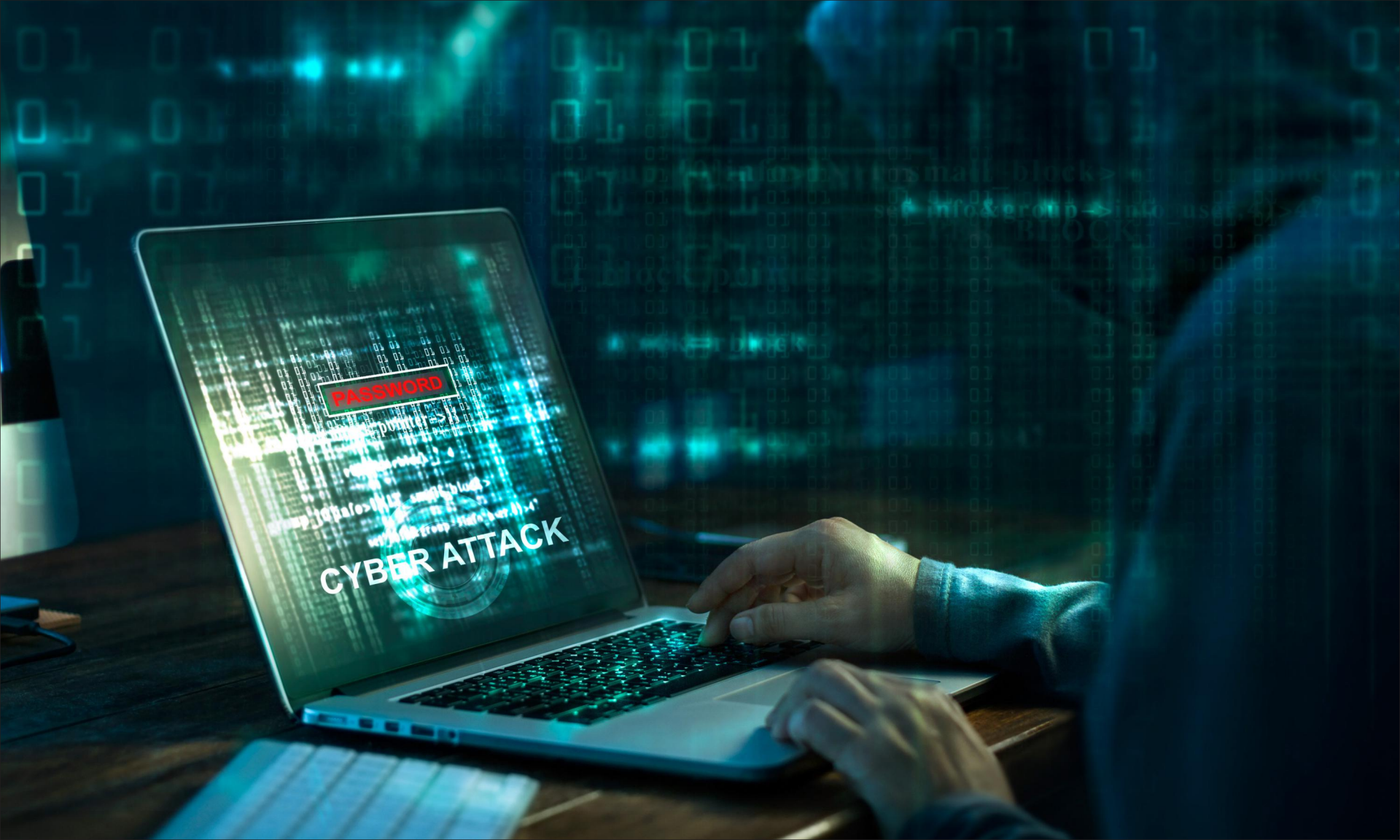


Upsurge in human-induced threats

The number of known cybercrime groups targeting energy sector increased from 87 in 2015 to 155 in 2019 ^[24]

In 2015, 0.2 million people were left without power for ~6 hours in Ukraine as attackers gained access to internal networks of 3 utilities ^[25]

