GRIDCO
Empowering Odisha

CDRI
Coalition for Disaster Resilient Infrastructure

Risk-Informed Governance and Policy Development

Component II, Task III

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

ADB	Asian Development Bank
CCS	Cabinet Committee on Security
CDR	Climate and Disaster Risk
CEA	Central Energy Authority
CESU	Central Electricity Supply Utility
CGM(O&M)	Chief General Manager (Operation and Maintenance)
CMD	Chief Managing Director
CoR	Commissioner of Relief
CPSU	Central Public Sector Undertaking
CWC	Central Water Commission
DG Sets	Diesel Generator Sets
DISCOMs	Distribution Companies
DLNA	Damage, Loss and Needs Assessment
DM	Disaster Management
DMC	Disaster Management Cell
DoE	Department of Energy (Odisha Government)
DoF	Department of Finance (Odisha Government)
EBRD	European Bank for Reconstruction and Development
ED	Executive Director
EHT	Extra High Tension
EOC	Emergency Operations Centre
EWDS	Early Warning Dissemination System
GACC	Global Agreement on Climate Change
GRIDCO	Grid Corporation of Odisha
HRVCA	Hazard Risk Vulnerability and Capacity Assessment
IMD	India Meteorological Department
INCOIS	Indian National Centre for Ocean Information Services
IPCC	Intergovernmental Panel on Climate Change
JICA	Japan International Corporation Agency
MD	Managing Director
MDB	Multilateral Development Banks
MNRE	Ministry of New and Renewable Energy
MoP	Ministry of Power

Abbreviations

MPCS	Multi-Purpose Cyclone Shelter
NDMA	National Disaster Management Authority
NDMF	National Disaster Mitigation Fund
NHPC	National Hydro Power Corporation Ltd
NIDM	National Institute of Disaster Management
NLDC	National Load Despatch Centre
NTPC	National Thermal Power Corporation Ltd
OERC	Odisha Electricity Regulatory Commission
OHPC	Odisha Hydro Power Corporation
OPGC	Odisha Power Generation Company
OPGW	Optical Ground Wire
OPTCL	Odisha Power Transmission Corporation Ltd
OSDMA	Odisha State Disaster Management Authority
PDNA	Post-Disaster Needs Assessment
PFC	Power Finance Corporation
PGCIL	Power Grid Corporation of India Ltd
POSOCO	Power System Operation Corporation Limited
PRI	Panchayati Raj Institutions
RC	Relief Commissioner
RDNA	Rapid Damage Needs Assessment
REC	Rural Electrification Corporation
SDG	Sustainable Development Goals
SDMA	State Disaster Management Authority
SDMF	State Disaster Mitigation Fund
SFDRR	Sendai Framework for Disaster Risk Reduction
SLDC	State Load Despatch Centre
SRC	Special Relief Commissioner
ToT	Training of Trainers
TPCODL	Tata Power Central Odisha Distribution Limited
TPNODL	Tata Power North Odisha Distribution Limited
TPSODL	Tata Power South Odisha Distribution Limited
ULB	Urban Local Bodies
WB	World Bank

Executive Summary

The increasing demand for power supply coupled with the effects of climate change has severely impacted Odisha's power infrastructure, leading to power outages, changes in transfer capacity and physical damage. For instance, the Disaster Management Plan of the Department of Energy in Odisha highlights the critical risks faced by the state's power infrastructure, particularly from cyclones and floods. These disasters often cause significant damage to transmission lines, grid substations, transformers and towers.

Interlinkages between Governance and Financial Mechanisms

This report emphasizes an integrated governance approach across all aspects of disaster events, from disaster preparation to recovery, to build and strengthen resilience in Odisha, thereby offering a comprehensive perspective on vulnerabilities, institutional frameworks, global good practices and financial considerations specific to the state.

Aiming to establish an all-encompassing governance framework to safeguard critical infrastructure, the report also maps out the involvement of stakeholders at both state and central levels in disaster preparedness efforts, detailing the responsible nodal heads and agencies and their corresponding actions during emergencies.

Institutional Landscape for Disaster Management

The report outlines central and state governments' roles, responsibilities and institutional frameworks in managing disaster events while delving into India's financial landscape and alternative funds for enhancing recovery and adaptation efforts. Emphasizing the significance of hazard risk vulnerability capacity assessment (HRVCA), the report underscores the need to analyze past disasters and losses to inform preparedness, response and recovery strategies. It advocates for systematically evaluating potential disaster damages through hazard vulnerability assessments.

The report also suggests that vulnerability assessments can optimize pre-disaster planning and resource mobilization, prioritizing critical infrastructure locations based on asset value. HRVCA aims to identify vulnerabilities and quantify associated risks, aiding decision-makers in bolstering capacity, particularly in disaster-prone regions.

In response to emergencies such as cyclones and floods, the report highlights establishing an institutional mechanism for coordinating and disseminating warnings and alerts. This mechanism operates from the central level, led by the IMD in collaboration with the Ministry of Home Affairs, and extends to affect state governments and districts. Furthermore, the report advocates for enhanced coordination among all stakeholders to adopt a comprehensive approach to disaster management, integrating resilience with disaster risk reduction and climate change response efforts.

Roles and Responsibilities for Major Stakeholders

The report further highlights the coordination of various national and state stakeholders to activate roles and responsibilities at the onset of disasters and map the associated vulnerabilities. Structural measures are bound to be strengthened by choosing different strategies and guidelines to enhance capacity building and training of the various stakeholders involved.

The document reflects the primary responsibility of state and central government to undertake preparedness, response and reconstruction measures during a disaster, which further supplements the efforts through logistic and financial support.

It focuses on enhancing preparedness and mitigatory activities immediately after receiving an early warning or anticipating an impending disaster. The report has laid out an effective management framework among organizations like ministries, National Load Despatch Centre, RLDC, State Load Despatch Centre and state departments of Odisha for better managing things during a disaster event.

The report highlights the different roles and responsibilities carried out by stakeholders at the national and state levels, along with the concerned lines in the department. The Energy Department of Odisha has various stakeholders such as Odisha Hydro Power Corporation (OHPC), Odisha Power Generation Corporation (OPGC), Odisha Power Transmission Corporation Limited (OPTCL) and state DISCOMs such as Tata Power Northern Odisha Distribution Limited (TPNODL), Tata Power Southern Odisha Distribution Limited (TPSODL), Tata Power Western Odisha Distribution Limited (TPWODL) and Tata Power Central Odisha Distribution Limited (TPCODL). They form essential risk data sources and aid disaster response, preparedness and capacity building.

Policy and Regulatory Landscape

The report further depicts the institutional mechanism, the roles and responsibilities of various departments and stakeholders, and the activation of multiple departments and stakeholders in the event of cyclones and floods. The report follows the Disaster Management Act, 2005; Disaster Management Plan for Power Sector, 2021; State Disaster Management Plan of Odisha 2021-22; Departmental Disaster Management Plan, Department of Energy, 2018; and Guidelines issued by the National Disaster Management Authority (NDMA) and National Institute of Disaster Management (NIDM). The section describes the administration operationalization of ministries, central departments, state departments and district administrations. The role of NDMA and NIDM in response and capacity building, respectively, occurs at the national level. However, the actions are carried out and supported by central agencies for fund mobilizations and logistic deployment on request after providing an assessment report. A four-tier structure has been implemented to manage disasters and adequately activate the power sector.

The report outlines a financial overview of the power sector. It includes the various financial mechanisms mentioned under the Disaster Management Act, 2005 (National Disaster Response Fund or NDRF and State Disaster Response Fund or SDRF) and the 15th Financial Commission under which fund quantum and mobilization occurs. Under the Disaster Management Act of 2005, a financial mechanism has also been set up through the NDRF at the national level and the SDRF at the state level to meet the rescue and relief expenditure during any notified disaster.

To make the power sector in India disaster resilient, achieve substantial disaster risk reduction and significantly decrease the loss, it is crucial to maximize coping capacity towards disasters at all administration and field levels. The report highlights the activation of central departments upon receiving early warnings from departments like IMD/CWC and further reflects the early warning dissemination to the last mile. The document reflects upon the pathway to issue instructions to all the line departments and aid state authorities (Department of Energy, DISCOMs, GRIDCO, OSDMA/SDMA).

Best Practices: A Global Approach Towards Resilience Mechanism

The report indicates the best practices and global case studies, giving insight into long-term betterment recovery and reconstruction. It highlights the different recovery measures of short-term, mid-term and long-term efforts, emphasizing the transition from immediate relief and recovery to backup resources to revitalize the power sector operation quickly.

A holistic approach to post-disaster needs assessment and methodology has been proposed to establish clear institutional responsibilities for recovery actions. This approach requires continual monitoring, mapping and partnerships at various levels. The report emphasizes the importance of incorporating the recovery process into the overall development strategy. We have also identified different ways and potential stakeholders that can enhance capacity building for both structural and non-structural measures. Additionally, it highlights the necessity of integrating the principles of 'Build Back Better' to improve resilience, particularly in the power sector of Odisha.

Fund Mobilization and Disaster Response Activities

The report emphasizes the importance of sectoral assessments, which evaluate the social and financial impacts of catastrophic events. It identifies existing gaps and outlines strategies for 'Building Back Better' and 'Making It Right' decisions about the allocation of financial resources and technical expertise.

The report outlines several interventions, including conducting baseline diagnostic exercises, preparing inventories and integrating climate adaptations into risk management strategies. While the recommended actions are conservative due to the limited data available, both short-term and long-term recommendations are provided. It emphasizes the importance of clearly defining roles and responsibilities from the apex body at the central level down to the state level, specifying the actions that should be taken for effective disaster management.

Disaster management necessitates a comprehensive approach that addresses both the response phase and the implementation of optimal preparedness and resilience measures. Ultimately, the report aims to develop proactive actions for disaster preparedness, mitigation, response and recovery within the power sector, ensuring coordination among all relevant stakeholders.

1 Introduction

1 Introduction

Odisha faces catastrophic events twice yearly: during the pre-monsoon and the retreating monsoon. The post-monsoon (October–December) season faces more severe cyclones than the pre-monsoon (March–May) season. Cyclones are caused by atmospheric disturbances around a low-pressure area distinguished by swift and often destructive air circulation. Cyclonic winds usually rotate towards the west, northwest and north, some re-curving towards the northeast after initial north-westward movement. Though considered much weaker in intensity and smaller in magnitude compared to the cyclones of other regions, post-monsoon cyclones, which cross over the east coast of India or Bangladesh, are highly devastating (Sarkhel et al. 2019).

Tropical cyclones, having the initial genesis in the Bay of Bengal, travel in the northwest direction and upward, owing to the shape of the Indian landmass and the nature of the storms' anticlockwise spin. **While the other Indian states along the eastern coast prevent deflection of winds owing to plain-land topography, Odisha, with its curved coastline and shore, becomes an easy target for most incoming storms.** The coastal landfall of the state is directly exposed to the Bay of Bengal, making it more vulnerable to catastrophic events like cyclones and floods. Odisha has faced many disasters recently, making its **infrastructure critically prone to damage and loss.** Despite the significant increase in capacity building and decrease in lives lost in the last few years, the power sector continues to suffer heavy damages due to these catastrophic events. Therefore, a paradigm shift from relief and recovery response to an integrated response must be opted to mitigate the loss and damages incurred by the state.

Most districts in Odisha are vulnerable to **cyclones and floods**, increasing the urgency towards building a resilient mechanism to reduce damages and adversities. Table 1.1 outlines the impact of recent cyclones on the power infrastructure across the region.

