GRIDCO
Empowering Odisha

CDRI
Coalition for Disaster Resilient Infrastructure

Capacity Mapping & Development and Knowledge Management

Component II , Task IV

Disaster Resilient Power Systems for Odisha

Power Research and Development Consultants Private Limited

KPMG Advisory Services Private Limited

TARU Leading Edge Private Limited

Foreword

Power infrastructure and a stable electricity connection is an essential enabler of development. It supports homes, businesses, schools, hospitals, and the supply of other utilities. The introduction of smart grid technologies, bolstering renewable energy sources, and enhancing load efficiency is imperative for achieving global climate commitments.

Escalating climate risks present a challenge to this essential infrastructure and its interconnected systems. Power infrastructure in coastal regions is particularly vulnerable given the magnitude of climate intensified extreme weather events in these regions.

India has a coastline stretching over 7,500 kilometres. Its coastal areas are home to more than 260 million inhabitants. Cyclones like Fani (2019), Gaja (2018), and Hudhud (2014), which were accompanied by severe flooding, caused extensive damage to lives and livelihoods across the coastal states of Odisha, Andhra Pradesh, Tamil Nadu, and Kerala.

In response, India has become a leader in building resilience in coastal areas. Improved disaster preparedness, early warning systems, and well-executed evacuation strategies, have played a pivotal role in safeguarding vulnerable populations.

Odisha's experiences in recovering quickly from various disaster events offer compelling evidence for the development of resilient power infrastructure. The state became the first state in India to establish a disaster management authority in 1999 after the Super Cyclone, even before the establishment of the National Disaster Management Authority (NDMA) in 2005. It was also the first Indian state to create an early warning system for disseminating critical disaster-related information to the very last mile. Odisha State Disaster Management Authority has utilized the best technical expertise for building over 800 multi-purpose cyclone shelters together with evacuation roads along the state's entire coastline. Odisha's success in bringing down the casualty to double digits and putting in place robust mechanisms for risk-informed decision-making is a significant achievement.

In support of these efforts, recognizing the particular importance of power infrastructure, and to develop evidence that can be shared with other vulnerable regions, CDRI's study "Disaster Resilient Power Systems for Odisha" has aimed at strengthening the power infrastructure.

This work has identified key challenges and best practices within the Transmission and Distribution (T&D) sector at the subnational level. To understand vulnerabilities related to the T&D infrastructure system along its entire 480 km of coastline, 16 indicators were identified ranging from commissioning year to asset failure history. Recommended actions, including investment options to strengthen resilience of the T&D infrastructure, were prepared accordingly. The study serves as a vital resource for stakeholders in the power sector.

On behalf of CDRI, I express sincere gratitude to all stakeholders from the Government of Odisha, including GRIDCO Ltd, for their invaluable contributions to the report's methodology and policy recommendations for the short, medium, and long term. I would also like to extend my sincere appreciation for NDMA's support throughout the entire effort. Collaboration with Taru Leading Edge, Power Research and Development Consultants (PRDC), and KPMG - India has been instrumental in preparing this report, which serves as an indispensable tool for policymakers, practitioners, manufacturers, and other stakeholders in the power sector.

CDRI believes that the resilience of the power sector to extreme weather events is pivotal in safeguarding the lives and livelihoods of millions, particularly those in vulnerable regions. We are committed to take the lessons learned in Odisha and expand similar work to support coastal regions around the world.

Amit Prothi
Director General, CDRI
New Delhi, India, June 2024

Foreword

Global energy consumption is steadily increasing annually, with an anticipated 48 percent growth over the next two decades, driven by the exponential rise in global population. In the face of escalating challenges posed by climate change, ensuring resilience in energy systems is imperative for overall development. Given the historical impact of extreme weather events on the state of Odisha, particularly the Transmission and Distribution (T&D) segment, the state has demonstrated remarkable resilience. It has rebounded and recovered by developing innovative adaptation and mitigation strategies in response to periodically changing wind speeds and the looming risk of climate change.

Understanding the socio-economic impact and losses in this regard, this study serves as an essential tool and a precursor at the sub-national, national, and global levels for coastal regions and regions with similar geographies. It provides insights into strategies that can be replicated not only for risk identification and estimation but also for capacity building, knowledge management, and financial preparedness.

This initiative aims to evaluate the climate resilience of Odisha's power infrastructure in a unique way. It will not only help in reshaping the policy landscape and risk-based governance for coastal regions but also provide valuable insights for energy sector practitioners, Original Equipment Manufacturers (OEMs), and regulators. The report details individual unit-level assets, their vulnerabilities, and offers investment options on how to build more resilient transmission and distribution assets. By setting a new standard for resilience initiatives, the study is expected to significantly influence the development of robust and adaptive energy systems, ensuring a sustainable and secure future for all.

I extend my appreciation to the Coalition for Disaster Resilient Infrastructure (CDRI) and the project stakeholders for this collaborative effort, which will help enhance the reliability and resilience of the state's power infrastructure. I strongly believe that the report will serve as a benchmark in climate-proofing of energy infrastructure in Odisha.

Principal Secretary to Government
Energy Department,
Government of Odisha

Preface

India is highly vulnerable to various natural hazards such as cyclones, tsunamis, earthquakes and floods, among other catastrophes. Approximately 12 percent of the nation's land area is prone to flooding and river erosion, while more than 58 percent is vulnerable to earthquakes of moderate to very high intensity (MHA, 2015). The susceptibility to cyclones and tsunamis affects approximately 76 percent of the coastline, particularly impacting the eastern coastal states of Tamil Nadu, Andhra Pradesh, Odisha and West Bengal (CEA, 2021). Climate change has increased the frequency and severity of these catastrophic events, wreaking havoc on the economy and society.

Odisha, with a 480-km coastline along the Bay of Bengal, often faces severe impacts from these disasters. Power infrastructure is one of the most severely affected sectors in the region. Large-scale damage to the state's transmission and distribution (T&D) infrastructure due to cyclones is common, leading to extended power supply outages in affected areas. Additionally, floods in Odisha are another major obstacle to the electricity infrastructure, making it impossible to operate and maintain during high rains and severe waterlogging. Between 1996 and 2018, Odisha experienced 13 years of floods and five years of cyclones (Sethi, 2019).

In light of the profound consequences that climate change and disasters have on power infrastructure, the National Disaster Management Authority (NDMA) of India convened a meeting in July 2019, inviting all stakeholders involved in developing policy and research at the national level, as well as those involved in building and operating power generation, transmission and distribution infrastructure in Odisha. The meeting discussed the power sector's damages and losses and brainstormed a road map for creating disaster- and climate-resilient power infrastructure in Odisha and, by extension, in all high-risk areas of India. The meeting also involved a thorough analysis of the cyclone's impact on the power infrastructure in Odisha, including the technical, organizational and functional factors contributing to significant damage and prolonged power restoration, which was universally acknowledged.

The following action was proposed to move forward: NDMA, in cooperation with relevant stakeholders, would conduct a comprehensive study to improve the power sector's disaster and climate resilience. Drawing from Odisha's experience, the power sector has adopted various innovative approaches to mitigate the effects of cyclones. These innovations, which have been adopted on an on-going basis over the last two decades, need to be systematically documented and disseminated so that the advances made by Odisha may benefit other cyclone-affected states in the country. The Coalition for Disaster Resilient Infrastructure (CDRI) supports NDMA in carrying out this comprehensive assessment of the resilience of power infrastructure in Odisha state.

The study on the resilience of power infrastructure in Odisha is categorized into two distinct phases. Phase I of the study relates to developing and adopting mechanisms for ensuring preparedness, preventing grid collapse, assessing losses, estimating needs and channelling adequate funds to disaster-affected areas promptly for early restoration and resilient recovery and reconstruction. It also includes aspects of community engagement.

The Phase - II study consists of two components, which yield a total of five reports. Component II focus areas include a) Risk Identification and Estimation and b) Codes, Standards, Regulations, Technology and Innovation. Component III focuses on a) Risk-based Governance and Policy Development, b) Capacity Building and Knowledge Management and c) Financial Preparedness and Adaptation.

The Phase-II reports will be a crucial instrument for policymakers to strengthen the power system's resilience, particularly in terms of T&D assets. Additionally, they will aid in evaluating and ranking investments in the power sector among similar geographical areas at every level.

The report **'Strategies for Effective Risk Identification and Estimation'** aims to differentiate the level of susceptibility and the associated risks faced by Odisha's power infrastructure due to disasters. Evaluation has meticulously considered exposure and vulnerabilities, particularly within the various components of the power infrastructure.

The report **'Codes, Standards and Technological Innovations for Infrastructure Design'**, an examines various mechanisms crucial for establishing, enforcing, and regularly updating scientifically informed design standard, codes, and regulations to enhance power infrastructure resilience. This assessment factored in evolving technologies and their changing profiles to ensure efficacy. This study also considers an array of technologies and innovations available to bolster power structure resilience against diverse hazards, emphasizing the tools and technologies that could be integrated to strengthen disaster risk management.

The report **'Risk-Informed Governance and Policy Development'** reflects the need to imbibe strong institutional governance, augmented capacity building and financing for disaster resilience in the power sector. The report further recommends and provides a way forward to build a comprehensive post-disaster need assessment (PDNA) strategy and enhance the techno-regulatory capacity building of Odisha's power infrastructure. It additionally identifies the various gaps and provides plausible interventions to strengthen the resilience in both structural and non-structural aspects of the power sector in the state.

The report **'Capacity Building of Stakeholders for Better Preparedness'** addresses governance and policy structures coupled with capacity-building efforts and makes recommendations for different stakeholders of the state and Energy department. These recommendations aim to facilitate the integration of disaster and climate resilience principles into the planning, operation, maintenance and continuous improvement of power infrastructure in Odisha.

The report **'Financial Preparedness Strategies for Adaptation and Resilience'** states that financial resources are required at various stages to build further disaster-resilient infrastructure, such as disaster prevention, preparedness, response and recovery. This section of the report addresses the financial and adoption strategies.

Acknowledgements

The successful completion of the Disaster Resilient Power Systems study for coastal Odisha stands as a testament to the extensive collaborative and technical effort invested over three years.

The project encompassed thorough desk research, data collection, cleaning, analysis and calculations. The successful accomplishment of this monumental task would not have been possible without the unwavering dedication and hard work of numerous individuals and teams, to whom we express our sincere appreciation and gratitude.

We would like to express our gratitude to Shri Gagan Bihari Swain, Director (F&CA), GRIDCO and his team for their valuable guidance and coordination in collecting relevant data from different stakeholders during the study period. We also appreciate the contributions of OPTCL, TPCODL, TPNODL, TPSODL and OSDMA in providing the required information for the study.

We extend our heartfelt appreciation to our esteemed consultants, M/s Power Research and Development Consultants Private Limited-PRDC, M/s KPMG India and M/s Taru Leading Edge, for their critical contributions to the study.