In 2000, 19 transmission networks in Colombia was damaged by guerrilla terrorists ^[26]



THREAT 2

HUMAN-INDUCED

EXAMPLES 1/2

2020 Cyber Attack Enel, Italy



Major Areas of impact^[27]

- Blockage of internal IT network causing temporary disruption to customer care activities
- Isolation of ENEL's corporate network

Initiatives undertaken^[27]

- Existing systems enabled expeditious detection; Developed an organization wide model to block 2 million potentially risky e-mails/ day, 300+ attacks on the web portal, 1,300 viruses and 625,000 malicious web sites
- Constituted global control room to prevent attacks on IT systems, industrial assets and critical infrastructure
- Implemented range of Artificial Intelligence (AI) tools for smart grid applications

2018 Cyber Attack Haryana, India



Major Areas of impact^[3]

- Cybercriminals hacked the commercial billing software of one of the DISCOM of Haryana and demanded extortion money in the form of Bitcoins

Initiatives undertaken^[3]

- Backup availability of the affected data ensured minimal impact
- The DISCOM ensured usage of Secure Shell (SSH) protocol for remote login
- Conducted a complete system analysis headed by officers, cyber experts as well as other IT experts to ensure compliance with standards

2016 Cyber Attack, Pacific Gas and Electric Company (PG&E), United States (U.S.)



Major Areas of impact ^[28]

- Critical database of cyber assets and system passwords was exposed on the internet
- Federal regulatory commission imposed fines to the tune of USD 2.7 million on the utility

Initiatives undertaken ^[28]

- Conducted cyber attacks on the network in a simulated environment to elevate network security protocols
- Implemented a comprehensive cyber risk management framework to ensure early detection of imminent threats
- In its ongoing efforts, the utility is implementing Identity and Access Management Program to strengthen authorized system access controls

2015 Cyber Attack Ukraine Power Grid



Major Areas of impact ^[25]

- Seven 110 kV and twenty three 35 kV substations were disconnected
- Power outage affected ~0.2 million residents of western Ukraine for a period from 1 to 6 hours

Initiatives undertaken

- Identified security lapses in the IT and SCADA systems as well as human factors responsible for the attack
- Improved scanning for malicious signatures and initiated employee cybersecurity training ^[29]
- The manufacturer, General Electric (GE), released a patch for its Human Machine Interface (HMI) software in response to the incident ^[30]

THREAT 3

TECHNOLOGICAL

IMPACT ON UTILITIES

Unexpected failure or underperformance of an assets (equipment failures, software failures, malware, and incompatible technologies)

Impact on key domains

Physical assets

- Short-circuit of transmission lines
- Threat to performance of distribution and transmission equipment
- Damage to generation facilities including equipment
- Impact on operations of load dispatch centers

Business Process

- Delay in routine O&M activities
- Sub-optimal power procurement
- Inaccurate billing
- Delay in meter reading and billing services
- Delay in redressal of customer complaints

IT Infrastructure

- Communication network failure
- Damage to IT infrastructure components
- Loss of sensitive customer data and threat to customer privacy
- Loss of files stored on servers and workstations
- Disconnection of SCADA systems

Largest blackouts around the globe due to technical failures



~670 million were left without power in India for 15 hours in 2012 due to transmission line overload ^[5]



Another major blackout in India impacted ~230 million for ~18 hours in 2001 due to substation failure ^[31]



Transmission line failure led to a 12 hour blackout in the U.S. in 2011 impacting ~2.7 million ^[32]

2017 Power Plant Explosion, India



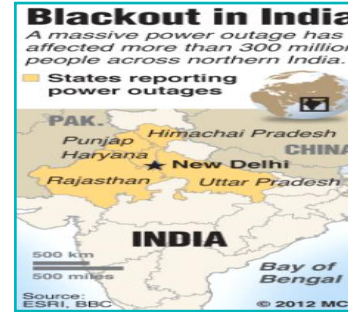
Major Areas of impact ^[33]

- Explosion in the boiler area of a 500 MW unit of 1,550 MW coal-powered NTPC plant
- Affected the power supply across nine states