Table 1.1 Damage to the Power Sector by Cyclone (1999-2020)

Year	Name of Cyclone	Total Districts Affected	Damage to the Power sector (in INR crores)
1999	Super Cyclone	14	INR 400.00 Crore
2013	Phailin	19	INR 1,048.14 Crore
2014	Hudhud	11	INR 66.00 Crore
2018	Titli	17	INR 133.03 Crore
2019	Fani	9	INR 8,139.00 Crore
2020	Amphan	10	INR 320.00 Crore

Source: Memorandum Phailin (2013), Hudhud (2014), Titli (2018) and Fani (2019)

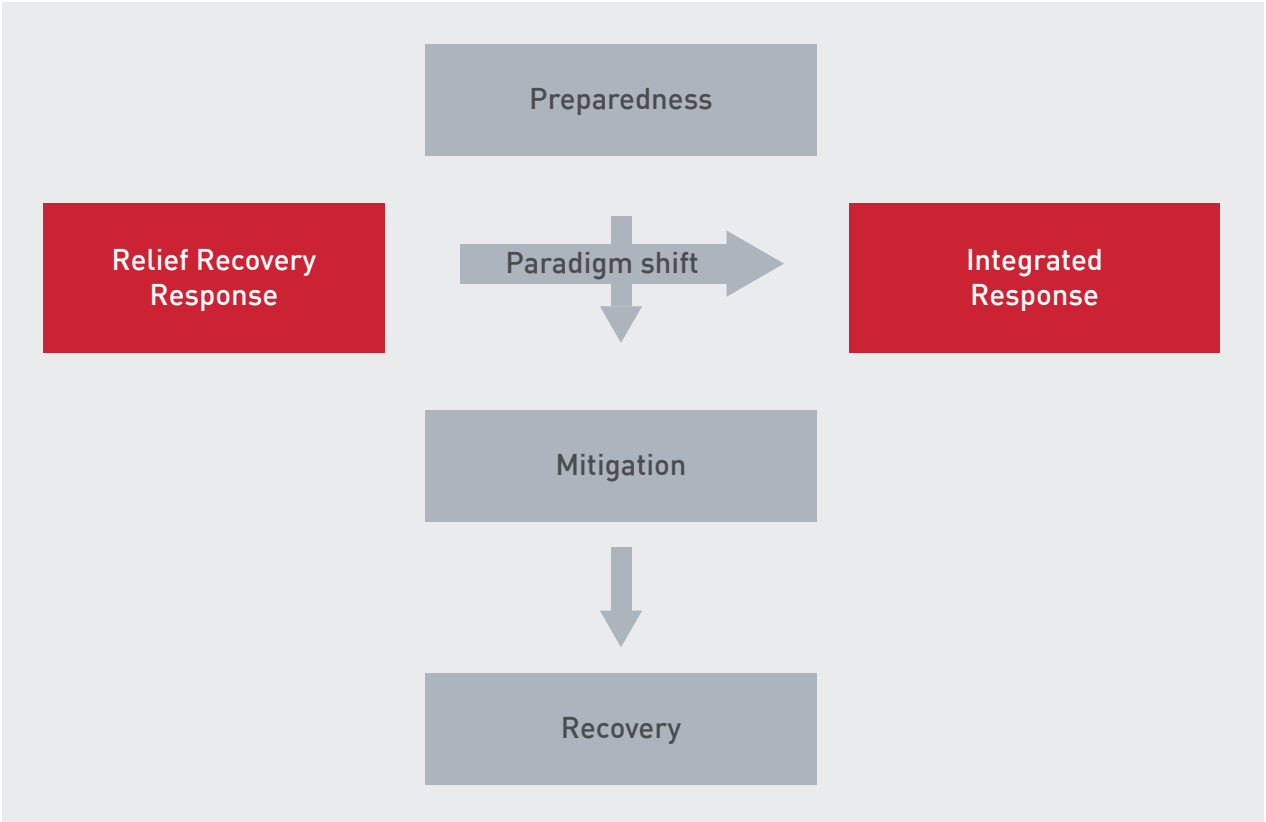
1.1 Adapting to Climate Change-Induced Risks

With the rising intensity of cyclones in Odisha, the nature of the hazard is also constantly fluctuating. Hence, the state needs an adaptive policy and framework that fosters a sustainable, systematic and resilient infrastructure capable of withstanding cascading risks and complexity.

To increase resilience in power infrastructure, it is essential to integrate governance into disaster risk reduction (DRR) efforts. This integration will enable national and administrative authorities to collaborate systematically, fostering an environment where resilience is actively promoted. A holistic approach would lead to further improvement in governance, incorporating proper mechanisms and timely actions and integrating all stakeholders across sectors.

To enhance resilience in power infrastructure, a paradigm shift must be implemented from a 'relief-recovery response' approach to an 'integrated response' approach. This approach involves managing disasters in all phases, i.e., preparedness, mitigation and recovery (Figure 1.1). By adopting this integrated response approach, the power sector can enhance its resilience by reacting to disasters when they occur while also proactively preparing them to reduce vulnerabilities of the components and shorten recovery time.

Figure 1.1 A paradigm shift towards integrated response



Source: KPMG Internal Analysis

1.2 Enhanced Stakeholder Engagements

The implementation of this initiative requires the active involvement and catalysing actions of a wide range of stakeholders at all levels (Ministry of Power, Ministry of Home Affairs, Ministry of New and Renewable Energy, Central Energy Authority, National Disaster Management Authority, National Institute of Disaster Management, Department of Energy, Department of Finance, Odisha Power Transmission Corporation Limited, Distribution Companies, Odisha State Disaster Management Authority, State Disaster Management Authority and Grid Corporation of Odisha). Incorporating governance and disaster mitigation practices into all development plans and processes is essential for enhancing the resilience and interdependency of organizational strategies. Effective integration can be achieved by managing different risks and vulnerabilities affecting power infrastructure, hazard zonation and assessment, strengthening structural measures and investing in capacity building.

1.3 Innovative Governance Mechanisms

The same can be achieved by adhering to effective governance mechanisms. A comprehensive approach involves strengthening physical infrastructure to withstand potential hazards. Implementing resilience should ensure better outcomes, supported by robust governance across all disruption phases. It is necessary to integrate disaster management planning in all developmental plans, which entails identifying potential risks and outlining mitigation strategies. Capacity building is essential to empowering communities and systems to cope with and recover from disruptions. The recovery should be an amalgamation of short-term, mid-term and long-term efforts highlighting the transition from immediate relief and backup of resources to revitalizing the sector's operation to restoring services disrupted.

2 Institutional Landscape for Disaster Management

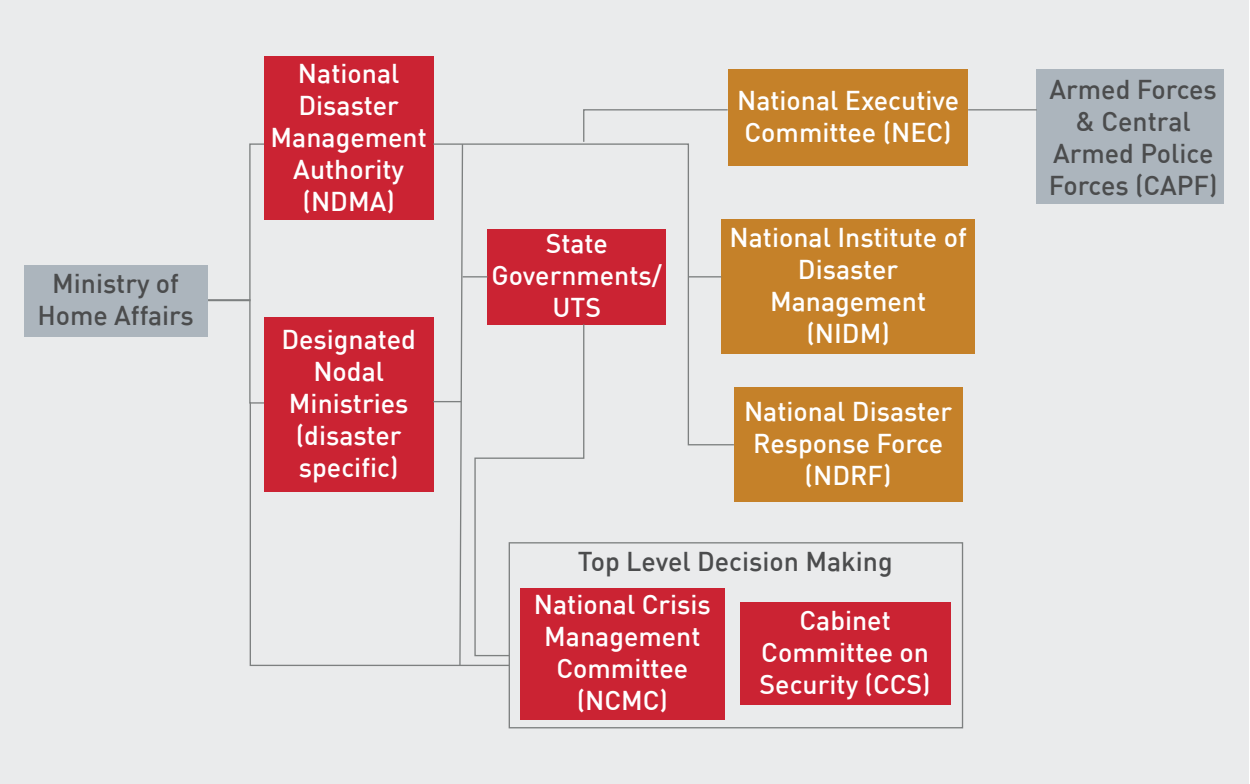
2 Institutional Landscape for Disaster Management

Component II addressed risk identification and its estimation, codes, standards, design and regulation, with technology and innovation to improve disaster resilience in Odisha's power infrastructure. However, it did not focus on the institutional mechanisms in disaster management that form the backbone of coordinated, effective and structured disaster responses. It is important to understand that these mechanisms are vital for prevention preparedness, response and recovery activities, all of which collectively contribute to minimizing losses and promoting resilience across power systems and other infrastructure. Adopting a participatory approach in disaster management ensures that the resilient measures are widely known and understood by all those involved, including disaster management officials, power sector officials and the state's general public.

2.1 Institutional Landscape at the National Level

Effective institutional governance is required for better management and response to disasters. Well-organized dissemination of roles and responsibilities, starting from the apex body at the national level to the ground level (state level), sets the groundwork for the course of action to be taken for proper disaster management. Figure 2.1 presents the coordination, decision-making and actions undertaken by different authorities for disaster management.

Figure 2.1 National-level Disaster Management Institutional Framework



Source: CEA (2021)

2.1.1 National-level Organizations

National and state disaster management authorities: As per the Disaster Management Act of 2005, a multitiered institutional system was set up consisting of the National Disaster Management Authority (NDMA) (headed by the Prime Minister), the State Disaster Management Authority (SDMA) (headed by the state Chief Minister) and the District Disaster Management Authorities (headed by District Collectors and cochaired by the chairpersons of the local bodies).

Role of Ministry of Home Affairs and other stakeholders: From the moment a potential disaster is detected to the onset of one, the Ministry of Home Affairs (MHA) is the apex body that coordinates all disaster management-related actions. The National Crisis Management Committee (NCMC), in coordination with the Cabinet Committee on Security (CCS), is responsible for high-priority decisions along with MHA. The NDMA and MHA coordinate, enforce and implement various policies, actions and guidelines. The involvement of different line departments/nodal agencies hinges on the nature, scale and severity of each disaster.