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Abbreviations

ATI	Administrative Training Institute
BCDMP	Business Continuity and Disaster Management Plan
CDMP	Crisis and Disaster Management Plan
CDRI	Coalition for Disaster Resilient Infrastructure
CEO	Chief Executive Officer
CGM	Chief General Manager
CMD	Chief Managing Director
CPRI	Central Power Research Institute
CSIR	Council of Scientific and Industrial Research
DISCOM	Distribution Company
DM	Disaster Management
DMP	Disaster Management Plan
DOE	Department of Energy
DRM	Disaster Risk Management
EHT	Extra - High Tension
ERS	Emergency Restoration Systems
GoI	Government of India
GRIDCO	Grid Corporation of Odisha Limited
GIS	Gas-Insulated Substation
GSI	Geological Survey of India
GSS	Grid Substation
IMD	India Meteorological Department
MTs	Master Trainers
MoP	Ministry of Power
NDMA	National Disaster Management Authority
NGO	Non-governmental Organization

Abbreviations

NIC	National Informatics Centre
NIDM	National Institute of Disaster Management
NLDC	National Load Despatch Centre
NPDM	National Policy on Disaster Management
NPTI	National Power Training Institute
O&M	Operation & Maintenance
OHPC	Odisha Hydro Power Corporation Limited
OPGC	Odisha Power Generation Corporation Limited
OPTCL	Odisha Power Transmission Corporation Limited
OSDMA	Odisha State Disaster Management Authority
PFC	Power Finance Corporation
PGCIL	Power Grid Corporation of India Ltd.
PSS	Primary Substation
RDMG	Regional-Level Disaster Management Group
RLDC	Regional Load Despatch Centre
SCADA	Supervisory Control and Data Acquisition
SDMA	State Disaster Management Authority
SDO	Sub - Divisional Officer
S/S	Substation
ToTs	Training of Trainers
TPCODL	Tata Power Central Odisha Distribution Limited
TPNODL	Tata Power Northern Odisha Distribution Limited
TPSODL	Tata Power Southern Odisha Distribution Limited
TPWODL	Tata Power Western Odisha Distribution Limited
UNDRR	United Nations Office for Disaster Risk Reduction

Executive Summary

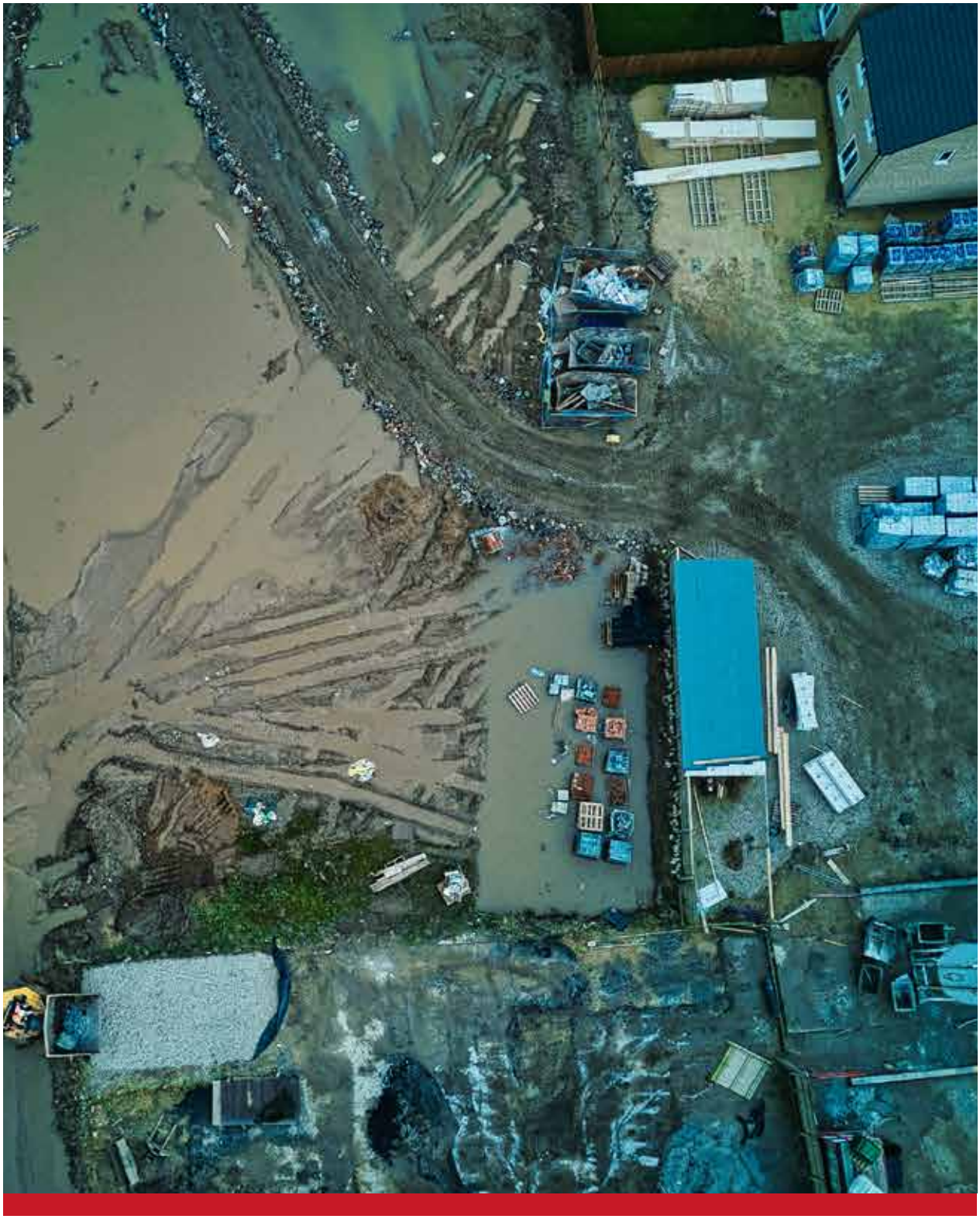
Building resilience against cyclones and floods in Odisha requires a comprehensive approach that addresses essential disaster risk reduction components. Establishing catastrophe risk reduction as a national and local priority entails building institutional capacity through policy formation, legislative frameworks, and strong governance. This includes developing policies, rules, and protocols under the supervision of competent authorities to ensure successful disaster management across all government levels.

Capacity building is critical for preparing individuals, emergency responders, and communities. Conducting regular mock drills and exercises can help improve disaster response by encouraging a more coordinated and efficient approach during real-time crises. To strengthen disaster preparedness, institutions, individuals, and communities need to be equipped with the information and skills required to successfully manage and mitigate disaster risks. This includes developing scientific, technological, and technical capacities to identify, assess, and monitor disaster risks, as well as improving early warning systems.

Creating a culture of safety and resilience entails strengthening and expanding technical capabilities, such as impact and vulnerability assessment, monitoring and evaluation, and community-based education. Assessing knowledge and developing awareness are critical components. This includes evaluating the level of awareness among the population and conducting public awareness campaigns to educate stakeholders and government officials on dangers of cyclone and mitigation measures. It is essential to integrate catastrophe risk reduction planning and capacity building across several sectors to address underlying risk factors. This involves guaranteeing healthcare functionality in the health sector during catastrophes and introducing new building rules, standards, and practices in housing and construction to make structures resistant to disasters.

Creating a culture of safety and resilience entails strengthening and expanding technical capabilities, such as impact and vulnerability assessment, monitoring and evaluation, and community-based education. This process involves a comprehensive study of present infrastructure, resources, and vulnerabilities, and identifying important players to ensure successful collaboration and resource allocation. This phase outlines plans and initiatives for developing resilient infrastructure capable of mitigating cyclonic disasters.

In summary, this chapter outlines a comprehensive capacity-building strategy that includes institutional governance, training, knowledge assessment, awareness raising, gap identification, and collaboration with a variety of stakeholders. Better preparedness can greatly minimize disaster-related damage and contribute to the development of a resilient community.



1 Introduction

1 Introduction

Disaster recovery operations involve not only the specific steps used to recover from damage and restore power but also internal coordination and cooperation with other utilities, governmental organizations, and municipalities. To achieve successful recovery and reconstruction of the power system, continuous work is necessary to enhance the capabilities of individuals, organizations, and communities. This is especially crucial in the case of Odisha, which has experienced multiple disasters of various types and sizes, resulting in significant economic damage.

According to the United Nations Office for Disaster Risk Reduction (UNDRR) (2019), 'Capacity refers to all the strengths, attributes and resources available within a community, organization or society to manage and reduce disaster risks and strengthen resilience'. The Government of India, in the Disaster Management Act (GoI, 2005) defines capacity building for disaster management as follows:

(i) Identification of existing resources and resources to be acquired or created

(ii) Acquiring or creating resources identified under sub-clause

(iii) Organization and training of personnel and coordination of such training for effective managment of disasters

Figure 1.1 Sectional areas for capacity building

Capacity-building actions include curriculum development, large-scale awareness, mock drills, response exercises, and human resource development through individual and organizational training. Figure 1.1 illustrates various areas within power sector utilities targeted for capacity building, spanning from vulnerability assessments to the dissemination of early warning information.

Effective disaster preparedness, like capacity building, requires a strong knowledge management system that includes the processes of generating, sharing and applying knowledge (Kusumastuti et al., 2021; Seneviratne et al., 2010). Furthermore, effective disaster preparedness strongly depends on knowledge management as a fundamental component. Implementing knowledge management approaches increases decision-making capabilities, speeds up reaction times, raises the visibility of humanitarian operations, fosters collaboration and facilitates the capacity development of humanitarian actors and communities (Kusumastuti et al., 2021). The report underscores the critical importance of capacity building and knowledge management in reducing disaster risks. The subsequent sections provide a comprehensive analysis of the current scenario in India and Odisha, focusing on the major stakeholders in disaster management and the electricity sector, and their respective management approaches. The report concludes with recommendations to enhance capacity building and knowledge management procedures in the Odisha power sector, supported by case studies from diverse geographical contexts to demonstrate their efficacy.

1.1 Background

Building upon the imperative outlined in the introduction for continuous efforts in disaster recovery operations, the National Policy on Disaster Management (NPDM) 2009 envisioned a pivotal role for the National Institute of Disaster Management (NIDM) in capacity development. As stated in the NPDM 2009, the NIDM plays a central role in capacity building in collaboration with other research institutions. This multifaceted role includes training, research, documentation and the development of a comprehensive national-level information base.

The partnership involves a diverse array of stakeholders, including Union Ministry officials, the National Disaster Management Authority (NDMA), secretaries of various nodal ministries and departments of the Government of India, state governments, heads of national-level scientific, research, and technical institutions, and prominent scholars, scientists and practitioners. This collaborative composition ensures a comprehensive and cyclopaedic approach to capacity development for disaster risk reduction across various sectors.

The subsequent section will explore the specific context of capacity building and knowledge management within the power sector. It will examine both the national and state perspectives, emphasizing the critical integration of national and local priorities and implementing community-based disaster risk management (DRM).

1.1.1 National level

At the national level, the power sector's disaster risk reduction efforts are meticulously coordinated by key bodies, each with a unique role in enhancing capacity and preparedness. The Ministry of Power (MoP) works with key institutions such as the Central Electricity Authority (CEA) (nodal agency), National Power Training Institute (NPTI), Central Power Research Institute (CPRI), National Load Despatch Centre (NLDC), Regional Load Despatch Centre (RLDC), and state power departments and utilities at the state level. These organizations undertake a wide range of activities, including organizing workshops, seminars and training programmes, as well as implementing awareness campaigns. They also play an important role in creating and disseminating information, education and communication materials, fostering a comprehensive approach to disaster risk reduction. Furthermore, the Power Sector Skill Council ensures an appropriate supply of competent and certified manpower.

CEA, NPTI and NIDM work closely together to develop disaster risk reduction curricula for the power sector, including central public sector undertakings. These organizations are responsible for incorporating gender-sensitive and equitable approaches to capacity development, addressing all aspects of disaster management. CEA, central public sector undertakings, NLDC and RLDC play a major role in conducting mock drills. Additionally, they also promote planning and execution of emergency drills.

1.1.2 State level

A network of institutions operating in tandem at the state level enhances disaster risk reduction measures in the power sector. The State Power Department, the State Load Despatch Centre, the State Transmission Unit, the generation companies, the distribution companies (DISCOMs), the Administrative Training Institute (ATI) and the State Disaster Management Authority (SDMA) work together to organize workshops, seminars and conferences to build capacity for disaster risk reduction in the power sector at the state level. These state-level agencies actively follow and participate in national-level capacity-building programmes and initiatives, ensuring a consistent and synchronized approach to disaster risk reduction.

The Central Electricity Authority Regulation 2010 (measures relating to safety and electric supply) recognizes the importance of training and skill development, including disaster management, for personnel involved in the operation and maintenance of generation, transmission and distribution systems to increase resilience. Individual businesses in Odisha's power industry, such as the Central Electricity Supply Utility, currently Tata Power Central Odisha Distribution Limited (TPCODL), and the Odisha Power Transmission Corporation Limited (OPTCL) Power Training Centre, have established internal training facilities.

These institutes offer programmes that teach field engineers and workers about safety and disaster management. Moreover, CEA has accredited the OPTCL Power Training Centre as a Category Technical Training Centre.

Furthermore, in accordance with the Disaster Management Plan (DMP) 2018, the Department of Energy (DOE) has developed a comprehensive framework for categorizing training programmes based on the intended audience, as shown in Table 1.1.