Initiatives undertaken ^[6]

- Ensured extension of supply from other plants operated by NTPC avoiding outages
- Dispatched a specialized force for emergency restoration
- In response to this, CEA issued an advisory related to ash handling capacity, workforce safety, operations and maintenance practices, etc. in thermal power plants ^[34]

2012 Transmission Line Overload, India



Major Areas of impact ^[32]

- Two severe blackouts due to overloading of transmission line and lack of timely action by State Load Dispatch Centers (SLDCs) led to loss of 32 GW in generated power
- Outages affected over 670 million people lasting ~ 15 hours

Initiatives undertaken

- Ensured startup supply to generating stations and extension of supply to subsystems from neighboring grids ^[35]
- Implemented Black-Start Recovery Plan facilitating supply from hydro and gas-based power stations ^[35]
- Central Electricity Regulatory Commission (CERC) initiated a probe to review the need for revised penalty to ensure grid discipline and strengthen compliance ^[36]

2011 Transmission Line Failure, Southwest U.S.



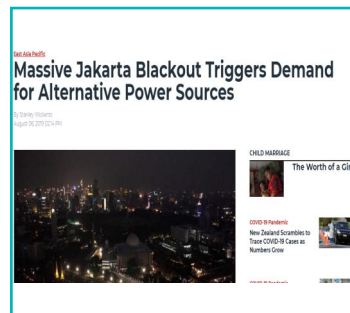
Major Areas of impact ^[32]

- Tripping of a major transmission line during peak load led to the system collapse
- Power outage affected 2.7 million customers lasting for about 12 hours

Initiatives undertaken ^[37]

- The national regulatory commission established a steering committee to review the need for new or revised standards
- Institutionalized a process for N-1 contingency analysis (events consisting of initial loss of a single component)
- Developed real time simulation capabilities for the Reliability Coordinator to enable accurate evaluation

2005 Transmission Line Failure, Indonesia



Major Areas of impact ^[38]

- Failure in a 500 kV transmission line in the grid having installed capacity of 19,615 MW primarily due to lack of generation capacity
- Power outage affected 120 million customers for about 7 hours

Initiatives undertaken ^[39]

- Set-up emergency restoration systems restoring power within 24 hours
- Enhanced focus on capacity addition with announcement of two wind-power projects adding 145 MW to the overall installed capacity

2017 Power Plant Explosion, India



Major Areas of impact ^[32]

- 400 transmission lines, 531 generating units tripped for 96 hours due to high reactive power
- Led to unavailability of real-time information due to faulty software

Initiatives undertaken ^[40]

- The Canadian govt. launched Energy Efficiency (EE) campaign calling upon customers to reduce consumption by 50%
- The U.S. government included reliability provisions in the Energy Policy Act of 2005 strengthening North American Electric Reliability Corporation (NERC)
- Conducted regular audits to evaluate reactive power and voltage control practices and established guidelines for real-time operating tools

2012 Transmission Line Overload, India



Major Areas of impact ^[32]

- Failure of a substation along with poor and inadequate transmission equipment triggered the collapse
- Power outage affected 226 million customers for 16 - 20 hours

Initiatives undertaken ^[41]

- Installed automatic under frequency relays in the sub-stations to prevent future outages
- Institutionalized time synchronization procedure amongst the Regional Load Dispatch Center (RLDC), the generating stations and the SLDCs
- Installed voice activated recorders with timer facilities in the control rooms of the RLDCs, to record instructions and ensure accountability

THREAT 3 TECHNOLOGICAL

RECENT EVENTS

“ On August 20, 2020, major fire broke out in Srisailem power plant in Telangana, India due to a suspected short circuit causing 3 deaths ^[42] ”

“ Transmission failure at a grid substation on August 17, 2020 caused power outage in Sri Lanka affecting 22 million customers for 7 hours ^[43] ”

“ A 500 MVA transformer at a substation in Uttar Pradesh, India caught fire on August 19, 2020 causing blackout in the area affecting 0.6 million customers ^[44] ”

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National

3 dead in fire mishap at Srisailem hydel power house, relief measures underway

By N. Srinivasan, Hyderabad | Updated on August 20, 2020, 13:27 IST

Massive power outage: Sri Lanka goes dark after nationwide power breakdown

The Ceylon Electricity Board (CEB) said the power disruption was due to a transmission failure at the Kerawalapitiya Grid Sub-Station. There was chaos on the streets of Colombo as traffic lights failed following the breakdown in the electricity supply.