Inter-organizational mechanisms (including NDMA and MHA): NDMA and MHA coordinate with the SDMA to disseminate response measures properly. The National Institute of Disaster Management (NIDM) provides aid by building an information base and capacity building. At the same time, the National Executive Committee (NEC) ensures the assistance required by the state government to discharge its function. Coordinating this committee with the National Disaster Response Force (NDRF) ensures specialized response during disaster, supplemented by extended support of the Central Armed Police Forces (CAPF). For a detailed overview of the roles and responsibilities of various national bodies, refer to Table 2.1.

Table 2.1 Roles and Responsibilities of Institutional Bodies at National Level

Institutional Body	Composition	Roles and Responsibilities
Ministry of Home Affairs (MHA)	Disaster Management Division	Disseminates multifarious responsibilities for preparedness, response, mitigation and capacity building to concerned lining departments.
National Disaster Management Authority (NDMA)	Prime Minister (Chairperson)	Co-ordinates and implements the concerned guidelines and policies and procures required resources.
	Members (not exceeding nine, nominated by chairperson)	
National Institute of Disaster Management (NIDM)	Union Home Minister, NDMA Vice Chairman, etc.	Collaborates with NDMA to develop capacity building and creates a database.
	Members include secretaries of various nodal ministries and departments of the Government of India and state heads of national-level scientific research and technical organizations and scholars	

Source: CEA (2021)

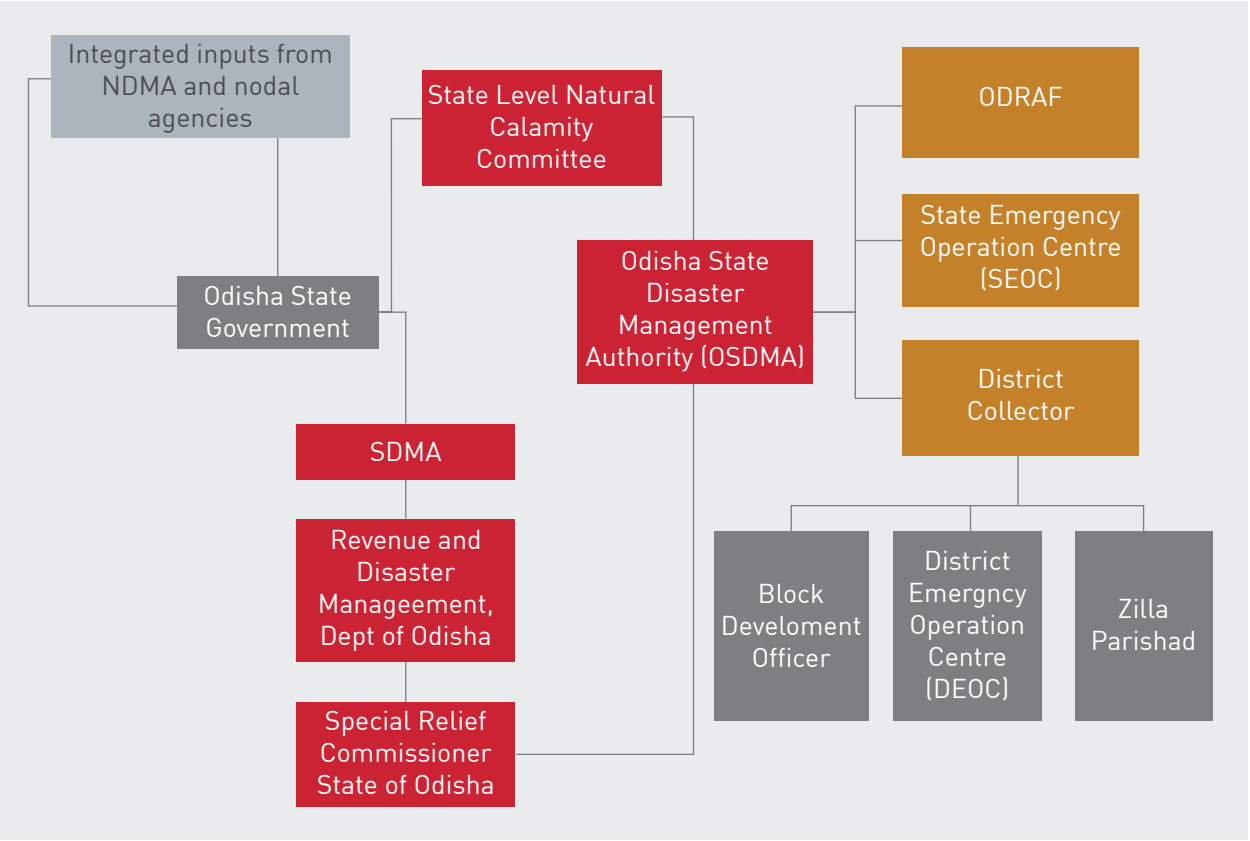
Institutional Body	Composition	Roles and Responsibilities
National Executive Committee (NEC)	Union Home Secretary (Chairperson) Secretaries to the GOI in the concerned ministries/ departments	The executive committee of NDMA supervises the discharge and implementation of guidelines to ensure compliance with actions taken according to the guidelines laid down.
National Disaster Response Force (NDRF)	Headed by a Director General	Specialized in disseminating operations such as response, search and rescue.
Cabinet Committee on Security (CCS)	Prime Minister, Minister of Defence, Minister of Finance, Minister of Home Affairs and Minister of External Affairs	Overlooks national security and well-being
National Crisis Management Committee (NCMC)	Cabinet Secretary (Chairperson) Secretaries of ministries/ departments and agencies with specific disaster responsibilities	Oversees the command, control and coordination at the time of disaster.
Central Armed Police Force (CAPF)*	Director General/Designated Nodal Officer	Trains workforce to carry out rescue and relief operations. (*CAPF includes Assam Rifles, BSF, CRPF, CISF, ITBP and SSB).

Source: CEA (2021)

2.2 Institutional Landscape at the State Level

Depending upon the type of disaster, state-level implementations of plans, guidelines and policies established by the national institutional bodies are crucial for better disaster management. The state-level organizations coordinate with different stakeholders and play a pivotal role in disaster management by offering a structured, coordinated response that focuses on preparedness, response and recovery. Figure 2.2 gives an overview of the disaster management institutions at the state level in Odisha.

Figure 2.2 Institutional Mechanism for Disaster Management in Odisha



Source: CEA (2021)

2.2.1 Role of State Disaster Management Authority

At the state level, the SDMA promotes an integrated approach to preparedness for relief and recovery, ensuring proper disaster management with all the stakeholders involved. Further, in partnership with the Revenue Department, Relief Commissioner and State Executive Committee (SEC), SDMA sets clear roles and responsibilities at the onset of a disaster. Additionally, in incoordination with the line department, it implements and activates the necessary response forces and resources (Table 2.2).

A unique feature of Odisha's approach to disaster management is establishing an additional state-level body to support disaster management operations, apart from the SDMA mandated by the Disaster Management Act, 2005. This additional body, Odisha State Disaster Mitigation Authority (OSDMA), was established by the Government of Odisha as an autonomous organization after the Super-cyclone in 1999. OSDMA is mandated to plan and implement disaster risk mitigation activities and other post-disaster activities such as relief, restoration and reconstruction. Accordingly, OSDMA coordinates with the line departments involved in reconstruction, as well as bilateral and multi-lateral aid agencies, to seek financing, technical assistance and national- and state-level non-governmental organizations to support implementation.

During a disaster, key stakeholders, such as the Ministry of Power, the Central Electricity Authority (CEA) at the national level and the power department at the state level, are actively engaged in coordinating their efforts. The State Emergency Operation Centre (SEOC) plays a central role in coordinating all disaster response efforts, working closely with various response forces. A similar chain of command is established at the district level also to protect districts from further adverse impacts of disasters.

Table 2.2 Roles and Responsibilities of Institutional Bodies (State Level)

Institutional Body	Composition	Roles and Responsibilities
Odisha State Government	State government officials	Assists OSDMA and SDMA in the implementation of proper measures for disaster management.
Odisha State Disaster Management Authority (OSDMA)	Chief Secretary – Chairman	Involved in taking up mitigation, relief, restoration and reconstruction activities. Also involved in coordinating with line departments and bilateral and multilateral agencies.
	Secretaries of line departments	
	Special Relief Commissioner	
State Disaster Management Authority (SDMA)	Chief Minister – Chairperson	The executive committee of SDMA supervises the discharge and implementation of guidelines. Further, it ensures compliance according to the guidelines laid down.
	Members (not exceeding 8, nominated by chairperson)	

Source: SDMP-Odisha (2019)

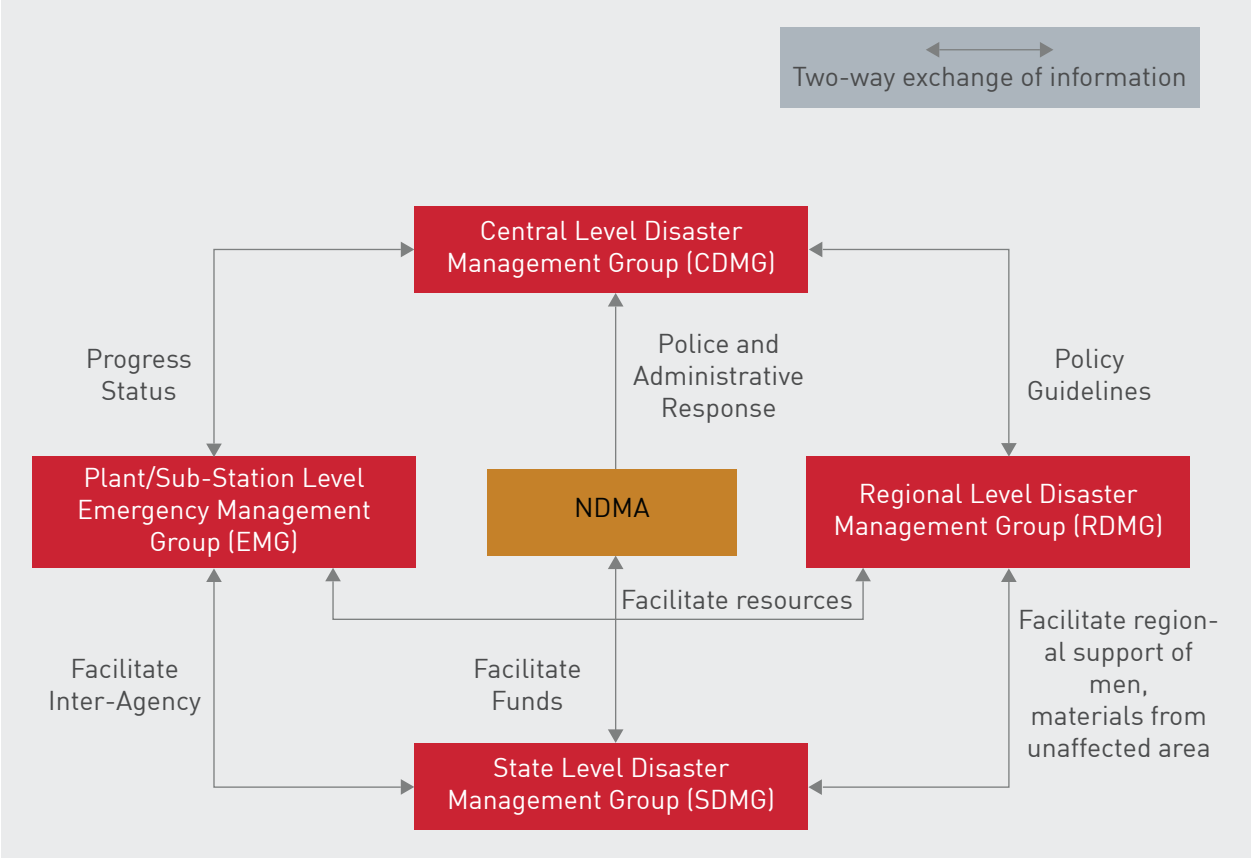
Institutional Body	Composition	Roles and Responsibilities
Revenue and Disaster Management Department	Principal Secretary/Addl. Chief Secretary	Responsible for providing immediate relief to the people affected by various calamities. Also takes initiatives for relief, rescue, rehabilitation and restoration work. Exercises all administrative and financial powers.
State Executive Committee (SEC)	The Chief Secretaries of theStates – Chairman Four secretaries of state government are the other member's ex-officio	Coordinates and monitors the implementation of national plans and policies.
State Emergency Operations Centre (SEOC)	Headed by Special Relief Commissioner	Works round the clock for proper disaster management.
District Emergency Operations Centre (DEOC)	Headed by District Collector/Commissioner	Plays an important role in effectively and efficiently coordinating multi-agency, intergovernmental responses to disaster events.
State-Level Committee on Natural Calamities (SLCNC)	Constituted under the chairmanship of the chief minister	Advises state government against various calamities and further assesses the quantum and nature of relief to be provided.
Odisha Disaster Response Action Force (ODRAF)		Aims at reducing casualties, clearance of communication channels, quick personnel and equipment deployment, minimizes expenditure and time lag, and supports institutional arrangement.
Block Development Officer		Ensures the availability of all resources and the proper functioning of the control room. Ensures proper activation of early warning dissemination services. Monitors and coordinates various disaster management teams.