Table 1.1 General approach to disaster management training

S. no.	Training programmes	Key components	Target audience
1	Awareness and sensitization on best disaster management practices with the existing resources	» Planning for deployment of technical and non-technical groups during the exigency » Checking the available tools and allotment to each group	Superintending engineer, executive engineer, sub-divisional officer (SDO) and junior manager of the concerned area
2	Training and develoment skills	» CEA guidelines relating to safety and power supply » Use of safety tools during a disaster	Executive engineer, SDO and junior manager of the concerned area. Training can be bifurcated based on categories such as operation and maintenance, rate contract holders, repair manpower, gas-insulated substation (GIS) experts, etc.
3	Preplanning of material Procurement and services	» Earmarking of budget » Delegation of financial powers for disaster management	Superintending engineer and executive engineer of the concerned area
4	Approach for restoration of power supply on priority	» Restoration of power supply on priority according to the nature of public service of the institution	Executive engineer, SDO and junior manager of the concerned area
5	Training programme on safety	» Mock drill	All electricity staff officers and contractors

1.1.3 Importance of community-based disaster risk management

Recognizing communities' critical role in disaster risk reduction, the Disaster Management Act 2005, the National Disaster Management Policy 2009 and strategic planning documents such as the Eleventh and Twelfth Five-Year Plans emphasize the importance of community-based DRM in mitigating vulnerabilities. In this context, boosting local preparedness involves establishing early warning systems and increasing community capacity through awareness programmes, mock drills and specialized training for critical first-responder functions such as search, rescue and first aid. These measures are critical in improving local-level disaster preparedness. Given the impact of climatic variability, particularly on hydrometeorological hazards, it becomes imperative to incorporate hazard risks into risk reduction strategies. This proactive approach ensures a more resilient and adaptable community-based DRM framework.

While Odisha has taken proactive measures for disaster response and recovery, this report summarizes the Ministry of Energy's capacity-building actions in the state. It specifically outlines educational initiatives in Odisha's power sector, including training, disaster preparedness and upskilling of technical personnel. The analysis indicates that the training programmes are currently supply-driven, necessitating the recommendation of a framework that addresses gaps and provides a strategy aligned with available manpower. This strategic approach aims to improve recovery and restoration preparedness while producing meaningful disaster risk reduction results on the ground.

2 Capacity Mapping of Various Hierarchies of Power Sector Organizations in Odisha

2 Capacity Mapping of Various Hierarchies of Power Sector Organizations in Odisha

In this section, we will assess the capacity of Odisha's power sector institutions/organizations to anticipate, prepare for and effectively respond to power supply interruptions at both the zonal and ward levels. We will also highlight the availability of trained human resources across various functions, with a specific focus on risk management pertaining to systems, processes and actions. The assessment will involve competence mapping for disaster management, which will identify the essential knowledge and skills required by the workforce to perform during disasters. An important component is the availability of competent manpower/resources at all skill levels in order to reduce reliance on third parties during disasters and strengthen institutional capability.

2.1 Odisha Power Transmission Corporation Limited

As the state's exclusive transmission utility, Odisha Power Transmission Corporation Limited (OPTCL) plays a critical role in maintaining the state's enormous transmission network. OPTCL manages 141 grid substations and 20 switching stations located throughout the state. In total, it oversees approximately 13,500 circuit kilometres of extra-high tension (EHT) lines at 400 kV, 220 kV and 132 kV levels.

The power network is more concentrated near the coastline and industrial regions. It includes critical infrastructure such as EHT towers, interconnected transformers, autotransformers, power transformers, and grid substations. As these assets focus on bulk power transmission, they are vulnerable to cyclones, tsunamis and floods, which could cause massive power outages across extensive regions.

In Figure 2.1, the steps used by OPTCL authorities to effectively manage disaster events and prioritize the restoration of power supply are depicted. Each stage shows the stakeholders involved and their respective functions. At the management level, the chief managing director (CMD) and chief general manager of operations and maintenance strategize. Further restoration is carried out with the assistance of departmental staff, field engineers, sub-engineers and manpower from rate contract holders.

Figure 2.1 Flow of events according to disaster management cycle

01 Disaster warning issued by IMD followed by the State Govt.

02 CMD appraises about the imending disaster and its probable implications to Chief General Managers (CGM) and gives instruction to remain prepared for any contingency which differs from case to case according to the nature of severity.

03 CGM (O&M) intimates all concerned field engineers to get ready with men & material according to the checklists already provided to them. A 24x7 control room is established in the CGM (O&M) office and acts as the main control centre to track events and forward directives.

04 Rate contract holders are called for and given assignments to mobilize their manpower to different zones with vehicles, fuel, food and T&P. They provide the main logistics support during such situations.

05 Related Grid Substations act as local mini control rooms where walkie-talkie facilities are available in addition to other communication modes. Transmission line-in-charges are asked to recheck the towers for any missing members and replace them immediately. Substation & line materials are released to their site (if not available with them) for storing as buffer stock.

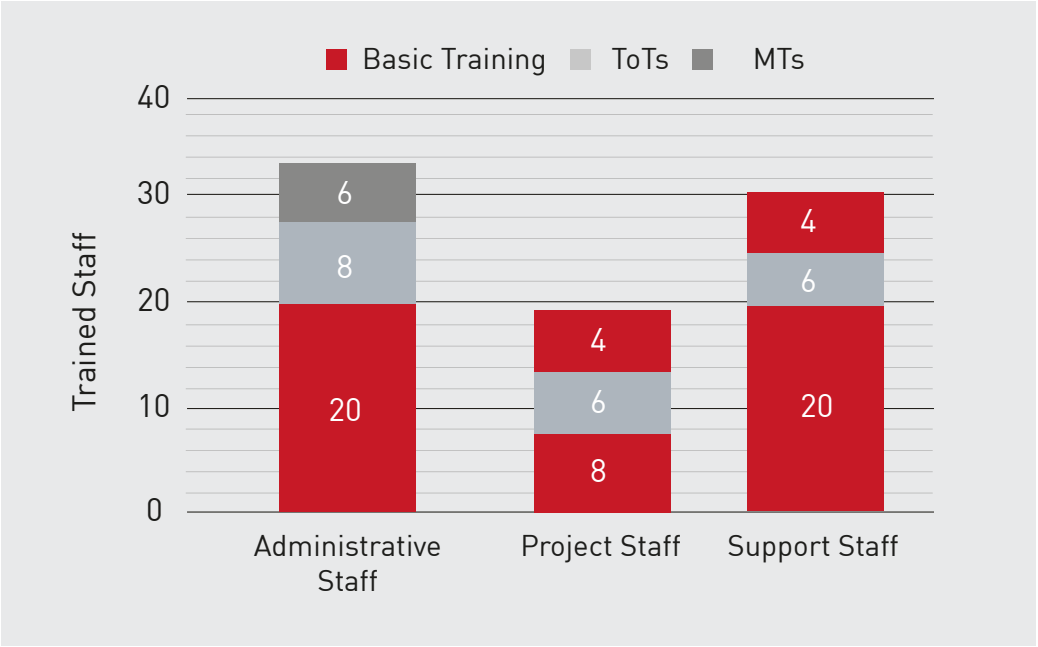
06 If any tower damage is reported due to the disaster, priority is given to restore power supply from an alternate source. Then, considering the severity of damage, topography etc. ERS towers are temporarily mobilized from nearest available location for restoration. At present the available locations are Mancheswar, Chatrapur and Budhipadar.

Source: Department of Energy (2019)

As per the OPTCL disaster management plan (DMP), the organization ensures that 100 percent of its human resources are trained in disaster risk reduction. This training includes three categories: basic, training of trainers (ToTs) and master trainers (MTs) (refer to Figure 2.2). MTs have advanced knowledge, while basic and ToT participants are introduced to fundamental disaster management concepts.

OPTCL relies on rate contract holders for crucial logistical support. To ensure an efficient response, the disaster training facility was expanded to include the workers of rate contract holders.

Figure 2.2 Framework of human resources in the department trained on disaster management



Source: Department of Energy (2019)

2.1.1 Capacity mapping: at DISCOM level

In line with the Business Continuity and Disaster Management Plan (BCDMP), the team operates under the supervision of Tata Power's chief operating officer in the event of a disaster. Table 2.1 outlines stakeholder engagement in disaster management activity and its related functions. The table lists the various disaster management teams, their functions and the team members.

Table 2.1 Functions and responsibilities of DISCOMs' disaster management teams

S. no.	Disaster management team	Functional role	Team personnel
1	Chief incident controller (CIC)	Overall in-charge of the disaster management process	Chief operations managment from the corporate office of Tata Power
2	Core assessment team	Responsible for assessing the emergency and giving feedback to the CIC for invoking the BCDMP as per the disaster	Officials from the corporate office of Tata Power
3	Emergency management team	Responsible for extending all support to the circle teams	Seniors from the corporate office of Tata Power
4	Circle incident controller	The circle head of the respective incident location will be in charge and will be the local in-charge of BCDMP	Head of incident location
5	Emergency operations team at the site	This is the core operations team in the field	Executive engineer / sub-divisional officer / junior engineer of the incident site
6	Emergency support team head	This will direct all the additional operational support to the field teams	Senior general manager of technical, planning, operations and maintenance department
7	Emergency support team	Additional operational support to the field team	Pre-identified team drawn from various functions
8	Disaster management cell	Continuous monitoring for disaster alerts and trigger for invocation of BCDMP	Consist of team members at corporate level

Each divisional officer is responsible for keeping track of the resources in their division, accompanied by corresponding lists of competencies and skills. This strategy ensures efficient resource utilization during a disaster. In addition to their primary responsibilities, individuals undergo phased training on additional essential functions, focusing on timely skill development. However, several challenges have been identified, including the ageing and steady decline of technical staff, a lack of skilled workforce and shortages from enlisted vendors. These shortcomings significantly hinder the existing capabilities of the departments.

2.1.2 Tata Power Central Odisha Distribution Limited

Tata Power Central Odisha Distribution Limited (TPCODL), a joint venture between Tata Power and the Government of Odisha, has a significant impact on the power distribution sector. Tata Power owns a 51 percent share and oversees 2.6 million consumers with a peak load of 1550 MW in nine revenue districts in Odisha. TPCODL's operations cover an extensive area of 29,354 sq. km and span Cuttack, Puri, Dhenkanal, Angul, Khurda, Kendrapara, Nayagarh, Jagatsinghpur, and part of Jajpur.

TPCODL has implemented a robust business continuity and disaster management plan to proactively mitigate risk exposure by integrating disaster recovery management and other contingency measures. The company maintains an average workforce age of 44 years, and supervises 4917 permanent employees and 435 contractual employees of the central electricity supply utility (according to the available records, there is no history of staff trained in disaster management).

2.1.3 Tata Power Southern Odisha Distribution Limited

Tata Power Southern Odisha Distribution Limited (TPSODL), a joint venture between Tata Power (51%) and the Odisha government (49%), operates on the public-private partnership model. It plays a critical role in power distribution. TPSODL manages a registered user base of 2.4 million and a peak load of 850 MW across Odisha's eight revenue districts. TPSODL's operations span 47,000 sq km and include Ganjam, Boudh, Malkangiri, Rayagada, Gajapati, Kandhamal, Nawrangpur and Koraput.

TPSODL oversees the Southern Electricity Supply Company of Odisha Limited's (SOUTHCO) entire workforce, which includes 389 executives and 1610 non-executives, with an average age of 43 years. According to the Government of Odisha's energy department's DMP, only 2.5 percent of administrative staff is trained in disaster management. This underscores the need for increased training to ensure that TPSODL is equipped to handle any disaster-related emergency. Table 2.2 provides an overview of the existing human capacity trained in disaster management, highlighting TPSODL's current level of preparedness.