Substation shut after fire, third snag in BHEL transformer

A 500 MVA transformer at the Sector 148 UPPTCL (UP Power Transmission Corporation Limited) substation caught fire early on Wednesday.

Meenakshi Sinha • TNN • August 20, 2020, 13:27 IST



NOIDA: A 500 MVA transformer at the Sector 148 UPPTCL (UP Power Transmission Corporation Limited) substation caught fire early on Wednesday. It is the third such transformer provided by BHEL (Bharat Heavy Electricals Limited) that caught fire with a similar internal technical fault, the other two being in Lucknow (about a week ago) and in Baramulla (last year).

THREAT 4

HEALTH EMERGENCIES

Spread of local and global infectious diseases

IMPACT ON UTILITIES

Impact on key domains

Business Process

- Scaling-down/suspension of physical meter reading
- Unavailability of workforce
- Limited accessibility of bill payment centers
- Delay in regulatory compliances
- Delay in project execution-commissioning of new capacity
- Delay in routine O&M activities
- Delay in redressal of customer complaints

IT Infrastructure

- Breakdown of communication network
- Increase in cyber-security risks and burdening of existing infrastructure due to remote operations
- Loss of sensitive customer data and threat to customer privacy

Impact of COVID-19 on global power sector

~2.5% drop in global electricity demand in the first quarter of 2020 as compared to the previous year ^[45]

Energy investment is likely to reduce by ~20% (YoY) in 2020 ^[45]

~8% reduction in global coal demand ^[46]





THREAT 4

HEALTH EMERGENCIES

EXAMPLES 1/2

COVID-19 Pandemic, U.S.

How the Pandemic Impacts U.S. Electricity Usage

A big data project is analyzing social distancing's impact on U.S. electricity consumption during the pandemic

By Jeremy Hsu



Major Areas of impact^[19]

- Working capital constraint due to low revenue collection, deferred payments and lower consumption of electricity
- Workforce unavailability

Initiatives undertaken^[19]

- Federal Energy Regulatory Commission (FERC) requested Federal Reserve to extend access to short-term debt financing for electric utilities through the Commercial Paper Funding Facility (CPFF) program^[47]
- Several utilities waived late payment fees, introduced flexible payment plans^[48], established targeted financial assistance programs and reduced tariff for affected customers

COVID-19 Pandemic, India

Energy News / Latest Energy News / Power

Coronavirus impact: Within ten days, 26 per cent fall in India's energy consumption

The percentage fall in daily energy consumption itself has grown from 15 per cent to 26 per cent during this period.

Major Areas of impact^[20]

- Reduction in demand by 25% in April 2020 (YoY basis)^[53]
- Low revenue collection across states^[54]
- Suspension of manual meter reading process impacted billing accuracy^[55]

Initiatives undertaken^[20]

- Several utilities provided extension on bill due dates without levying late payment surcharges^[49]; incentives offered on digital payments and reduction in fixed charges^[50]
- In many cases disconnection due to non-payment of bills was deferred
- Offered additional rebate on submission of self meter-reading^[51]

THREAT 4

HEALTH EMERGENCIES

EXAMPLES 2/2

2009 U.K. H1N1 Swine flu



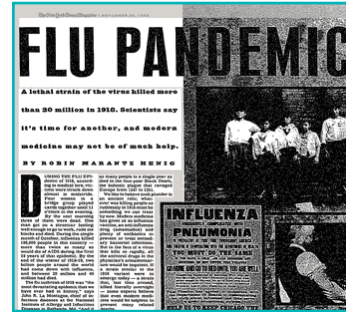
Major Areas of impact ^[32]

- Shortage of workforce – affected routine maintenance activities of assets

Initiatives undertaken ^[52]