Source: SDMP-Odisha (2019)

2.2.2 Establishment of a Four-Tiered Disaster Management Structure for Odisha's Power Sector

Owing to recurrent episodes of cyclones and floods in Odisha, huge loss of property and infrastructure has occurred in power sector, to INR 320 crores in 2020 alone. To enhance the resilience in Odisha and its power sector, a four-tiered structure at the central, regional, state and local unit levels has been set up to effectively respond to incidents. These units exchange information regarding the course of actions to be taken depending on the type and severity of the hazard (Figure 2.3). This four-tier structure has been formulated to implement measures and integrate development projects, ensuring a robust response to any challenges that may arise in the power sector.

Figure 2.3 Inter-Group Relationship in Disaster Management - Power Sector



Source: CEA (2021)

The structure aims to provide a comprehensive disaster management system with initiatives and support at the central, regional, state and plant levels. While the Central-Level Management Disaster Group (CMDG) and State-Level Management Disaster Group (SMDG) interventions are facilitated for major disasters, the local level focuses on minor incidents. In association with the CEA, the Ministry of Power (MoP) prepares a Disaster Management Plan (DMP) for the power sector at the national level in consultation with all stakeholders. The CEA is responsible for developing, maintaining, reviewing and updating the basic DMP for the power sector at the national level.

The relationship between groups helps implement measures to prevent disasters, focusing on mitigation, preparedness and capacity building as guided by central authorities. In coordination with national authorities like NDMA, all the groups facilitate and inter-coordinate to ensure effective dealing with disaster situations in the power sector. The group, coordinating with stakeholders, including the police and administrative agencies, facilitates and mobilizes funds and resources. All the groups have different governing heads, with specific roles and responsibilities to be executed (refer to Table 2.3).

Table 2.3 Roles and Responsibilities of Different Groups

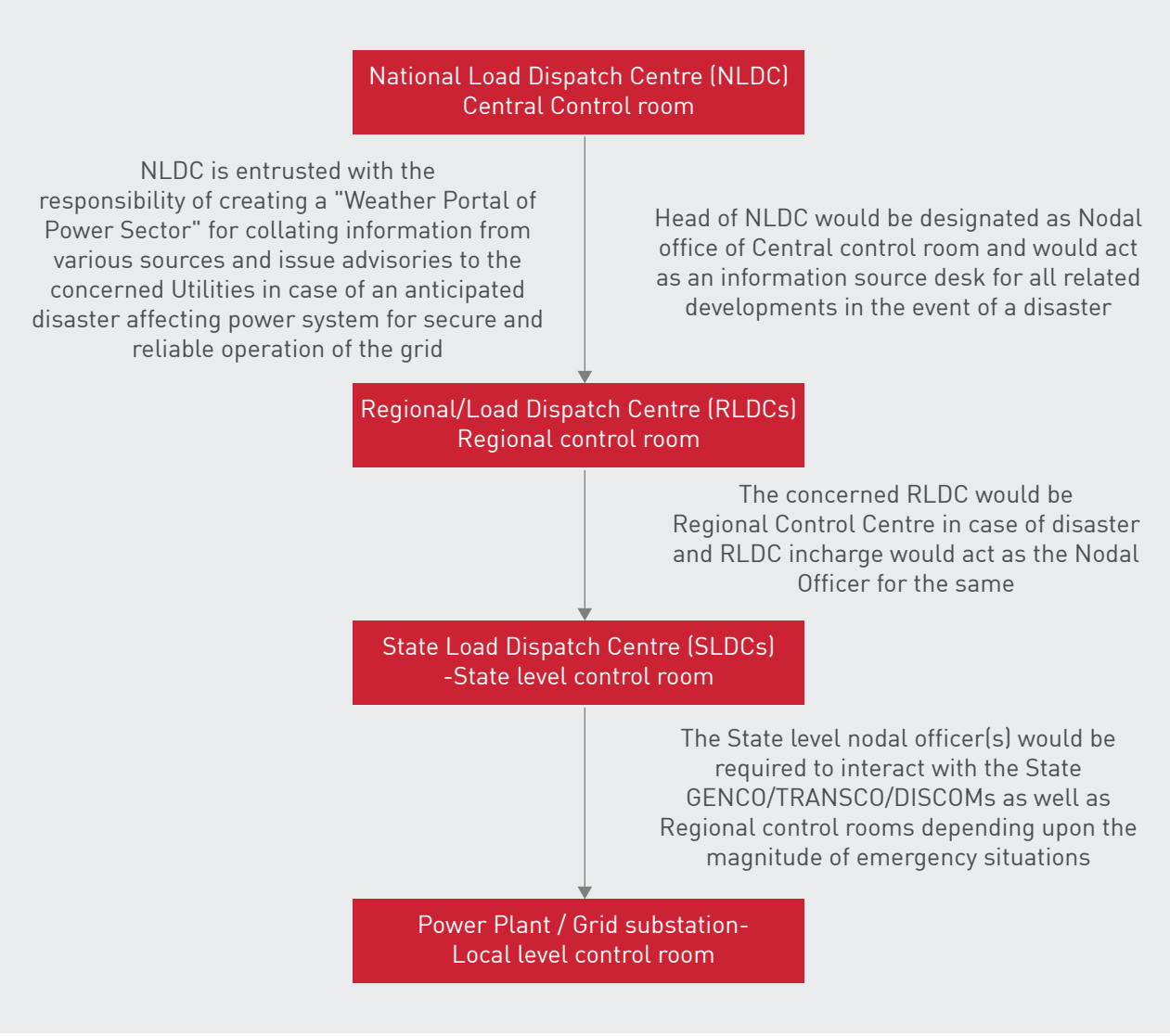
Institutional Body	Composition	Roles and Responsibilities
Central Level Disaster Management Group (CDMG)	Secretary (Ministry of Power) -Chairman	Facilitates the development of DMP and policy for the power sector. Coordinates and acts as an information source for disaster management.
	Chairperson-CEA CMD- POSOCO, NTPC, NHPC, PGCIL	
	Chairman-CWC Director-General -IMD Director-INCOIS	
Regional-Level Disaster Management Group (RDMG)	Member Secretary (RPC) - Chairman Regional HODs CPSUs Representatives of each State Civil Defence	Provides inter-state emergency and start-up power supply. Participates in damage assessment and facilitates resource movement to affected states from other regional states.
	Deputy Director-General, (IMD) Chief Engineer, CWC, Group Head, Ocean Information and Forecast Services Group (ISG)	
	Head of RLDC	
State-Level Disaster Management Group (SDMG)	Principal Secretary/ Secretary (Energy) of the State - Chairman	To facilitate inter-agency support, damage assessment and mobilize resources. To ensure proper management of disasters at the state level.
	IGP, Chief Fire Safety Officer	
	MDs of Generation, Transmission and Distribution companies	
	Director – CWC Representative-IMD Representative- Ocean Information services	
	SLDC in charge	
Plant/Substation Emergency Management Group (EMG)	In charge Installation	To ensure proper safety and assistance. To ensure minimum damage to lives, property and environment.
	Plant/Substation Safety Manager	
	Chief Plant/Substation Operation Administration	
	A representative of District Administration	

Source: CEA (2021)

To ensure an integrated approach at all levels, a four-tier control system has been developed to effectively deal with the emergencies arising from disasters in the power sector. The structure comprises national-, state-, regional- and plant-level despatch centre[1] (Figure 2.4).

The control room ensures and coordinates with all stakeholders for proper dissemination of information. The National Load Despatch Centre acts as a central control room to deal with disasters in the power sector.

Figure 2.4 Control Room Structure and Coordination for DM Institutions - Power Sector



Source: CEA (2021)

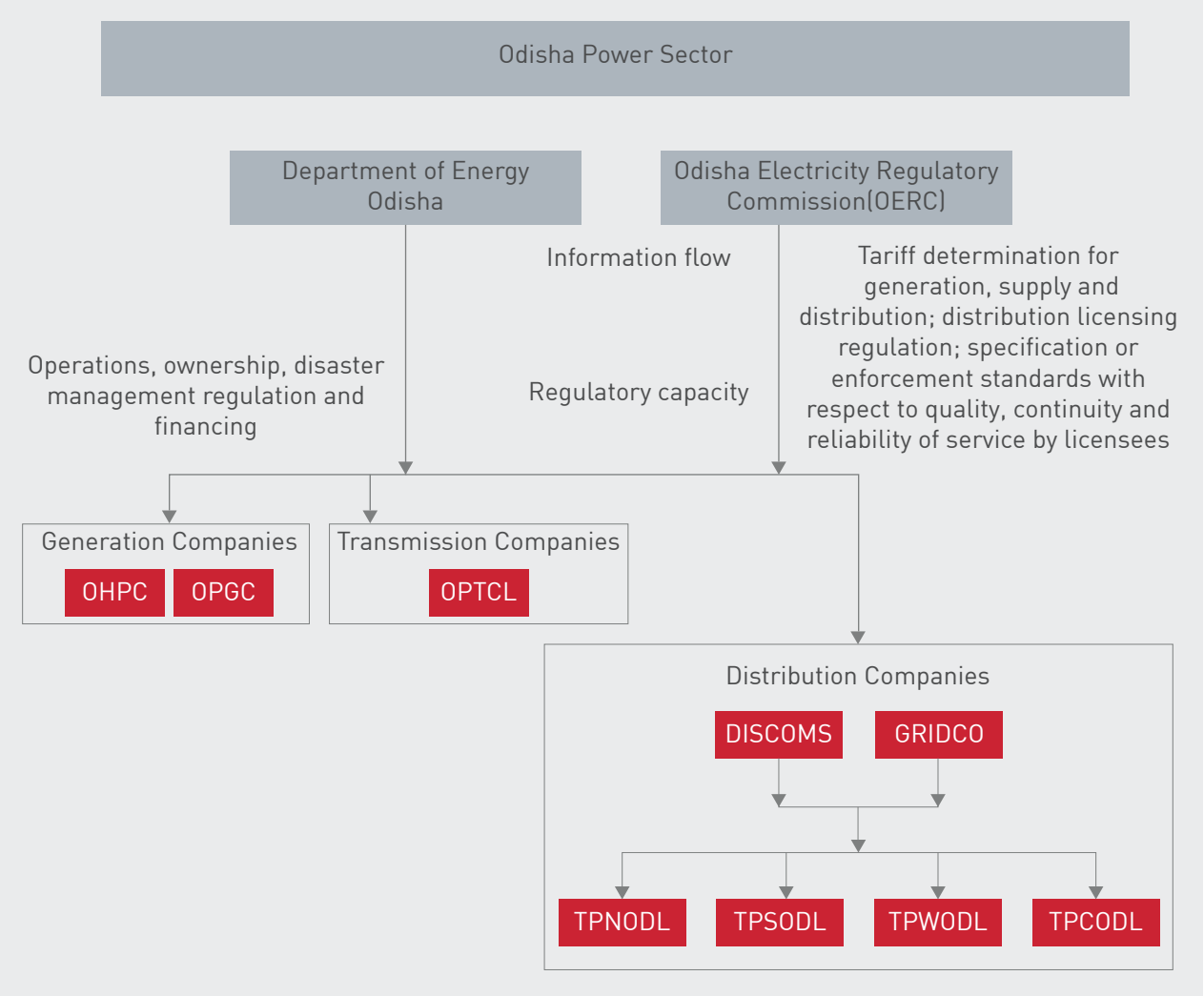
This mechanism is primarily geared towards disaster response and how it is operationalized during disaster management situations in Odisha.