Table 2.2 Human resources in TPSODL

S.no.	Category	Total staff	No. of trained staff in disaster management			
			Basic	ToTs	MTs	Total
1	Administrative staff	403	3	7	NIL	10
2	Accounts and clerical	554	NIL	NIL	NIL	NIL
3	Support staff	1448	NIL	NIL	NIL	NIL

2.1.4 Tata Power Western Odisha Distribution Limited

Tata Power Western Odisha Distribution Limited (TPWODL), a joint venture with Tata Power owning a 51% share. TPWODL manages a sizeable workforce, including 479 executives and 1883 non-executives from Western Electricity Supply Company of Odisha Ltd. (WESCO). The company serves 88 lakh people in nine districts of Western Odisha, including Sundergarh, Jharsuguda, Deogarh, Sambalpur, Bargah,Bolangir, Sonepur, Kalahandi, and Nuapada, covering a distribution area of 48,373 sq km across theRourkela, Sambalpur, Bargarh, Bolangir, and Bhawanipatna circles. It is important to note that there iscurrently no disaster management strategy in place for TPWODL, as it is classified as one of the least affected areas.

2.1.5 Tata Power Northern Odisha Distribution Limited

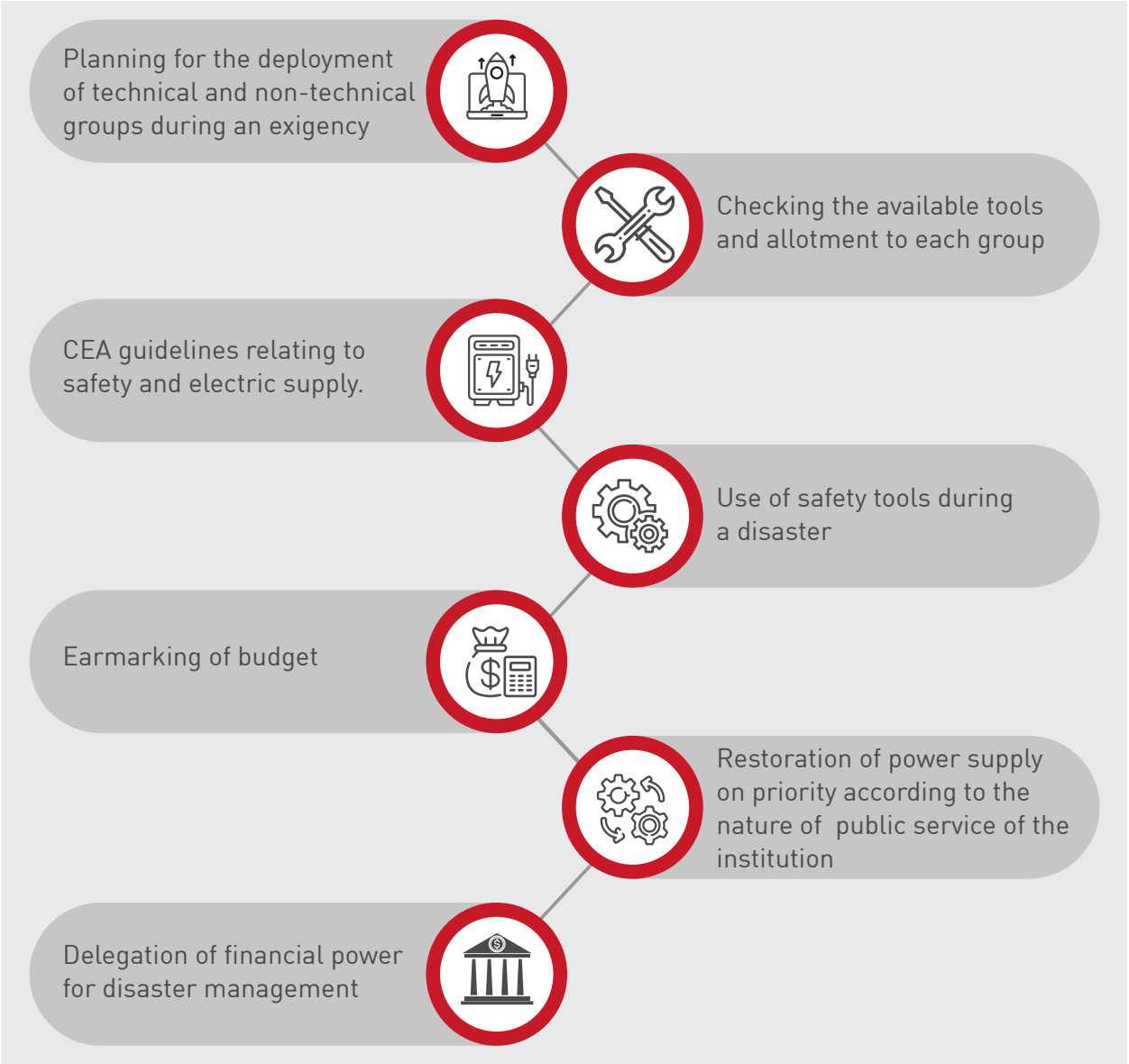
Tata Power Northern Odisha Distribution Limited (TPNODL) is a joint venture with Tata Power holding a 51% share. It is a vital player in delivering services to over 2 million customers across five districs in Northern Odisha. TPNODL has a registered user base of 2.05 million and operates in an area covering 27,920 sq km in the five districts of Balasore, Bhadrak, Jajpur, Keonjhar and Mayurbhanj. The company efficiently manages its operations with a workforce of 2304 regular employees and 13 contractual employees, contributing to the utility's robust workforce. According to the Department of Energy's DMP, TPNODL currently lacks trained human capacity in disaster management. However, the utility has a comprehensive DMP in place, which includes incident management, damage assessment, recovery and restoration.

3 State Capacity-Building Initiatives for Disaster Management Activities for the Power Sector

3 State Capacity-Building Initiatives for Disaster Management Activities for the Power Sector

This section focuses on the importance of capacity mapping, particularly emphasizing the need for skilled staff in disaster risk reduction for the Odisha power sector. It highlights the critical aspect of making educated judgments in the face of unexpected circumstances, focusing on the importance of effective human resource and management systems. Within this perspective, the section looks at numerous educational programmes in the Odisha power sector, such as training, disaster preparedness, and technical personnel upskilling. All these efforts significantly impact the preparedness and reaction capabilities of the workforce. Figure 3.1 illustrates the important components of capacity-building initiatives required for disaster risk reduction. These efforts, which must be implemented prior to any hazard, establish the groundwork for effective disaster response and recovery.

Figure 3.1 Capacity-building initiatives



At the state level, capacity development primarily benefits government disaster management personnel and power sector entities. At the DISCOM level, superintending engineers, executive engineers, subdivision officers and junior managers receive essential training, recognizing their critical roles in crisis management.

3.1 Capacity building: OPTCL

Within the context of OPTCL's DMP, the organization focuses on capacity building by drawing on the expertise of professionals through a combination of practical and theoretical training.
The Power Training Centre at Chandaka plays a crucial role in meeting the training demands of the transmission and distribution sector. It offers training modules for lineman skills, line and substation planning, and line and substation installation and maintenance (up to 33 kV). The centre incorporates practical insights from original equipment manufacturers of emergency restoration systems (ERS) towers to ensure up-to-date procedures and practices are effectively conveyed (see figure 3.2).

Figure 3.2 Capacity-building training

Capacity-building initiatives : Theoretical

- Disseminate ideas, activities and procedures along with safety measures
- Modules of training programmes
- Technical programme training is provided to different executives and non-executives of the department at regular intervals in collaboration with external agencies and experts

Capacity-building initiatives : Practical

- Mock drills
- Training programmes on Safety & Safe Working Practices, Management Development Programmes (MDPs)
- Engineers, training and orientation session

In times of disaster, it is crucial to maintain communication with rate contract holders, especially considering the severity of possible damages. To improve their training, rate contract personnel participate in mock drills. These drills provide valuable feedback for improving future training sessions. According to OPTCL's DMP-2019 (Department of Energy 2019), these mock drills are typically conducted once a year. Furthermore, there are plans in place to conduct training programmes focusing on advanced EHT equipment and power-line carrier communication in the supervisory control and data acquisition (SCADA) system.

3.2 Capacity building: DISCOMs

This section outlines the comprehensive training requirements for DISCOMs in accordance with the strategic framework provided in the Department of Energy's (DoE) DMP. Table 3.1 categorizes training requirements based on employees' roles and responsibilities within the organization, giving a thorough road map for effective capacity building.

Table 3.1 Required training for the department

S. no.	Category	Types of training required	Training institutions
1	Policymakers / heads of institution	» Disaster preparedness and mitigation plan » Arrangements for strengthening the infrastructure	NIDM, New Delhi
2	Technical staff	» Restoration and response training » Adherence to safety measures during the disaster » Training on information flow during the disaster	Centre of Excellence in Disaster Mitigation and Management (CoEDMM), Uttarakhand
3	Administrative staff		
4	Project staff		
5	Accounts and clerical staff	» Damage assessment and accounting of expenditure	NIDM, New Delhi
6	Support staff	» Inter-departmental relationship	

The training curriculum is specifically developed to address the needs of government decision-makers, DISCOM's executive engineers and local community leaders. It ensures that capacity building is addressed at all levels, from state governments to grassroots groups. Community capacity building entails working with volunteer organizations and civic authorities, including the police, fire departments, municipalities, hospitals and waterworks. The goal is to develop coordination and communication procedures for effective disaster response.

Table 3.2 provides an overview of the general training programmes and their target audiences. However, it is important to note the lack of detailed frameworks, especially in areas such as sustainable technology, best practices, and financial management. Addressing these deficiencies will be crucial for a more comprehensive capacity-building strategy.

Table 3.2 Capacity-building plan – general training programmes

S. no.	Training programmes	Key component	Target audience
1	Basic disaster management	» Introduction to disaster management	Assistant Manager/ Deputy Manager/ Manager
2	Flood/cyclone disaster risk mitigation and managment	» Preparedness and mitigation plan	Assistant Manager/ Deputy Manager/ Manager
3	Administrative staff assessment, restoration, and reconstruction	» Assessment of damage and action plan for restoration and rectification	Junior Manager/ Assistant Manager/ Deputy Manager/ Manager
4	Databases for disaster management and communication systems in disaster situations	» Flow of information during a disaster	Assistant Manager/ Deputy Manager/ Manager
5	Safety preparedness for disaster management	» Adherence to safety measures during the disaster	Junior Technician/ Lineman/Helper

Tables 3.3 and 3.4 provide a broad overview of disaster preparedness, response, and restoration. However, it is crucial to recognize that the training programmes at the state and district levels should not be uniform, as the roles and responsibilities of stakeholders vary at each level. Specific training programmes should be designed with consideration for the distinct roles and responsibilities of stakeholders.

Table 3.3 State-level capacity-building programmes

S. No.	Stakeholders	Programmes
1	Additional Secretary, Joint Secrtary, Deputy Secretary, Under Secretaries, Section Officer and Assistant Section officer	» Training-cum-awareness and effective management during disasters such as cyclones/floods at the state level for better supervision, monitoring and preventive measures
2	Managing Director, OSDMA and other officers concerned	» Preparedness of the DISCOM » Assessment of the electrical infrastructure prone to disasters » Financial assistance to DISCOM for capacity building » Priorities for restoration of power supply to important institutions
3	CEO, Chief General Manager (Technical) and all Superintending Engineers (Distribution)	

Source: Government of Odisha (2018)

Table 3.4 District-level capacity-building programmes

S. No.	Stakeholders	Programmes
1	Additonal District Magistrate, Block Development Officers and Tehsildars	» Training-cum-awareness and effective management during disasters, such as cyclones/floods, at the state level for better supervision, monitoring, and preventive measures » Assessment of stock of material with DISCOM » Preparedness of the DISCOM » Assessment of the electrical infrastructure prone to disasters » Financial assistance to DISCOM for capacity building » Priorities for restoration of power supply to important institutions
2	All Executive Engineers (Distribution)	

Source: Government of Odisha (2018)

Strengthening local disaster resilience entails actively engaging communities, raising awareness through campaigns and training, strengthening local capacity through partnerships with organizations,and investing in resilient infrastructure to improve safety. Table 3.5 indicates a good approach to increasing capacity and cooperation from local communities.