- Set up a Joint Response Team and formulated a National Emergency Plan (NEP) of electricity
- Developed business continuity plans to maintain supplies at normal service levels in periods of high staff absence

1918 U.S. Influenza pandemic



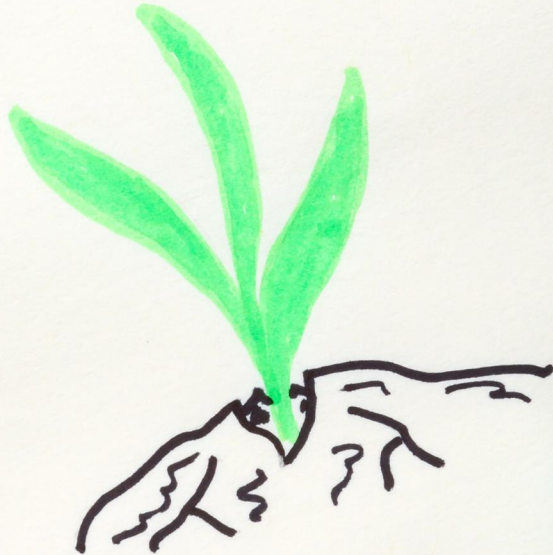
Major Areas of impact ^[56]

- 50% reduction in coal production in few mines whereas some mines were temporarily closed
- Reduction in fuel inventory at major power plants

Initiatives undertaken ^[56]

- Issued guidelines to enhance fuel reserve capacity at key power plants
- Priority access to medical facilities, antiviral drugs, vaccines and other critical products and services for coal mining workers
- Introduced a common planning and response framework for all coal-based power plants

Resilience



WHAT

CAN DISCOMS DO?

EXAMPLES 1/2

The mitigating measures undertaken by DISCOMs in response to such events along with leading industry practices can provide a template to manage risks effectively and build resilience.

Key attributes of a resilient DISCOM

Organizational: Monitor readiness, agility and effectiveness at the corporate and business unit levels

Technological: Deploy digitally enabled systems and focus on upgradation of existing infrastructure

Financial: Create mechanisms for liquidity management and financial recovery

Planning: Understand the operational risk at various levels to develop supply chain mitigations

Workforce and customer: Implement crisis management best practices to ensure health and safety of employees and customers

WHAT CAN DISCOMS DO?

EXAMPLES 2/2

Steps to becoming resilient

Organizational	Technological	Financial	Planning	Workforce and Customer
<p>Embed resilience as an important criterion during investment planning</p> <p>Prepare and regularly update the disaster response plan incorporating new techniques</p> <p>Have a clear definition of governance structures specifically charged with implementing resiliency strategies</p>	<p>Enhance network visibility and remote control capabilities through deployment of AMI infrastructure and advanced IT-OT solutions</p> <p>Focus on e-governance through digitization of approval processes, document management, workflow systems, etc.</p> <p>Ensure higher level of digitization for key operations through deployment of drones/UAVs, DMS/OMS, predictive maintenance models and sensors</p>	<p>Enhance the focus on digital payments through customer sensitization and exemption of processing fees for digital payments</p> <p>Establish disaster resilience fund in collaboration with central and state govts., CSR funds, customers, etc.</p> <p>Develop innovative insurance products to ensure rapid mobilization of funds</p>	<p>Identify and implement system strengthening and hardening measures (such as dynamic circuit reconfiguration, network islanding, among others)</p> <p>Enable DER solutions (including PEV, Microgrids) especially for critical loads</p> <p>Conduct vulnerability testing exercises including simulation-based cyber attacks and technical failures</p>	<p>Define customer and employee safety guidelines and ensure employee training on aspects of emergency response plan</p> <p>Develop mechanisms for robust customer engagement and provisions for proactive updates to customers</p> <p>Ensure independent safety audits in a regular manner</p>

WHAT

CAN DISCOMS DO?

ORGANIZATIONAL

Embed resilience as a key criteria during investment planning

DISCOMs may evaluate a particular investment considering its operational, societal and environmental benefits along with aspects of electrical safety to minimize the severity of high-impact disasters and threats.