[1]The information with respect to how this control structure operationalizes and interacts with the state level disaster management agencies is still awaited

2.3 Streamlining Governance and Coordination in Odisha's Energy Sector: Role of State Government and Utilities

The Department of Energy acts as a nodal body for operations, ownership, disaster management, regulation and financing in coordination with the Odisha Electricity Regulatory Commission (OERC). It ensures that generation companies (Odisha Hydro Power Corporation Ltd or OHPC and Odisha Power Generation Corporation Ltd or OPGC) and transmission companies (Odisha Power Transmission Corporation Ltd or OPTCL) operate effectively. Meanwhile, the OERC mainly supervises the tariff determination and enforcement of standards across various distribution companies, which include distribution companies (DISCOMs) and Grid Corporation of Odisha Ltd (GRIDCO). GRIDCO is responsible for maintaining the reliability and quality of service of Tata Power North Odisha Distribution Limited (TPNODL), Tata Power South Odisha Distribution Limited (TPSODL), Tata Power West Odisha Distribution Limited (TPWODL) and Tata Power Central Odisha Distribution Limited (TPCODL) (refer to Figure 2.5).

Figure 2.5 Institutional Landscape of Odisha Power Sector



Source: DDMP, Energy Department, Govt of Odisha, 2021

Central agencies, including the India Meteorological Department (IMD) and the Ministry of Power, along with other line government sources, provide information to the Disaster Management Cell (DMC) and Department of Energy, Government of Odisha.

Before a disaster occurs, the state collaborates with central authorities, including the Ministry MHA, MoP, NDMA and agencies like the IMD and Central Water Commission (CWC), to receive a continuous stream of information. The state government and relevant departments then conduct mapping to determine the appropriate course of action.

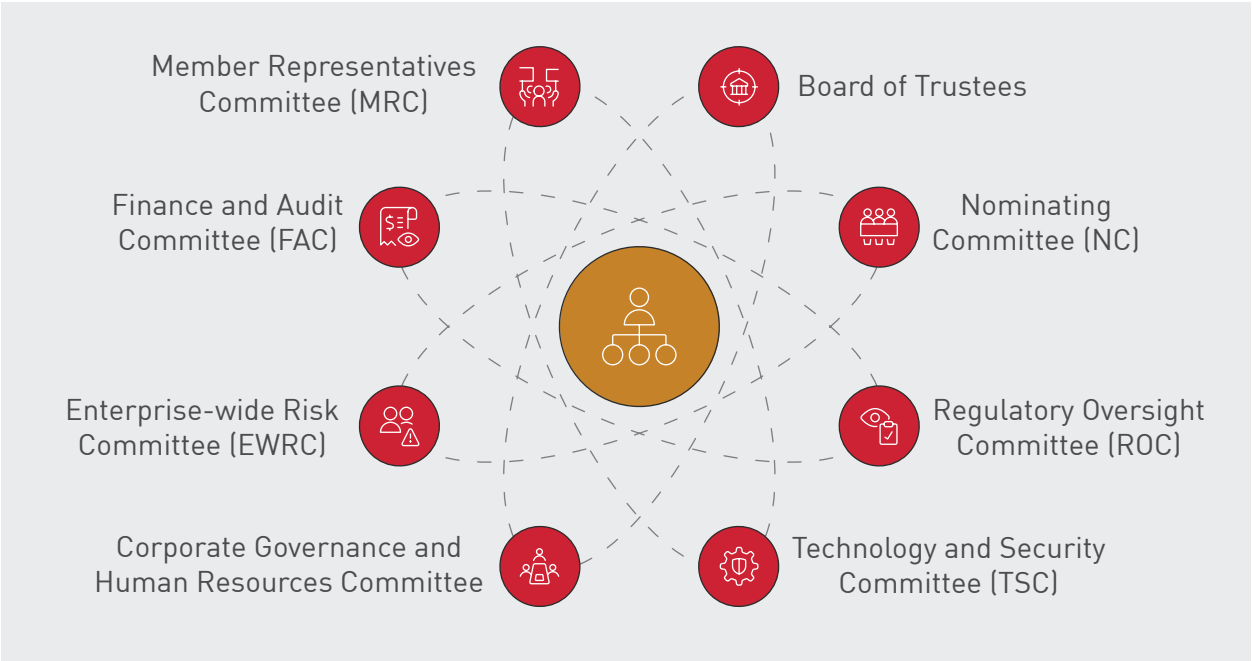
Risk-Based Governance Model Insights from NERC's Practices

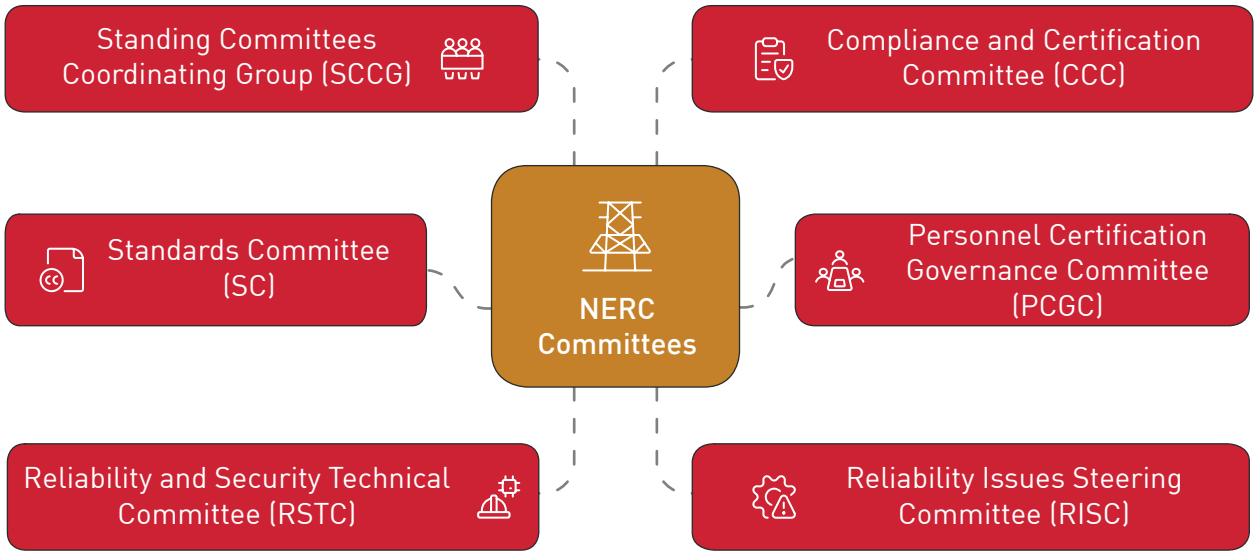
India stands to gain significantly by examining the best practices of the North American Electric Reliability Corporation (NERC) to enhance its resilience against climate change impacts and ensure the reliability of its electric power supply. NERC's Transmission Planning Standard (TPL) 001-4 stands out as a noteworthy example. This standard integrates climate-relevant data into electric power system operations and planning, providing a robust framework for addressing climate-induced challenges. By adopting a similar approach, India can optimize its infrastructure investments and improve overall system reliability amidst changing environmental conditions.

One key aspect India can learn from NERC is incorporating scientific expertise into the regulatory framework. By involving the CEA in consultation and leveraging scientific expertise, India can improve its ability to accurately assess and predict climate-related risks. This collaboration can ensure that updated wind zonation maps reflect the latest climate data, enabling more effective risk assessment and mitigation strategies.

Furthermore, India can learn from NERC's approach to standard development and authorization processes by establishing a dedicated governance committee or body similar to the US Standards Committee (SC). This is important given the urgent need for regular and precise updates to India's wind maps in the power sector. This approach would enable a systematic review and authorization process, thereby ensuring that updated wind maps reflect the latest climate data and are integrated into the regulatory framework on time. Refer to Figure 2.6.

Figure 2.6: (a) NERC Governance Structure and (b) NERC Committees





To understand this, consider India's overhead transmission line and tower regulations. In India, these are governed by IS 802, which relies on outdated standards like IS 802: 1977 or IS 802: 1995. These standards are based on wind maps from IS 875 (Part 3): 1987. Consequently, this has led to power infrastructure failures, especially in cyclone-prone regions, due to inadequate consideration of wind factors.

Though efforts were made to update standards, like introducing a cyclonic factor (k4) in IS 875 (Part 3) in 2015, subsequent revisions of IS 802 needed to align with these changes. Expert reports consistently highlighted the need for better wind considerations in design, proposing updates to wind zone maps, reliability levels and drag coefficients.

Recent regulations, such as the Central Electricity Authority (Technical Standards for Construction of Electrical Plants and Electric Lines) Regulations in 2022, aim to address these issues by recommending updated wind zone maps, introducing the k4 factor, and adjusting reliability levels and drag coefficients. However, further improvements are needed to ensure transmission line resilience in extreme weather events.

Therefore, regularly updating wind maps is essential for assessing and mitigating the risks associated with extreme weather events, particularly in vulnerable coastal regions. By collaborating with stakeholders at all levels, including the CEA, power utilities and disaster management authorities, India can ensure that updated wind maps are based on scientific evidence, providing a reliable basis for decision-making.

In conclusion, India stands to gain valuable lessons from NERC in the US, particularly regarding the integration of climate-relevant data into the regulatory framework and the establishment of a dedicated governance committee or body that oversees periodic and consistent updating of wind zone maps in the country. By adopting similar practices and leveraging the SC framework, India can update wind maps regularly and accurately, enhancing the resilience of its power sector infrastructure against climate change impacts.

2.3.1 Role of Key Stakeholders in Enhancing Disaster Resilience in Odisha's Power Sector

Stakeholders such as IMD, OERC, GRIDCO and DISCOMs play an important role in increasing disaster resilience in power infrastructure by disseminating different roles and functions during disasters. Table 2.4 presents the role of major power sector stakeholders in enhancing disaster resilience for Odisha.

Table 2.4 Function of Major Stakeholders of Odisha Power Sector

Department	Functions
GRIDCO	GRIDCO is involved in bulk purchasing and selling power to the four DISCOMs inside the state. As a major stakeholder, DISCOMs will contact GRIDCO for support distribution during disasters in coordination with stakeholders like DoE, GoO, OERC and OSDMA/SDMA.
OPTCL	It is involved in preparatory and restoration activities in the preparedness and response phase of a disaster.
DISCOMs	To strengthen and enhance the disaster resilience of the infrastructure and maintain the stock of essential resources and subsequent disaster restoration.
OERC	OERC aims to provide efficient and economically viable electricity in Odisha while playing a key role in mitigating disaster impacts. As a major contributor and stakeholder, OERC is responsible for restructuring the electricity industry. This includes rationalizing the generation, transmission, distribution and supply of electricity, encouraging participation from private sector entrepreneurs and establishing a regulatory commission for the state, independent of the state government.