Table 3.5 Community-level capacity-building programmes

S. No.	Stakeholders	Programmes
1	Sarpanch and other local representatives / volunteer organizations	» Public awareness programmes on disaster risk awareness and early recovery strategy of the department
2	Disaster recovery awareness to the public	» Public awareness programme through distribution of relevant posters, leaflets, and pamphlets in Odia/local language » Cooperation from public/volunteer organizations for smooth restoration of power supply by DISCOM employees

Source: Government of Odisha (2018)

The capacity-building plan provides an overview of training initiatives, but further clarity is needed at the operational level. To achieve a lasting impact from a capacity-building activity, considerable attention must be given to planning and management. The plans currently lack information regarding training provided to third parties involved in the recovery and reconstruction phase.

3.3 Capacity building: through mock drill

The Ministry of Power, in collaboration with CEA, has developed a crisis and disaster managementplan (CDMP) for the power sector in consultation with all stakeholders. This plan provides a structure and direction for the country's power sector utilities for all phases of the disaster management cycle. A pivotal component of this plan involves the regular conduct of mock drill exercises across various power industry domains. Additionally, the document also requires each utility to submit a quarterly report to CEA detailing the nature of crisis circumstances, the response of various teams, observations, efficacy in dealing with emergency scenarios and areas of improvement, among other things. Several power plants, including Chamera-II Power Station in Himachal Pradesh, Parbati-III Power Station in Himachal Pradesh, Loktak Power Station in Manipur, Sataldih Thermal Power Project in West Bengal and Southern Generating Station in West Bengal, have conducted mock drills for scenarios such as flooding, chlorine leakage and acid leakage.

Mock drills are critical for disaster preparedness, response and recovery efforts. They work to synchronize, incorporate, and collaborate on organizational procedures, policies, duties and roles.These exercises extend to the state, district/city and gram panchayat levels, ensuring a comprehensive assessment of readiness at all organizational tiers.

The planning and execution as per TPCODL's DMP are as follows:

- **Design the mock drill:** Clearly outline the simulation details and provide a timeline for the proceedings. This will help assess the drill's success and identify the necessary equipment to make the drill realistic.
- **Briefing session:** Conduct a pre-exercise briefing to assign roles to all participants. Appoint a safety marshal who will initiate a medical safety plan and terminate the exercise if a real threat occurs.
- **Mock drills:** Initiate the mock drill by introducing a prepared mock situation that simulates a potential real hazard or vulnerability. Instruct everyone to follow the procedures outlined in the existing DMP. Deliver scripted messages to test the participants' reactions according to the developed timeline.
- **Evaluate the mock drill:** Evaluate the effectiveness of written procedures and address any shortcomings. Obtain feedback from designated observers on the participants' performance and fulfilment of the exercise objectives. Document all lessons learned through the mock drill for corrective action, as mentioned in Table 3.6.

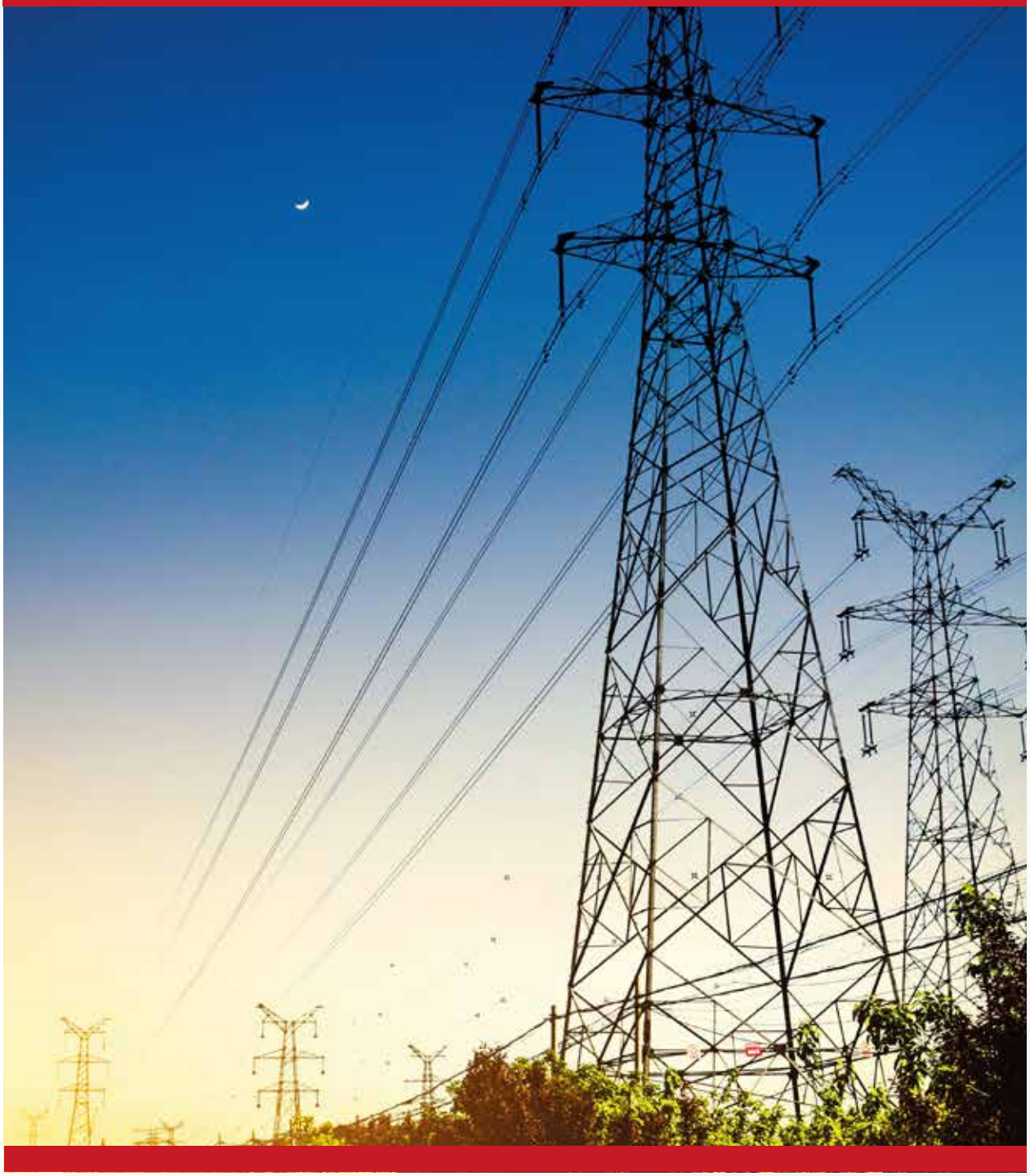
Table 3.6 Mock drill exercise conducted in Odisha

S. no.	Mock drills	Participants	Month of organization	To be organized by	Remarks
1	Preparedness	100	October to December each year	Each circle/ division head	Observation notes to be submitted within seven days of completion of the mock drill by each circle-head
2	Early assessment of damage				
3	Response for quick restoration of power supply				
4	Response to change over of supply				
5	Handing of safety equipment during a disaster				

Source: Government of Odisha (2018)

As per the state power sector's DMP, mock drills on disaster management are conducted twice a year as a preparedness exercise. These drills provide valuable insights into organizational readiness, help identify any gaps, and contribute to the continuous enhancement of crisis management policies and stakeholder abilities.

4 Assessment of the Knowledge Management Landscape in the State's Power Sector



4 Assessment of the Knowledge Management Landscape in the State's Power Sector

The lack of coordinated information on disaster management strategies in the state's electricity sector has led to inefficient information exchange and duplication of efforts in the disaster management initiatives. This fragmentation confines knowledge and experiences to individual or institutional levels.

In response to these issues, knowledge management emerges as a multidisciplinary approach that offers a strategic framework for developing, sharing, utilizing and managing knowledge. This proactive strategy aims to break down silos, promote teamwork and prevent duplication of efforts in disaster management techniques.

Given Odisha's pivotal role in disaster management both nationally and internationally, the state has built a robust network of partners spanning various fields related to disaster management, as detailed in Table 4.1. This broad network includes essential players from numerous sectors, contributing to the state's resilience and preparation to manage disasters efficiently.

Table 4.1 Partners of Odisha State Disaster Management Authority for capacity-building programmes

S. no.	Theme	Partners
1	Implementing partners	» UNDP, UNICEF, WB, OCAC, IAG, CRS
2	Knowledge partners	» UNDP, UNICEF, NRDC, AIDMI
3	Financial partners	» UNDP, UNICEF, WB
4	Strategic partners	» KSNDMC, BSDMA, GSDMA, CSR
5	Networking partners	» IAG
6	Technical partners	» IIPH, IIT, IITM, INCOIS, IMD, BMTPC
7	Coordination partners	» IAG, UNDP, UNICEF, WB
8	Research partners	» TISS, RMSI, TARU

Source: Government of Odisha (2017)

United Nations Development Programme (UNDP), United Nations Children's Fund (UNICEF), World Bank (WB), Odisha Computer Application Centre (OCAC), Inter-Agency Group (IAG), Catholic Relief Services (CRS), National Research Development Corporation (NRDC), All India Disaster Mitigation Institute (AIDMI), National Research Development Corporation (NRDC), Karnataka State Natural Disaster Monitoring Centre (KSNDMC), Bihar State Disaster Management Authority (BSDMA), Gujarat State Disaster Management Authority (GSDMA), Corporate social responsibility (CSR) initiatives, Indian Institute of Public Health (IIPH), Indian Institutes of Technology (IITs), Indian Institute of Tropical Meteorology (IITM), Indian National Centre for Ocean Information Services (INCOIS), India Meteorological Department (IMD), Building Materials and Technology Promotion Council (BMTPC), Tata Institute of Social Sciences (TISS), RMSI Pvt Ltd, TARU Leading Edge Pvt Ltd.

4.1 National approach to knowledge management

Knowledge networking is emerging as a critical initiative, encouraging collaboration among major government agencies, policymakers, disaster managers and specialists from a broad spectrum of backgrounds. It is envisioned under the Ministry of Home Affairs' GoI-UNDP National Disaster Risk Management Programme. This initiative aims to build strong networks and collaborations to facilitate the exchange of critical information and concerted efforts to reduce risk.

The initiative involves a network of approximately 500 Indian institutions, including government programme partners. Notably, it creates specific networks at the state and training institution levels, encouraging collaboration among the numerous players involved in disaster management. To facilitate this collaborative effort, the Government of India has developed a web platform that serves as an independent workspace for the states and research institutions. This platform enables them to seamlessly record, organize, find, and exchange knowledge.

The knowledge management portal operates on an extranet with controlled access levels, offering an efficient platform for capturing and managing various products of the programme. These products include disaster management plans, manuals, reports, information on trained human resources, emergency contact information, and hazard and vulnerability maps. The portal is currently accessible to network members but will eventually have a public interface. It will serve as a comprehensive archive of disaster-related information. In addition, the portal includes a list server, which allows for e-mail and discussion groups, as well as cross-posting and interactions across established networks.

5 Needs Assessment for Augmenting Capacity-Building Activities in the State

5 Needs Assessment for Augmenting Capacity-Building Activities in the State

The state administration and stakeholders conducted a gap assessment exercise to reduce climate- induced hazards and strengthen power sector resilience. This exercise aimed to identify both structural and non-structural initiatives that could be adopted by the state government and stakeholders. It involved studying and analyzing the current and planned interventions related to capacity for preparedness, mitigation and restoration. Based on the analysis and literature review, Table 5.1 lists the capacity gaps that were identified.

Table 5.1 Capacity gaps

Areas	TPCODL	TPSODL	TPNODL	OPTCL	Department of Energy
No dedicated training institution or master trainer and team for disaster risk reduction in the state's power sector	✓	✓	✓	✓	✓
Shortage of skilled workforce. Fresh talent has not entered the workforce during the last decade, destabilizing workforce demographics and technical competency	✓	✓	✓	--	--
Ageing and gradual diminishing of old technical manpower	✓	✓	✓		
Poor gender diversity	✓	✓	✓	✓	✓
Lack of training framework for employees at various levels	✓	✓	✓		
No assessment strategy to evaluate the level of awareness among the employees	✓	✓	✓	✓	✓
Major dependency on third parties during a disaster for restoration and reconstruction	✓	✓	✓	--	--
No educational tours for employees to other disaster-affected states/countries regarding advancement in disaster management/mitigation	✓	✓	✓	✓	--

The table identifies important missing aspects of capacity development in the respective organizations. Notably, all five institutions confront similar difficulties, such as:

- Lack of adequate gender diversity
- Lack of an assessment strategy to evaluate awareness
- No dedicated training team for disaster risk reduction

Furthermore, the three DISCOMs have substantial shortcomings, such as:

- Shortage of skilled workforce
- Lack of training framework for employees
- No educational tour and major dependency on the third party during disasters

Therefore, the gaps can be rectified by developing a systematic approach to provide trainings from policymakers at the institutional level to field personnel at the grassroots level.