Prepare and regularly update disaster response plan

DISCOMs may prepare an emergency response plan in order to effectively withstand extreme events and update the response plan incorporating new techniques in a regular manner.

Have a clear definition of governance structures

DISCOMs may develop formal governance structures such as reporting lines, titles and role descriptions, decision rights, along with committees specifically charged with implementing resiliency strategies.

Leading practices

The regulators in the U.S. have projected loss avoidance worth USD 135 billion in the gulf coast region with investments of USD 50 billion over the next 20 years^[58].

The energy department of Odisha released a disaster management plan in 2015 identifying areas prone to threats, and suggesting possible interventions across the value chain during crisis^[57].

During COVID-19 pandemic, Southern Company, a utility in the U.S., established specific sub-teams focused on critical operations and workforce reinstatement and aligned them to the overall organizational structure.



WHAT

CAN DISCOMS DO?

TECHNOLOGICAL

Enhance network visibility and remote control capabilities

Deployment of AMI infrastructure and advanced IT-OT solutions will improve operational efficiencies and enhance end-to-end network visibility during extreme events. DISCOMs may focus on the accelerated deployment of such technologies devising a clear implementation roadmap.

Focus on e-governance through digitization of processes

DISCOMs may focus on fast-track adoption of digital infrastructure including digitization of approval processes, bid process management, workforce management, electronic document management, digitize workflow systems, etc.

Ensure higher level of digitization for operations

DISCOMs may implement digital solutions including drones/UAVs for asset monitoring, DMS/OMS, and prioritize use of sensors and data analytics to track network indicators to monitor and optimize network performance.

Leading practices

The U.S. Government invested ~USD 4.5 billion for implementing utility and grid modernization projects post 2008 financial crisis creating nearly USD 7 billion economic output, 47,000 jobs, and over USD 1 billion in govt. tax revenue^[61].

Washington Utilities and Transportation Commission in the U.S. organized public meetings, hearings and workshops through digital channels during COVID-19 pandemic.

Utilities in Australia and New Zealand used unmanned aerial vehicles (UAVs) to assess damage to transmission lines and households post Cyclone Pam in 2015.

WHAT CAN DISCOMS DO?

FINANCIAL

Establish disaster resilience fund

- DISCOMs may set up specific disaster resilience and response fund to ensure timely recovery of the power system in an event of a threat.
- Such a fund could be financed through (i) additional surcharge on electricity tariffs or (ii) grants received from central and state governments.

Develop innovative insurance products

Innovative insurance products may be designed/explored by DISCOMs in collaboration with government, development banks, and financial institutions to cover the risks associated with natural disasters. Given the pre-determined trigger point, these instruments can be mobilized faster than many other traditional funding avenues.

Enhance the focus on digital payments

DISCOMs may improve online mechanisms and remote collection efforts to enhance revenue collection (in the absence of functioning cash collection centers during crisis)

Leading practices

The Crisis & Disaster Management Plan (C&DMP) for power sector released by CEA suggests to create a disaster management fund equivalent to 1% of the annual revenue^[2].

Govt. of Uruguay has invested in insurance products (~ USD 450 million) to protect its hydro-generation plants during drought^[58].

Several states in India including Rajasthan, Karnataka, etc. exempted processing fees on digital payment of electricity bills during COVID-19 pandemic.

Identify and implement system hardening measures in susceptible areas

DISCOMs may assess local requirements and technical feasibility for implementation of system hardening measures including dynamic circuit reconfiguration; reinforcing of overhead lines; increasing underground cables in more susceptible areas; network islanding; among others.

Enable DER solutions especially for critical loads

The greater use of distributed energy resources including Plug-in Electric Vehicle (PEV), Solar Rooftops, Microgrids will ensure continuous supply in the aftermath of an extreme event given they can operate separately from the main grid.

Conduct vulnerability testing exercises on regular basis

DISCOMs may focus on developing a testing mechanism including simulation-based cyber-attacks and technical failures on critical grid infrastructure.