Source: KPMG Internal Analysis

An effective course of action should be planned to ensure that information is promptly disseminated to every stakeholder. This approach aims to tackle and control the situation immediately, minimizing any potential loss. Information will flow from central authorities and agencies to state governments, as well as both external and internal stakeholders, in coordination with the Department of Energy. Disaster management teams from the DISCOMs will serve as the front-facing teams. In contrast, the central emergency centres, state control centres and OSDMA will provide the essential framework for managing the catastrophic event in a timely manner. All the DISCOMs and stakeholders receiving updates will act as key communication points and will work collaboratively to restore and resume the power supply throughout the state.

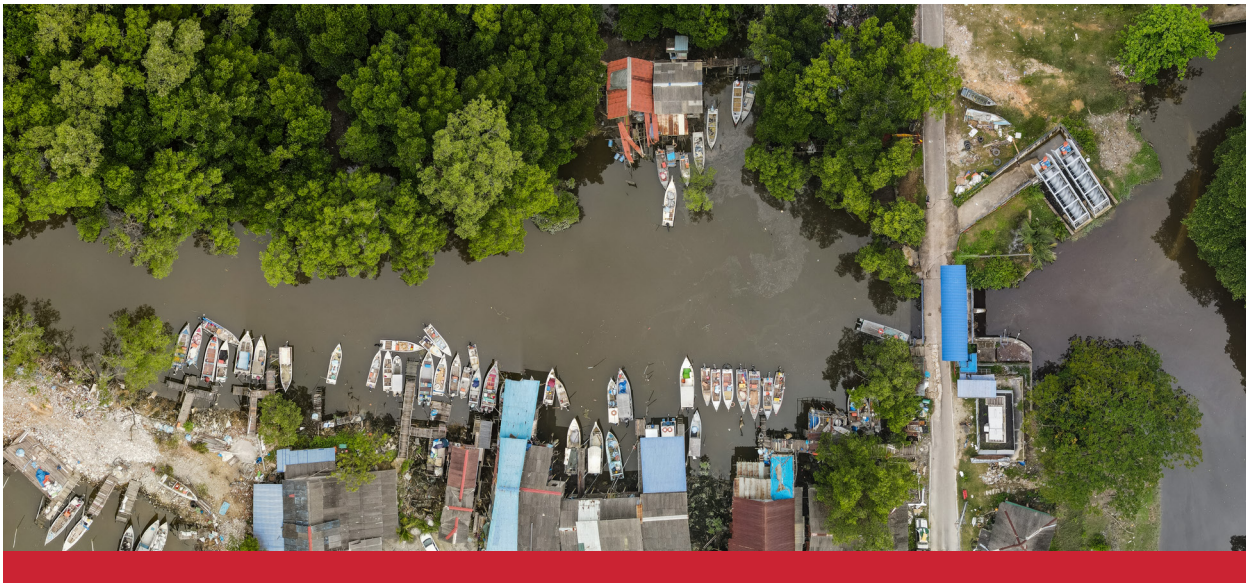
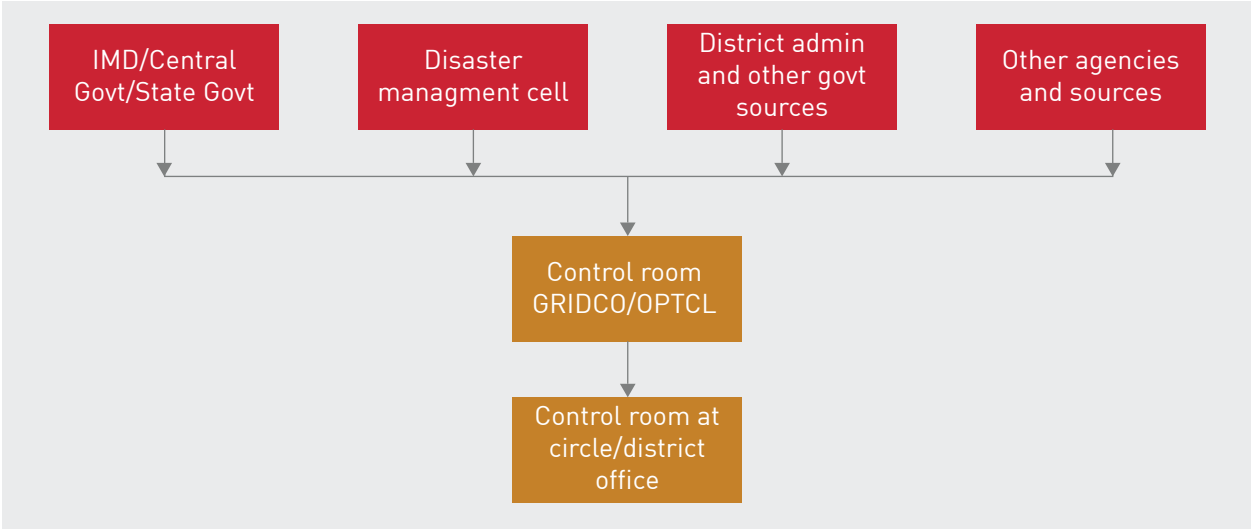


Figure 2.6: Broad Schematic Representation of Information Flow



Source: Departmental Disaster Management Plan, Department of Energy, 2018

Information regarding the disruption and restoration is continuously updated and disseminated to customers in the affected areas. If the disruption is prolonged and more intense, satellite phones are used to communicate. The DISCOMs mobilize their human and material resources based on their proneness to disruption. Usually, the local teams serve as first responders, receiving additional support from the emergency operation team.

2.3.2 Optimizing Disaster Response and Recovery Through Integrated Management Processes

Disaster management begins with the preparedness phase, primarily focusing on minimizing the losses associated with critical components and infrastructure during the response phase. The course of action for the response phase begins when information is received from higher authorities, mainly MHA and IMD, to the Central Control Emergency Centre, which acts as the nodal centre where stakeholders come together during an emergency to coordinate response and recovery actions and resources. It is operationalized and instantly activated at the onset of any emergency event (see Figure 2.6). It is further initiated by the head of the power control system and assisted by six circle heads. The government, DISCOMs and other in-line stakeholders have laid out mitigation plans based on the vulnerability of locations and assets. Furthermore, the mitigation and action plans interface with forces such as NDRF and State Disaster Response Fund (SDRF) and stakeholders like health, telecommunication, etc., to ensure a comprehensive approach to disaster management.

Although the proactive approach of the Odisha government has enabled efficient capacity building in the state, which has tremendously decreased the number of lives lost, there remains a significant challenge to not only build safe infrastructure but also a resilient one to attain normalcy after a cyclone. The government and various stakeholders must take prior steps to mitigate the losses. By taking an integrated approach through the adoption of alert categorization methods (Carter 2019) (the categorization of alerts may encompass the initiation, activation and deactivation of the disaster management system), these protocols are typically outlined in disaster response plans, which incorporate operational procedures for various spaces including the following:

- Stage 1: Readiness
- Stage 2: Standby
- Stage 3: Action
- Stage 4: Deactivation

Case Study: Quick Response during Cyclone Amphan by West Bengal

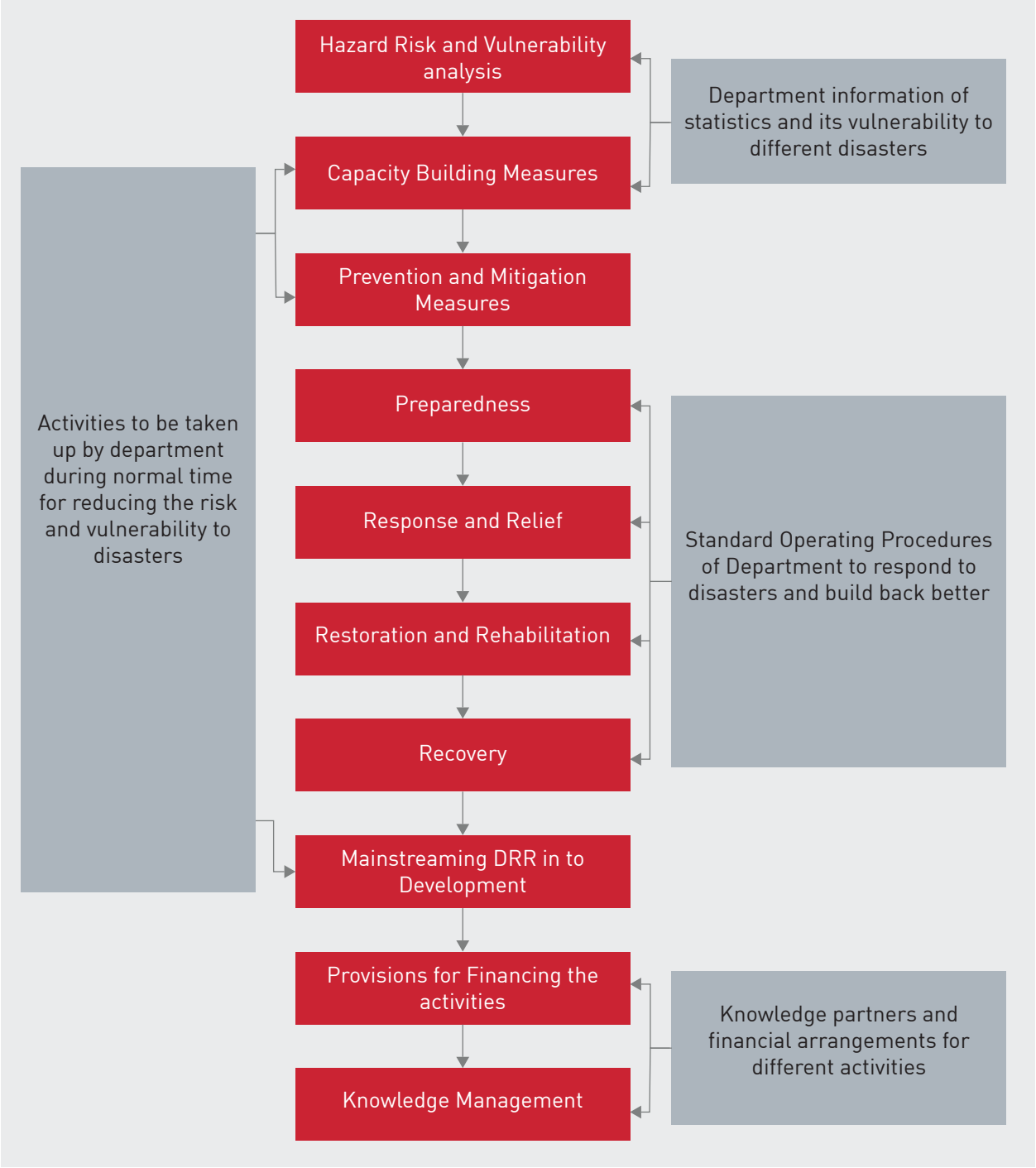
In response to Cyclone Amphan, the National Disaster Response Force (NDRF) deployed its self-contained rescue and relief teams in the coastal areas of West Bengal. A total of 38 NDRF teams were deployed at coastal areas of West Bengal, including Kolkata, Nandigram, Kontai-1 Block and Digha (East Midnapore), Arambagh (Hooghly), Uluberia and Domzur (Howrah), Sandeshkhali, Hasnabad and Hingalganj (24 Pargana, North), Pathar Pratima, Naamkhana, Gosaba, Kakdweep and Sagar Island (24 Pargana, South), and Rajarhat.