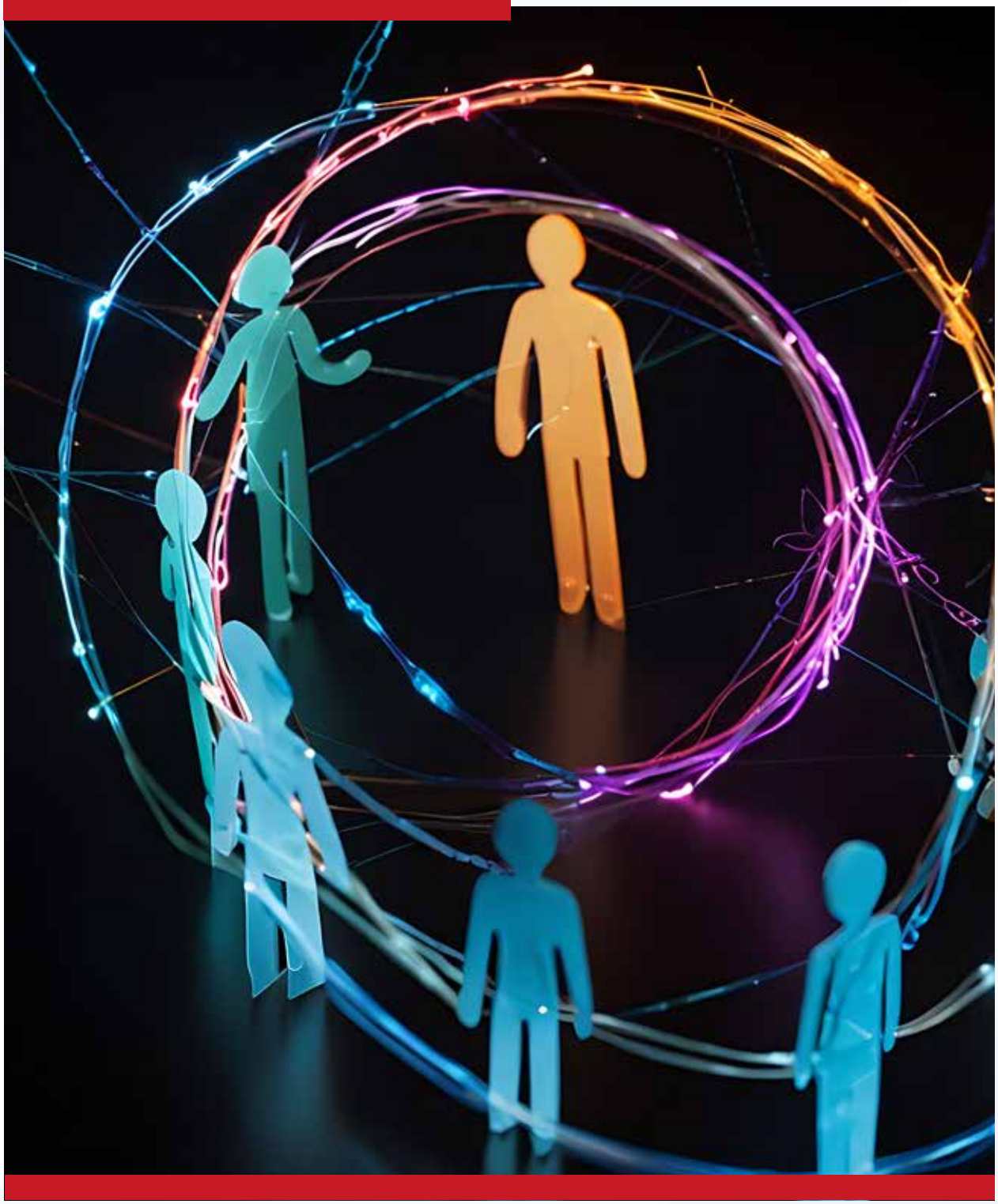
1. **Policymaker's training:** Launch comprehensive training programmes for top-level policymakers to ensure they understand the importance of integrating disaster management into policies and decision-making.

2. **Institutional training:** Implement institutional training to establish successful protocols, communication channels, and resource allocation strategies. This will guarantee that institutions are well-prepared to coordinate efforts during crises.

3. **Technical and operational training:** Provide specialized training for power utility staff on post-disaster infrastructure inspection and repair. Additionally, train emergency responders in search and rescue procedures.

The establishment of a holistic and well-coordinated disaster management system requires a systematic approach to training, ensuring coordination among policymakers, technical experts, and stakeholders. Section 6 outlines the recommendations to bridge the gaps in the power sector.

6 Recommendations



6 Recommendations

6.1 Knowledge management

It is crucial to engage stakeholders effectively to strengthen the resilience of the power sector. Collaborative efforts from diverse stakeholders are essential for conducting a comprehensive risk assessment, developing effective mitigation methods, and mobilizing resources successfully. In this setting, it is vital to align policies and regulations, establish transparent communication, initiate capacity-building programmes, adopt cooperative emergency response planning and embrace technological solutions. Regular evaluations and changes to the resilience strategy, in consultation with stakeholders, ensure flexibility to evolving hazards. Therefore, stakeholder engagement is essential for improving the overall strength and responsiveness of power sector resilience planning.

Drawing on the Lao PDR case study (Case Study 6.1), the Odisha government can learn important lessons on involving stakeholders in designing and planning policies for power sector resilience. In particular, the inclusion of stakeholders from various departments has proven to be beneficial. This approach not only enhances the local technical capability for resilience planning but also promotes consensus building by involving a diverse array of stakeholders. Furthermore, it ensures that local skills and institutional knowledge are readily available to assist future resilience planning efforts.

Case study 6.1: Stakeholder engagement for power sector resilience planning, Lao PDR

The Ministry of Energy and Mines of the Lao People's Democratic Republic (Lao PDR) is the lead government agency responsible for the country's energy sector. The Department of Energy, Policy and Planning is responsible for setting national policies and regulations (ADB, 2015). Électricité du Laos, a state corporation, owns and operates the country's electricity generation, transmission, and distribution assets (National Renewable Energy Laboratory, 2020).

The Ministry of Energy and Mines acknowledges that having access to reliable, secure, and affordable electricity is essential for the country's objectives. While the power system plays a vital role in the provision of power, it also faces potential risks from natural, technological and anthropogenic threats. To address this and enhance power sector resilience, the Ministry of Energy and Mines undertook a comprehensive national power sector vulnerability assessment and resilience action planning activity in 2018. It engaged first-of-their-kind advisory and stakeholder groups to support this work.

The advisory group provided strategic direction, which included power sector directors/ managers from the Ministry of Energy and Mines, Électricité du Laos, and Électricité du Laos-Generation Public Company. The wide-ranging stakeholder group included representatives from the Ministry of Industry and Commerce, Ministry of Science and Technology, Ministry of Natural Resources and Environment, Ministry of Finance, Ministry of Labour and Social Welfare, Lao Holding State Enterprise, Central Bank of Lao PDR and the Lao Women's Union (National Renewable Energy Laboratry, 2019). Diverse experiences and viewpoints from across the electricity system were captured owing to broad stakeholder involvement.

Source: Lee, Nathan, Sherry R. Stout, and Sadie L. Cox. Institutional Solutions to Enhance Power Sector Resilience. No. NREL/TP-7A40-73645. National Renewable Energy Laboratory (NREL), Golden, CO (United States), 2019.

Source: ADB. 2015. "Renewable Energy Developments and Potential in the Greater Mekong Subregion." Manila: Asian Development Bank (ADB). http://hdl.handle.net/11540/5054.

Source: Stout, Sherry R., et al. Lao Power Sector Vulnerability Assessment and Resilience Action Plan. No. NREL/TP-7A40-73069. National Renewable Energy Lab.(NREL), Golden, CO (United States), 2020.

Recognizing the importance of local expertise as a reliable source of knowledge, the state can proactively recruit local delivery partners to assist with training activities and capacity-building projects. The integration of local experience has proven to be a reliable and effective strategy, as evidenced by Case Study 6.2.

Case study 6.2: Safer Schools Project, Peru

The Peru Safer Schools Project involved engineers from the Pontifical Catholic University of Peru and the Peruvian National University of Engineering's Japan-Peru Center for Earthquake Engineering Research and Disaster Mitigation. Furthermore, assistance was given by Colombia's Universidad de los Andes. They worked on developing retrofitting solutions to make them safer in case of earthquakes. Leveraging information from regional academic platforms, the project successfully connected with the universities and the Ministry of Education and created a supportive atmosphere for disaster risk management. It is widely acknowledged that local experience is usually a more reliable knowledge source than that offered by a third-party advisor.

Source: UCL and GFDRR (2016) Reviewing the Impact of Capacity Building in GFDRR.
Details available at https://www.gfdrr.org/sites/default/files/publication/evaluation-ucl-reviewing-impact-capacitybuilding-gfdrr-2016.pdf

6.2 Capacity building

The training objectives and goals for successful disaster management and risk reduction in Odisha were extensively developed using a three-stage perspective plan that included short-term, medium-term and long-term objectives. It is proposed that the Department of Energy or an apex training and capacity-building institute for disaster management in the state could coordinate and execute this perspective plan.

The execution of training goals and objectives (see Figure 6.1) will occur in two distinct phases:
Phase 1 - Short-term and medium-term training goals and objectives
Phase 2 - Long-term training goals and objectives

This multi-stage strategy aims to empower a sizeable workforce capable of making a decisive impact on improving the overall resilience of Odisha's power sector. It utilizes a performance-based cascade training methodology, which includes the following core activities:

Formation of a training committee: The committee will include at least one representative from each organization in the Odisha power sector, as well as government stakeholders. This group will be responsible for identifying training needs and formulating goals and objectives.

Development of training modules and evaluation tools: The group will collaborate to develop comprehensive training modules, including training of trainer (ToT) modules and effective evaluation methods. This will entail defining the precise responsibilities that require training and determining the number of individuals to be trained

Identification of master trainers: Each organization must designate at least two master trainers. These trainers will be responsible for conducting ToT sessions, which will allow any organization to have its own group of trainers. Subsequently, these trainers will organize direct training programmes at various levels, including state, district, organizational, executive, non-executive and linemen.

Implementation of training programmes: Training programmes will be implemented with a clear separation of trainer roles to ensure the availability of necessary resources.

Designing evaluation and supervision strategies: To guarantee the effectiveness of the training programmes, an evaluation and supervision approach will be developed, which will include feedback systems and performance ratings.

Figure 6.1 Implementation of training plan

01

Short - Term Goals

< 1 Year Plan

- Preparation of 3 - stage plan.
- Training of Trainer (ToT) modules for policy, management and operation stages.

Medium - Term Goal

02

1-2 Years plan

- Develop at least two master trainers / master resource persons and a group of 10 trainers in each entity for organizing direct training programmes on different aspects of DM and DRR.

03

Long - Term Goal

2-5 Years Plan

- To train government officials, executives and non-executives of DISCOMs, OPTCL, GRIDCO, OHPC and OPGC in different aspects of DRR along different stages of the DM cycle.

Five-year Implementation Plan

6.2.1 Short-term training goals and objectives

The development and piloting of ToT modules are critical for achieving short-term training goals and objectives in the power sector. These modules should address major hazards at three unique levels: policy, management, and operations. These modules should address major hazards such as cyclones, floods, earthquakes, fires, automobile accidents, backup power outages, electrocution and more. Their goal is to provide precise actions to be followed at various stages of disaster management. Content for the ToT module should include, but not be limited to, disaster preparedness and mitigation strategies, restoration and response training, adherence to safety standards, information flowtraining and damage assessment with expense accounting. This organized method strives to provide targeted training content that is adapted to the specific needs and difficulties of the power sector, resulting in a well-prepared and resilient staff.