Leading practices

- KSEB in India installed flood prediction system & climate proof DTs in the aftermath of 2018 floods.
- MEEDC in Iran replaced steel-reinforced square poles with round concrete poles after 2003 earthquake^[60].
- Post earthquake and tsunami in Japan in 2011, the government has enhanced focus on RE and micro grid – mobilizing investments worth USD 21 million for microgrid demonstration projects^[23].
- NERC organizes a biennial grid security and emergency response exercise providing an opportunity for stakeholders to respond to a cyber-attack scenario in a simulated environment^[59].

Define customer and employee safety guidelines

DISCOMs may prepare detailed guidelines related to customer and employee safety during extreme events. This may include directions on de-prioritization of non-essential and risk prone functions, avenues for customer complaint resolution and safety of staff. They may also develop a training plan for internal employees on aspects of emergency response plan.

Develop mechanisms for customer engagement and management

In order to ensure deep customer engagement during extreme events, DISCOMs may set-up hotline channels, institutionalize presence on social media, and develop mechanisms to proactively provide updates on vital information regarding the services through messages/phone calls/emails.

Ensure independent safety audits in a regular manner

DISCOMs may ensure safety audits through independent bodies in a regular manner to assess the vulnerability of existing workforce and customers and identify optimal pathways to minimize the impact of extreme events.

Leading practices

- Great Britain's regulator for electricity and downstream natural gas markets, Ofgem, issued guidelines related to customer convenience and employee safety ensuring business continuity during COVID-19 pandemic.
- During cyclone Amphan in 2020, Odisha DISCOMs ensured wide dissemination of trajectory of the cyclone and timing of the landfall amongst customers in a proactive manner.
- Regulatory agency in California (CPUC) conducted a safety audit for PG&E, a utility in the U.S., post wildfires in California during 2018 revealing high risk of equipment-failure sparked fires in the area.

SUMMARY

CONCEPTUAL FRAMEWORK FOR BUILDING RESILIENCE IN POWER DISTRIBUTION

Nature and types of threats

Natural Adversities

- Weather events such as floods, cyclones, drought, etc.
- Wildfires

Human-induced

- War, Riots
- Terror Attacks
- Cyber Attacks
- Bomb Threats, Strikes

Technology

- System Irregularities
- Design failure
- Structural defects

Health Emergencies

- Epidemic and Pandemic such as Coronavirus disease (COVID-19), Influenza, flu, etc.

Areas of impact

Physical Network and Assets

- Substations, Distribution Transformers (Dts), lines and poles, meters, etc.
- Power plants
- Storage facilities

Business Process

- Planning and O&M activities
- Metering, billing & collection services
- Workforce
- Grid operations and management
- Fuel and power procurement
- Customer services

Information Technology (IT) Infrastructure and systems

- Software & hardware systems
- Control room
- Communication networks

Outcomes on DISCOM operations

Business continuity

- Workforce unavailability
- Service disruption

Outages

- Disruption in fuel supply
- Unavailability of workforce
- Asset break-down
- Customer inconvenience

Low Revenue

- Reduction in demand or supply
- Inability to meter readings

Low Collection

- Limited accessibility of collection centers
- Manpower shortage causing delay in bill delivery

Frozen Assets/Tools

- Loss of customer and DISCOM data,
- Damaged devices

Way forward

Organizational

- Resilience as a criterion during investment planning
- Disaster response plan
- Formal governance structures

Technological

- Deployment of AMI infrastructure and advanced IT-OT solutions
- DISCOM e-governance
- Digitization of operations

Financial

- Digital payments
- Disaster resilience funds
- Innovative insurance products

Planning

- System strengthening and hardening measures
- DER solutions
- Vulnerability testing exercises

Workforce and customer

- Customer and employee safety guidelines
- Robust customer engagement plan
- Safety audits

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The Smart Power for Advancing Reliability and Connectivity (SPARC) is a key initiative under USAID's Asia EDGE program. It is a three-year bilateral program with the Ministry of Power, Government of India. The objective of the program is to modernize electricity distribution utilities to improve their operational and financial performance. The implementing partner of the USAID SPARC Program is KPMG Advisory Services Pvt. Ltd.

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