The NDRF teams evacuated 7650 livestock to safer places. They also removed 7392 uprooted trees and 1150 electric poles and cleared 3152.5 km of road. Additionally, the teams assisted the state administration in the mass evacuation of more than 8.13 lakh people to safety.

Source: https://ndrf.gov.in/operations/super-cyclone-amphan-2020

The Odisha Department of Energy Disaster Management Plan (2018) has highlighted a roadmap of certain activities, as stated in Figure 2.7, that must be undertaken by various departments, forming the trajectory for the power sector disaster management.The respective departmental disaster management plans give input on all these aspects. Figure 2.7 represents the different activities to be carried out by the power stakeholders, starting from hazard risk vulnerability and capacity assessment (HRVCA) to coping measures to reduce the damage caused.

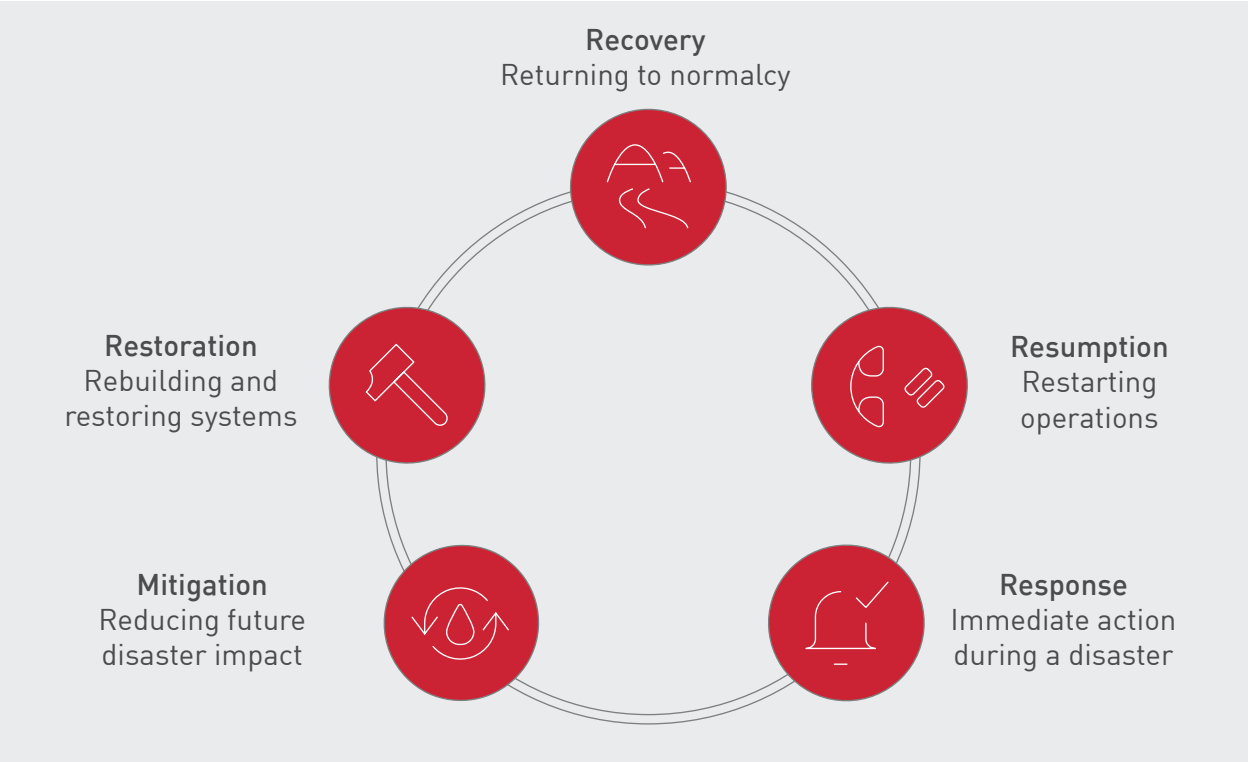
Figure 2.7: Flowchart Indicating the Various Activities to be Conducted by the Energy Department



Source: Departmental Disaster Management Plan of Energy Department, Odisha Government

To achieve this roadmap, it becomes crucial to implement practical measures that enhance capacity building throughout all the phases of disaster management, from mitigation to restoration. This process requires the alignment of all the departments and stakeholders associated (refer Figure 2.8).

Figure 2.8: Flow of events before, during and post-disaster



Source: KPMG Internal Analysis

The capacity-building measures encompass training on restoring networks and power restoration safely and speedily.

Here are a few points for DISCOMs:

- The DISCOMs must focus on an integrated approach to building material preparedness based on the affected districts.
- The DISCOMs must focus on empowering power backup availability and deploying conductors and communication aids closer to proximity and divisions in advance to minimize restoration time.
- DISCOMs must also periodically update the inventory and have inter-communication and coordination before the onset of any disaster.
- The DISCOMs must be involved in constructing resilient infrastructure with more robust poles and standardization of structures.

2.4 Departmental Roles and Responsibilities Analysis

2.4.1 Responsibility Matrix

This section details the responsibility matrix for all the stakeholders to strengthen inter-departmental coordination. The matrix (see Table 2.5) reflects the roles and responsibilities of nodal agencies at the central and state levels. The activities under the responsibilities of nodal heads facilitate easy implementation of warning to mitigation activities, further enhancing the resilience capacity towards disaster.

Table 2.5 Institutional Roles and Responsibilities of Various Stakeholders along with Nodal Heads

Department	Nodal Head/ Agencies	Nodal Head	Activities Carried Out
Development of policies and guidelines for cyclone w.r.t to power sector	MHA MOP, MNRE, CEA, NIDM. DoE, OSDMA	Secretary/ Chairperson	Develop appropriate guidelines to ensure the implementation of cyclone preparedness measures in the in-power sector.
Establishment of cyclone forecasting and warning mechanism	IMD	Director General, IMD	Issue daily weather bulletins and weather forecasts.
	MoP, MNRE, CEA, DM/RevenueDepartment	Secretary (Ministry of Power, Government of India) Chairperson, CEA	Establish a system of early warning and its dissemination to line departments and other institutions who are likely to be affected by cyclones.
	OSDMA	Chief Minister/ Secretary	Analyze the existing early warning and dissemination system, identify gaps and suggest advanced system.
	Department of Energy, GoO		Establish a warning mechanism and activate a restoration plan.
Dissemination of cyclone warnings	IMD	Director General, IMD	Periodic and hourly updates and warning.
	State government line department	Department of Energy and OSDMA, SDMA, SERC, SEOC, DISCOMs, Transmission department	Essential distribution and prepared-ness are measures to be initiated with proper allocation and mobiliza-tion of resources.
Activation of DMC and line departments	SDMC, RC, Revenue Dept., OSDMA, SDMA	Principal Secretary/Addl. Chief Secretary Chairperson/Chief Secretary	Establish activation and disaster management centres in coordination with the line departments to activate an efficient response task force.

Department	Nodal Head/ Agencies	Nodal Head	Activities Carried Out
	Line Departments -power sector-specific	CEO, Power System Operation Corporation (POSOCO), CMDs of NTPC, NHPC and Power Grid Corporation of India Limited	
Backup and mobilization of resources*- power sector specific	Distribution companies, transmission companies, SDMA/ OSDMA	Chairperson, designated officials	Timely distribution and setting up of mobile resources (DG Sets, power substations, restoration poles).
Activation of power sector preparedness and relief measures	Department of Energy, GoO	Joint Secretary	Activation and dissemination of relief measures to minimize the losses and damages incurred.
	NDLC/SDLC	ED	
	OSDMA	Chief Secretary	
	GRIDCO	MD	
	ODRAF	Chief Secretary	
Restoration and mitigation activities for transmission and distribution lines	Dept. of Energy, OSDMA/SDMA	Chief Secretary	Arrangement to restore power supply within the stipulated time to avoid disruption in the activities of critical infrastructures.
	Transmission and distribution companies	MD and Designated officials	
Cyclone preparedness, training and capacity-building/ awareness measures	Revenue (DM) Dept. OSDMA All line departments	Dist. Collectors Other Dist. Authorities	Training arrangements for: district trainers, Aapda Mitra volunteers, MPCS management committees and local bodies/PRI.

(*Mobile DG sets, Transport and other arrangements, Dewatering pump, Mobile substation)

2.5 Inter-departmental Assessment Framework of DM System in Power Sector: A Comparative Analysis

The framework presented in Table 2.6, Figure 2.9 and mentioned below gives a comparative assessment of all the governing institutes at the time of disaster in relation to enhancing the resilience of the power sector. This serves as a comprehensive tool for assessing the effectiveness of various governing bodies and organizations when dealing with disaster management, specifically in the context of strengthening the resilience of the power sector across all the phases of the disaster management cycle.

1 Disaster preparedness (policymaking, allocating funding sources, team constitution)

This phase refers to the various activities and measures undertaken in advance by the government and various stakeholders to be prepared to ensure minimal loss of lives, infrastructure and economy. This includes making holistic policies that are different, allocating funds, developing an early warning dissemination system (EWDS), guidelines, etc. All the concerned central agencies, along with the State Department of Energy and Disaster Management Authority, lay down the guidelines, warning systems, standard operating procedures (SOPs) and resource allocation to be prepared for different calamities. Sourcing and constituting teams and personnel play an important role. It has become a pre-disaster preparedness initiative rather than a post-disaster response activity. ODRAF consists of training against the operability of emergency equipment during the onset of disaster and training for personnel and effective coordination mechanisms to ensure minimum mitigation.

2 Disaster response (decision making, communication and implementation)

It refers to the action directly taken after the onset of a disaster. ***It includes making timely and efficient decisions and taking action to mitigate the loss created by catastrophe.*** The information concerned departments receive is the same and is communicated to stakeholders such as the Department of Energy, DISCOMs, GRIDCO and disaster management authorities. At the same time, SDRF/ODRAF are also involved in implementing the same.

3 Disaster recovery (relief and restoration)

The recovery process begins once the disaster stabilizes, focusing on restoring the affected communities to normal conditions. This phase aims to provide relief and restore any infrastructure lost. Various agencies, including transmission, distribution and generation companies, work to achieve restoration in the shortest time possible. The guidelines for recovery have been formulated with NIDM, while the state government allocates funds in collaboration with the Department of Energy.