As an illustration, a sample of ToT module material on recovery and restoration is provided in Box 6.1.

Box 6.1: Recovery and restoration

- **Overview of post-disaster restoration and recovery programmes, policies and process**
  - a) Basic concepts and processes
  - b) Institutional landscape
  - c) Post-disaster restoration and recovery programme framework
- **Restoration plan structure (pre-disaster activity : database build-up)**
  - a) Securing financial assistance for recovery
  - b) Incorporating resilience and "Build Back Better" principles into recovery framework
- **Restoration plan structure (post-disaster activity : formulation of restoration and recovery programme)**
  - a) Post-disaster needs assessment training
  - b) Communications strategy
- **Implementation mechanism**
  - a) Procurement process and modalities
- **Monitoring and evaluation**

6.2.2 Medium-term training goals and objectives

To facilitate the organization of direct training programmes for government officials and middle- and grassroots-level functionaries on different aspects of disaster risk reduction in the power sector, each entity should establish and make accessible at least two master trainers or master resource persons, as well as a group of 10 trainers. The overall purpose of the ToT module and workshop is to develop a group of instructors capable of conducting and directing effective training programmes. The ToT module acts as a guiding resource for master trainers, enabling them to provide training sessions for a variety of groups.

Beyond technical knowledge, the master trainers are encouraged to develop critical skills, such as:

- Guide participants to supplementary materials and reference resources.
- Lead discussions or initiate exercises that boost understanding.
- Listen effectively and be more responsive to the needs of the participants.
- Make observations to understand how adults learn and can participate in improving their practices.

Additionally, the trainers could learn the value of maintaining eye contact, displaying a pleasant attitude, speaking clearly, using proper gesticulation, maintaining attention, and clarifying any confusion.

6.2.3 Long-term training goal and objective

The comprehensive long-term training strategy includes training for government officials, executives, non-executives, and line employees at DISCOM, Odisha Power Transmission Corporation Limited (OPTCL), Grid Corporation of Odisha Limited (GRIDCO), Odisha Hydro Power Corporation Limited (OHPC) and Odisha Power Generation Corporation Limited (OPGC). The training is designed to cover many areas of disaster management and risk reduction at every stage of the disaster management cycle, such as mitigation, preparedness, response and recovery.

6.2.4 Target audience

The training programme is designed to cater to varied responsibilities within the key organizations, including the Odisha State Disaster Management Authority (OSDMA) and the Department of Energy Government of Odisha (OPTCL/DISCOM). Trainees are classified based on their roles in the energy department, including

Policymakers: Additional Secretary, Joint Secretary, Deputy Secretary, Under Secretaries from the Government of Odisha, Section Officers / Assistant Section Officers Managing Director, OSDMA, officers/directors from the Department of Energy, as well as CEOs/ chief managing directors of generating, transmission and distribution companies.

Programme/project managers: Chief general manager (Technical), superintending engineer (Distribution), and assistant manager / deputy manager / manager.

Operational staff: Technical staff, administrative staff, project staff, accounts and clerical staff, executive engineer (Distribution), junior technician/lineman/helper and other frontline employees.

The programme includes the participation of civil society participants, including executive directors and chief executive officers of non-governmental organizations (NGOs), as well as subject matter experts actively involved in disaster management and risk reduction operations. It also targets women, men and children from at-risk neighbourhoods, as well as community-based organizations such as sarpanch and local representatives/voluntary organizations. This inclusive strategy ensures that training reaches all levels of the electricity sector and its linked businesses.

6.3 Training approach

In order to achieve effective learning across diverse situations, hazards and organizational levels, a multifaceted training approach is required. Training methods should cover both theoretical and practical components, focusing on both cognitive understanding and behavioural skills, respectively. This distinction applies to both on-the-job and off-the-job training, forming the two broad categories for comprehensive management development. See Table 6.1.

Table 6.1 Key aspects of capacity development in disaster risk reduction

Key aspects	Brief description	Training approach	Intended audience
Prevention or mitigation for disaster risk reduction	» Knowledge session on climate change and its impact on power utility » Risk assessment and vulnerability study in each area of responsibility » Mainstreaming of disaster risk assessment, mapping and managment into development plans and programmes » Building resilience in electricity infrastructure	» Interactive lecture sessions » Discussions » Online training » Observation and study tour » Workshops, seminars and conferences	» Government officials
	» Public awareness programmes » Promote culture of disaster risk prevention, mitigation and better risk management » Awareness about precautions to be taken and emergency communication details of nodal officers	» Awareness campaign » Pamphlet and booklet » Permanent notice board at all suitable places	» Executives and non-executives » NGOs

Key aspects	Brief description	Training approach	Intended audience
Effective preparedness and response	» Response and recovery » Responsibilities of teams » Black start facilities » Emergency restoration systems » Rescue equipment at all levels	» Mock drill exercises » Promote planning and execution of emergency drills and restoration » Demonstrations » Field assignments	» Executives and non-executives » NGOs
	» Adoption and adaptation of emerging global good practices » Early warnings, maps / satellite data / effective dissemination of information » Systems to provide basic services in emergencies » Media relations	» Peer-to-peer twinning » Case studies » Media communications	» Government and executive officials
Recovery and Build Back Better	» Post-event investigation & analysis and strategy for the future » Damage assessment mechanisms » Planning capabilities to ensure coherence of Build Back Better with overall development efforts and goals » Studies on past disasters and recovery to draw useful lessons	» Training sessions Field assignments » Workshops » Observation and study tours » Brainstorming exercies	» Government and executive officials

Disaster management training can take various forms, such as workshops, seminars and online courses. Combining traditional segments with interactive activities improves the integration of disaster risk assessment and vulnerability studies into power sector growth plans and programmes.

Engaging in peer-to-peer twinning based on emerging global best practices (refer to Section 8) is extremely valuable for learning about new applications, processes and technologies for building resilience in the electricity sector. Observational study trips, mock drills, field assignments, case studies, role-playing, and simulation exercises improve the training experience, especially during the recovery and restoration phase.

Case studies suggest several good practices that can be implemented in Odisha, such as training on design support software and detailed wind-driven analysis and mapping, drills for setting up alternative pylons for quick restoration and having pre-trained technicians and logistics storage facilities ready to deploy during crises.

- **Comprehensive training:** The training programme should focus on equipping personnel with the knowledge and skills required for efficient disaster response. This includes educating them on the design and structural integrity of power transmission infrastructure to withstand extreme weather conditions. Additionally, specialized software and wind-driven analysis should be part of the training, enabling accurate assessment of the potential impact of cyclones and other disasters.

- **Resource stockpiling:** Maintaining a stockpile of critical equipments and materials in a strategic location can expedite restoration efforts. This includes spare parts, cables, and specialized tools required for repairs.

Overall, these practices establish a robust disaster management strategy for Odisha. They enhance the state's resilience in the face of cyclones, ensure the continuity of essential services, and minimize disruptions in power supply and communication systems during a crisis.

6.4 General recommendations

6.4.1 Training programmes for youth / local communities

Implementing disaster preparedness and response training programmes for local communities and university students in the power sector is critical. Collaboration with organizations, universities, and colleges can help create such training possibilities. Under the same concept, the National Disaster Management Authority (NDMA) has been operating a scheme since May 2016 to train community volunteers known as Aapda Mitra in disaster response, Case Study 6.3 discusses the need to develop human resources to implement important reforms in the power sector.

Case study 6.3: Human resource build-up, Republic of Angola

The lack of human professional capacity in managing the power sector has led to the failure to implement important reforms. In Angola, the inadequacy of human resource skills has increased the risks of project delay, lack of synchronization and redundancy in current investments.Thus, in addition to the traditional approach of reorganizing the sector's structure, increasing investments and welcoming foreign players, the country also needs to focus on developing human resources. Angola's Ministry of Energy has partnered with Agostinho Neto University to train specialists in pertinent technical and legal areas.

Source: National energy security strategy and policy, 2015 , available at The National Energy Security Strategy and Policy – Policies - IEA

6.4.2 Targeted workshop / focus group discussions

Conducting focus group discussions to highlight the benefits of rooftop solar power and the shift to a decentralized system will help improve the resilience of energy systems. In order to promote the use of solar energy in Odisha, government efforts can include programmes, policy implementation, and incentivized approaches. Refer to Case Study 6.4.

Case study 6.4: Capacity building in solar energy solutions

Ethiopian-Dutch joint venture company Solar Man sells 'adequate and sustainable solar energy technological solutions'. The company provides public awareness about solar energy and offers training for individuals with a technical background in electricity. In addition, it offers business development ideas for trainees throughout the country using its centres. Trainees are able to assemble solar energy equipment, including solar batteries, regulators, lamps and DC power system with inverters used for church and mosque amplifiers.

Source: The Ethiopian Herald (2012). Solar energy for households. The Ethiopian Herald, 20 October 2012.

6.4.3 Techno-legal training

These specialist trainings cover a variety of topics, including the following:

- Installation of underground cabling system, ring main units, compact secondary substation, gas-insulated substation and fault passage indicators in urban areas.
- Supervisory control and data acquisition (SCADA) systems extended to all 33/11 kV substations.
- Develop smart grid technology in urban areas.

- Geospatial asset mapping.

- Use of unmanned aerial vehicles / drones for monitoring vegetation growth on both sides of the line and restoration work.

6.5 Planning and management of capacity-building activity

Documentation often overlooks and neglects planning and managing capacity-building activities. Successfully defining capacity-development goals is strongly dependent on good documentation, a clear implementation strategy, and effective monitoring and assessment. For this, the following needs to be done:

- The project manager should collaborate with local stakeholders to develop a comprehensive plan for capacity-building initiatives. This strategy will provide a defined framework for implementing training activities.

- Effective progress tracking requires a solid implementation, monitoring, and evaluation plan. Conducting timely reviews of training activities and selecting appropriate indicators for ongoing monitoring will ensure that the progress aligns with objectives and forms a solid foundation for assessment.

- Developing and maintaining manuals and e-learning modules is vital. Establishing an institutional repository will help preserve information and resources for future use.

- Continuous learning requires support from a knowledge manager or knowledge management organization to monitor and integrate observations into training. This support mechanism facilitates achieving defined goals through effective learning and adaptability.

Case study 6.5: PDNA training, The Philippines

The consultant for the Philippines PDNA training selected local knowledge managers from a group of workshop participants. The goal was for these people to eventually work as PDNA trainers. Their secondary responsibility was to keep track of their peers' progress and report back to the implementing consultant. Because of this, the consultant was able to tailor capacity-building activities to the requirements of the participants while the project was being implemented, leading to more efficient and locally-owned disaster risk management capabilities.

Source: UCL and GFDRR (2016).Reviewing the Impact of Capacity Building in GFDRR.
Details available at https://www.gfdrr.org/sites/default/files/publication/
evalution-ucl-reviewing-impact-capacitybuilding- gfdrr-2016.pdf

6.6 Monitoring and evaluation

Establishing a systematic monitoring and evaluation framework is critical for assessing the effectiveness of interventions and goals. This framework not only ensures the efficacy of present actions but also serves as a road map for future changes and initiatives. Regular, systematic monitoring of training and capacity-building outcomes is essential for adapting programmes to changing demands. Evaluations are critical for verifying the underlying ideas and assumptions of capacity-building initiatives, recordingoutcomes and drawing lessons for continual improvement. Refer to Box 6.2.

Box 6.2. Ten steps to build a results-based monitoring and evaluation system

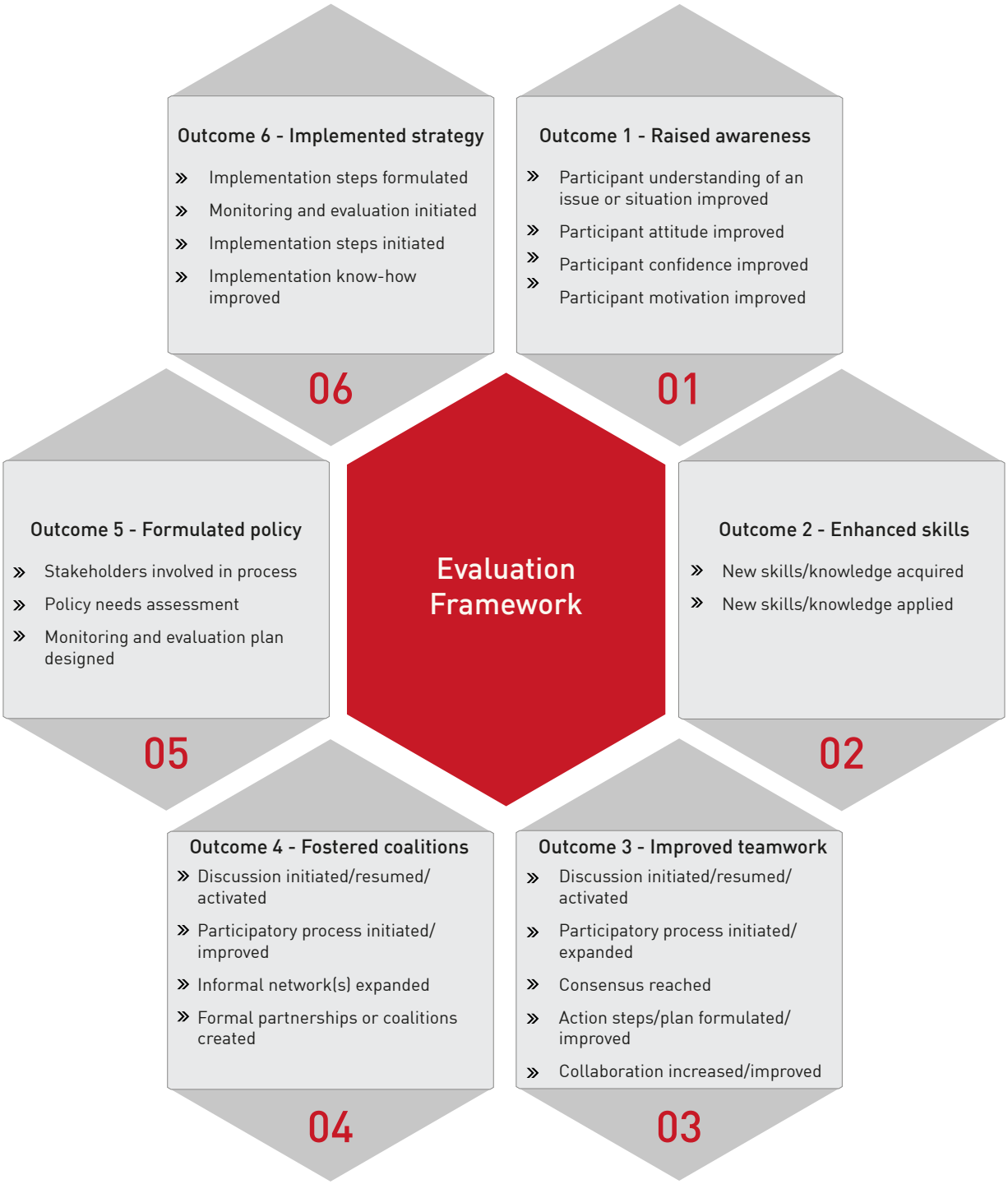
1. Conduct a readiness assessment of participants
2. Agree on performance outcomes to monitor and evaluate
3. Select key indicators
4. Gather baseline data
5. Set realistic interim targets
6. Build a monitoring system
7. Use evaluation information
8. Report findings
9. Use findings
10. Sustain the monitoring and evaluation system within the organization

Source: Davis (2014)

Framework implementation: The methods provided here create a thorough monitoring and evaluation system that can be smoothly integrated into each training session and maintained throughout the organization. This framework is customizable, allowing for the development of customized strategies for training programmes. The method includes post-assessment performance indicator development and participant consultation.

Balanced evaluation methodologies: For effective monitoring and evaluation, it is important to balance self-assessment and external assessment approaches. This combination offers both subjective and objective assessments of programme effectiveness. Figure 6.2 illustrates a framework for assessing the impact of capacity building, including learning outcomes and objectives. These indicators can guide project and task managers and be customized to meet task-specific needs.

Figure 6.2 Framework for evaluating the impact of capacity development



A few evaluation methodologies are listed as follows:

» **Feedback mechanism:** Each trainee completes a structured questionnaire to assess their understanding of the course material.

» **On-course quiz:** Quizzes are conducted for groups of students, with points awarded for correct answers to encourage participation and healthy competition.

- **Web-based application:** This publicly accessible platform facilitates tracking of completed and pending training activities and serves as a repository for training videos and publications.

- **Informal discussion:** Learners form groups and engage in discussions, recording essential learning topics on flip charts. This interactive strategy boosts interest while reinforcing training principles.

These assessment approaches drive the evaluation process, enabling a targeted approach to meeting participant requirements and implementing meaningful changes.

7 Conclusion and Way Forward

7 Conclusion and Way Forward

This report aims to enhance the preparedness of state authorities to build institutional capacity and knowledge management. It is based on the understanding that resilient measures must be monitored and evaluated to better respond to the changing patterns of hazards and the vulnerabilities thereof. By taking a participatory approach to disaster management, we can ensure that resilient measures are widely known and understood by all those involved, including disaster management officials, power sector officials and the general public. This approach also helps us understand the level of preparedness and potential for mitigation. It involves maintaining a complete inventory of resources available for response and recovery, as well as analyzing any gaps or overlaps in preparedness arrangements.

Therefore, the focus of this report is to develop a systematic approach comprising a three-stage perspective plan for capacity development in the Odisha power sector. This includes the following:

- **Separation of policies and modules:** This stage involves the initial separation of policies and training modules. It involves clearly distinguishing overarching policies from practical training materials. Policies provide guidelines and principles, while modules contain instructional content for training.

- **Training progression:** The plan involves training trainers in disaster management and risk reduction, equipping them with the necessary knowledge and skills needed to become master trainers. These master trainers are highly proficient and capable of delivering effective training to others.

- **Training execution:** The final stage focuses on implementing the training programmes, which are executed by a master trainer, targeting government officials, executives from different agencies of the state, and relevant stakeholders.

With this multi-stage plan, Odisha can address most of its capacity-building gaps. The proposed idea is to develop a training module that focuses on mainstreaming disaster preparedness, response, and reconstruction into development plans, and building resilience in the electricity infrastructure. Practical training methods, including physical training such as mock drills, field assignments, case studies, role play, simulation exercises, and workshop and classroom training sessions, can help in creating a skilled workforce to handle disastrous events. Odisha can also implement learnings from the case studies of France, Hong Kong, and the Philippines.

Annexures

Annexure 1

Case study 8.1: Access to Sustainable Energy Programme: Strengthening climate resilience of electric cooperatives (The Philippines)

The Access to Sustainable Energy Programme (ASEP) is a joint project between the European Union and the Philippine Department of Energy. The World Bank administers the ASEP investment support component, which is designed to improve the capacity of electric cooperatives to execute the rural electrification goal and promote renewable energy-based energy infrastructure.The technical assistance aimed to strengthen the network's ability to withstand typhoons by training electric cooperatives, technical staff to use design support software. This software enables them to model, analyze, and design various training and development support structures, whether for new projects, upgrades, retrofits, or adding ancillary equipment to existing lines. This training included instruction on Power Line Systems software, the world's most popular overhead line design application.

The presentation focused on technical assistance provided on (i) detailed wind data-driven analysis & mapping and (ii) capacity building for design support software. The wind analysis and mapping do the following:

- Provides a basic understanding of how high wind risk areas can be identified and integrated into distribution network planning.
- Allows for comparison against older engineering standards (e.g., a national or zonal standard).
- Helps inform decisions on whether measures to manage such risks are necessary, for example, through undergrounding of lines, strengthening of poles, and building redundancy in the network design to have alternative paths for supplying critical loads.
- Helps inform decisions on the necessity of softer measures, such as using better warning systems in the distribution-level SCADA and vegetation management, taking into consideration the timing of high wind risk events.

Case study 8.2: Super-typhoon drills to build emergency power restoration, Hong Kong

CLP Power Hong Kong Limited (CLP Power) is a utility subsidiary based in Hong Kong. It is wholly owned by CLP Holdings Limited and operates a vertically integrated electricity supply business in Hong Kong. The company provides highly reliable supply of electricity to 5.8 million people.

CLP Power Hong Kong conducts regular typhoon emergency drills, particularly ahead of Hong Kong's typhoon season. The drill simulated the collapse of a transmission tower during a typhoon and the construction of a temporary pylon to restore power, a process that would see electricity restored ten times faster than by repairing the damaged pylon.

In 2019, the CLP team recruited volunteers to support caring visits to customers affected by a super typhoon. They provided relevant training to the enrolled volunteers. The team also cooperated with the Social Welfare Department and NGOs to conduct caring visits to residents of the squatter area in Kwun Tong before a super typhoon, aiming to enhance their awareness and preparedness towards hazards.

CLP Power has introduced an emergency restoration system for the rapid construction of temporary pylons. Additionally, CLP has implemented several other measures to counter the potential impact of supertyphoons. These measures include installing smart switchgear on 11 kV and low-voltage overhead lines that supply electricity directly to 160,000 customers, installing flood alert systems in substations, and creating a typhoon response protocol and coordinating system.

Case study 8.3: Electricity Rapid Intervention Force, France

During the winter storms of 1999, Électricité de France faced significant damage to its network, which took almost two weeks to repair and reconnect the 2.2 million affected consumers. To prevent such prolonged outages in the future, authorities required the distributor to 'guarantee the delivery of electricity to at least 90 percent of consumers within five days after the incident, including in the case of an unusual weather event of similar magnitude to that of December 1999'.

In order to mitigate this challenge, the distribution network manager Enedis established the Electricity Rapid Intervention Force (Force d'Intervention Rapide d'Electricité, FIRE). This initiative allows resources and staff to be redeployed nationwide in order to quickly restore power. FIRE is one of the Électricité de France group's key measures to respond to extreme weather risks. Currently, FIRE has 2500 technicians who are trained for crises, along with 11 logistics storage facilities across the country, which enable the deployment of 2000 generators. Independent teams are organized according to their expertise and are immediately dispatched to affected areas when they are needed.

In the island regions, 95 percent of the new networks are built underground. Extreme weather events - Joaquim in December 2011 and Kirk in December 2013-have shown the value of this system. The average annual time without electricity per customer decreased from 119 minutes in 2010 to 73 minutes in 2011.

References

» Central Electricity Authority (2010).
Measures Relating to Safety and Electric Supply Regulations. New Delhi: CEA.

» Davis, Ian (2014).
Disaster Risk Management in East Asia and the Pacific. New York: Routledge

» Department of Energy (2019).
Disaster Management Plan for OPTCL. Bhubaneshwar: Government of Odisha

» Government of India (2005).
Disaster Management Act, The Gazette of India, Government of India, New Delhi.
Details available at https://ndma.gov.in/Reference_Material/DMAct2005

» Government of Odisha (2017).
State Disaster Management Plan
June- 2017: Odisha State Disaster
Management Authority (OSDMA) - Government of Odisha

» Government of Odisha (2018).
Departmental Disaster Management Plan of Energy Department 2018.
Bhubaneshwar: Government of Odisha

» Kusumastuti, R. D., Arviansyah, A., Nurmala, N., and Wibowo, S. S. (2021).
Knowledge management and natural disaster preparedness: A systematic literature review and a case
study of East Lombok, Indonesia. International Journal of Disaster Risk Reduction 58: 102223.

» National Disaster Management Authority (2009).
National Policy On Disaster Management.
Details available at https://nidm.gov.in/PDF/policies/ndm_policy2009.pdf

References

» Seneviratne, K., Baldry, D., and Pathirage, C. (2010).
Disaster knowledge factors in managing disasters successfully. International Journal of Strategic
Property Management 14(4): 376-390.

» Tata Power (2017).
Disaster Management & Business Continuity Plan. Details available at
https://www.tatapower.com/pdf/businesses/transmission-disaster-management-plan-version2.1.pdf

» UNDRR Terminology (2023)
Capacity. Details available at https://www.undrr.org/terminology/ capacity

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