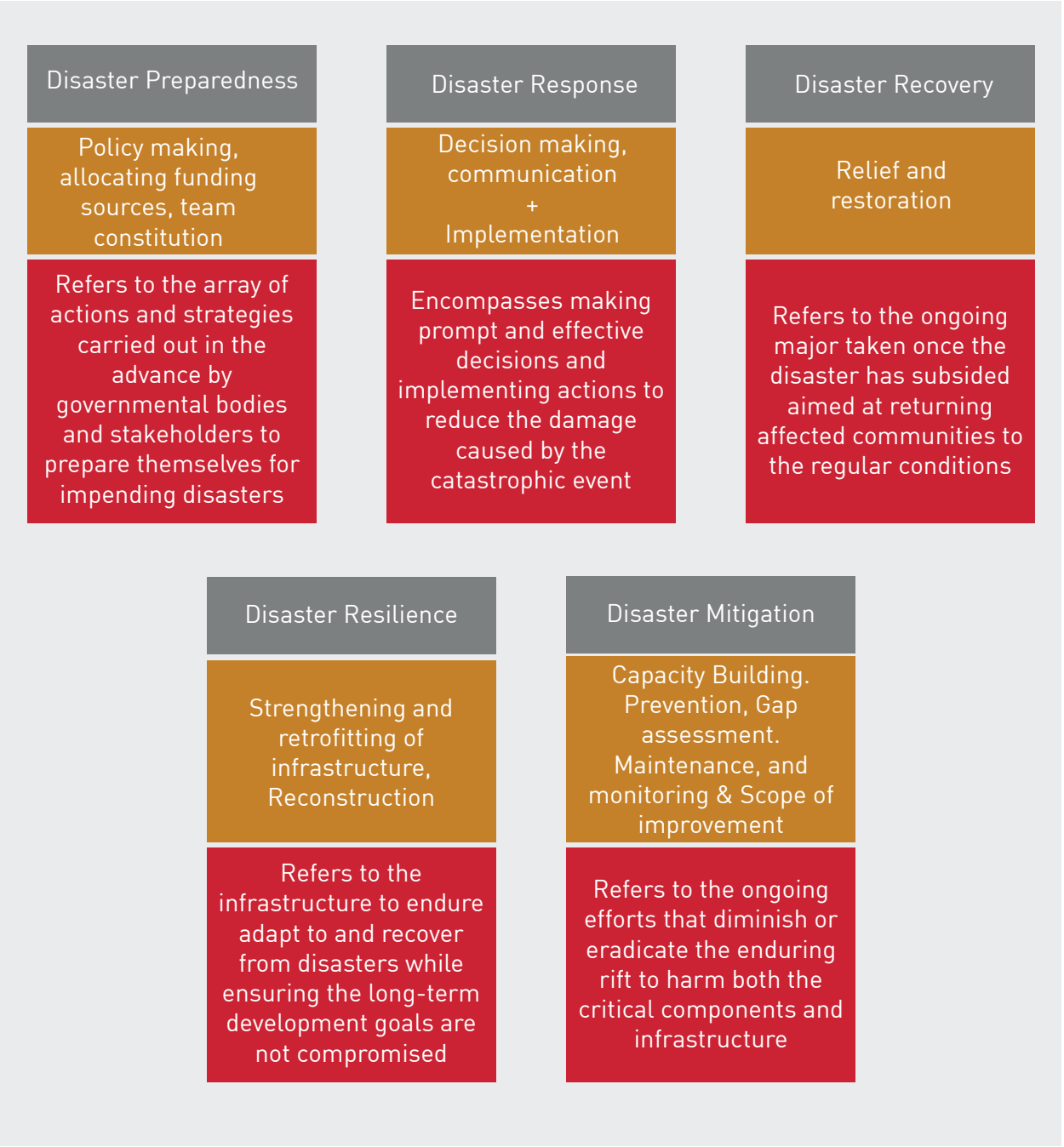
4 Disaster resilience (strengthening and retrofitting of infrastructure and reconstruction)

This emphasizes and refers to the ability of communities, organizations and infrastructure to withstand, adapt and recover from disasters without compromising the long-term consequences for development. The same can be achieved by learning from past disaster experiences and taking informed actions, such as strengthening infrastructure and retrofitting lines. With the help of guidelines provided by central agencies, GRIDCO, along with generation, transmission and distribution companies, carries out retrofitting and reconstruction acts to make the infrastructure more resilient.

5 **Disaster mitigation (capacity building, prevention, gap assessment, maintenance, and monitoring & scope of improvement)**

It refers to sustained actions that reduce or eliminate the long-term risk or damage to lives and infrastructure. ***It refers to structural and non-structural mitigatory activities such as capacity development, resource inventory, gap assessment, structure maintenance, and continuous monitoring and evaluation.*** Disaster management authority and the Department of Energy take up the management process with allied stakeholders to be better prepared for any calamity.

Figure 2.9: Inter-departmental Assessment Framework



Source: KPMG Internal analysis

Table 2.6 Assessment Framework for Different Governing Institutions

Assessment Framework	Disaster Preparedness (Policymaking, Allocating Funding Sources)	Disaster Response (DecisionMaking, Communication + Implementation	Disaster Recovery (Relief, Restoration)	Disaster Resilience (Strengthening and Retrofitting of Infrastructure, Reconstruction)	Disaster Mitigation (Capacity Building, Gap Assessment, Maintenance and Monitoring)
MHA	✓	✓			
NDMA/NIDM	✓	✓	✓		✓
CEA	✓	✓			
Other line Departments IMD/CWC	✓	✓			
Ministry of Power	✓				✓
MN&RE	✓				
NDRF/SDRF		✓	✓		
DoE-GoO	✓	✓	✓	✓	
ODRAF		✓	✓		
DISCOMs (TPNSODL, TPSODL, TPWODL and TPCODL)*	✓	✓	✓	✓	✓
Generation companies OPCG-OHPC			✓	✓	✓
Transmission company - OPTCL		✓	✓	✓	✓
OERC			✓	✓	✓
GRIDCO		✓	✓	✓	✓
OSDMA/SRC/ SDMA	✓	✓	✓	✓	✓

(*owing to less proneness to vulnerabilities, the organizations are not taken into consideration)

Source: KPMG Internal Analysis

2.5.1 Building Feasible and Cost-effective Design

Minimizing damage to transmission and distribution lines is essential to build a feasible and cost-effective design that further strengthens the infrastructure. Adopting lessons learnt from best practices, case studies and past experiences governing various outcomes (like retrofitting measures to have cyclone resilience and robust electricity transmission and distribution infrastructure) will promote resilience. Using better construction materials and suggesting suitable materials and/or changing the composition of existing materials help mitigate the associated risk. It is important to note that the distribution sector's electrical components are more affected than transmission systems during cyclones. In fact, data shows that up to 90 percent of damages occur in 33 kV, 11 kV and low-tension lines during cyclones. Also, the materials used in the transmission and distribution system are designed and procured as per the technical parameters stipulated in the Indian Standards (IS) published by the Bureau of Indian Standards.

The case studies in the annexure highlight cost-effective design approaches to improve infrastructure resilience, particularly in reducing losses within critical infrastructure like the power sector. They also provide valuable insights into identifying the gaps in guiding future mitigation efforts.

The increasing reliability of the power sector highlights the need to build resilient power infrastructure to ensure consistent and sustainable services across all critical infrastructures. While technical adaptations can help mitigate the probability of damage, they do not guarantee the omission of failure. The ever-increasing demand for power supply juxtaposed with climate change transitions has significantly impacted the transmission and distribution sector, resulting in the loss of power supply, changing transfer capacity and causing physical damage. Incorporating climate resilience measures is essential for mitigating damages and loss from climate change on the system. These measures are essential for maintaining a steady power supply, further enhancing Odisha's resilience and robust power governance. Although substantial investments are needed for resilient options like underground cables and climate-robust cables, a strong integrated assessment in alignment with the sustainability and resilience of the structure is required.

Odisha can draw valuable lessons from other states (Annexure A1.3.3) that have successfully enhanced their grid infrastructure against extreme weather events like cyclones. For instance, during Cyclone Amphan in West Bengal (Case study A.9) and Titli and Hudhud in Andhra Pradesh (Case studies A.10 and A.11), the following measures were implemented to minimize and mitigate damage with a specific focus on:

- Enhancing the electrical distribution system modelling of the grid infrastructure
- Underground burying of distribution lines to reduce vulnerability
- Prioritizing training
- Augmenting distribution transformation capacity
- Building GI and mobile substations
- Emergency restoration towers
- Deploying field stuff to restore the towers
- Storage of electric transformers and poles at strategic locations

2.5.2 Inclusivity of Updated Standards and Codes

In order to enhance the resilience of power infrastructure by developing and updating codes, standards, designs, regulations and new technologies regarding risk exposure and its criticality, it is important to include climate resilience into the guidelines from the outset. Codes currently used in India for specifying design wind loads for structures are analyzed and verified withstood capacity against available data on extreme weather events. Moreover, the overhead transmission lines are subjected to various loads, including climatic stressors (predominant being wind), which are dependent on the correctness and availability of the meteorological data.

Some of the measures taken under the response mechanism are immediate and short lived, while others focus on long-term risk reduction and strengthening resilience. Together, these efforts form an integral facet of the developmental process carried out through all the phases of disaster management. The development of a coherent approach, which is inclusive of both short-term and long-term measures, paves the way forward towards a power sector with increased resilience.

Hamessing Impact-Based Solutions for Disaster Resilient Power infastructure

The U.S. Drought Portal, located at www.drought.gov, serves as the U.S. government's authoritative platform for drought-related information. It functions as a comprehensive hub offering data, decision-support tools, resources, and insights spanning drought monitoring prediction, planning, preparedness, and applied research.

Originally established in 2008 to consolidate drought science and information, the portal has since evolved to meet the increasing demand for actionable and reliable data. By centralizing trustworthy and timely drought information, Drought.gov plays a crucial role in enhancing the nation's ability to proactively manage drought-related risks and bolster community resilience.

Managed by NOAA's National Integrated Drought Information System (NIDIS) in collaboration with NOAA's National Centres for Environmental Information (NCEI), the U.S. Drought Portal draws on interagency partnerships and utilizes data and decision-support products from federal, tribal, state, and local governments.

Drought.gov caters to a wide audience impacted by drought, including policymakers, decision makers across various goverrimental levels, researchers, the private sector, media professionals, and the general public.

In consultation with key stakeholders such as the Ministry of Power, India Meteorological Department (IMD), Central Electricity Authority (CEA), and other relevant bodies, similar innovative initiatives would serve as a timely updated and reliable sources for power sector related information. This is important because there is a need to draw upon inter-agency and public-private partnerships and utilize climate risk data from governmental, research, and industry sources to provide comprehensive insights and support decision-making at various levels.

Such an initiative is suggested to consolidate relevant data, decision-support tools, and resources to enhance monitoring, prediction, planning, preparedness, and applied research related to power supply and managerment, particularly in the context of factors like weather patterns, infrastructure resilience, and demand fluctuations thereby leading to the development of early warming systems (EWS) by the power sector, for the power sector.

By centralizing trustworthy and timely updated climaterisk information with respect to disaster events, innovative EWS initiatives in the power sector, especially for the vulnerable areas would enable proactive management of risks related to power supply disruptions, infrastructure damage, and energy demand variations caused by factors such as climate change, extreme weather events, and evolving consumption patterns.

Source: https://www.drought.gov/about/us-drought-portal

3 Policy and Regulatory Landscape

3 Policy and Regulatory Landscape

Building resilience in the power infrastructure against hazards must be prioritized at the policy and regulatory levels. The policy and regulatory landscape for disaster management typically includes state-enacted legislation, establishing state and district disaster management authorities, early warning systems, resource allocation and budgeting, coordination mechanisms, community engagement and capacity building. Critical to this effort is land use planning and building codes designed to minimize vulnerability, strategies for post-disaster recovery and rehabilitation plans, and international cooperation for resource sharing and collaborative efforts. This comprehensive framework facilitates a proactive approach to disaster risk reduction, efficient response mechanisms and sustainable recovery.

3.1 Disaster Management Act – A Brief Insight into the Regulatory and Financial Landscape

The Disaster Management Act, 2005 provides the institutional and coordination mechanism for effective disaster management at the national, state, district and local levels. It delivers a comprehensive approach to addressing disaster scenarios in a holistic, multi-dimensional, and multi-disciplinary approach involving diverse scientific, engineering, social and financial processes. The proactive approach to India's disaster management encompasses disaster prevention, mitigation, disaster preparedness, disaster response, relief and rehabilitation. As per Section 46(1)(b) of the Disaster Management(DM) Act, 2005, the government encourages contributions from individuals/organizations to aid in disaster mitigation efforts.

3.1.1 Financial Landscape – National Level

The State Disaster Response Fund (SDRF) constituted under Section 48 (1) (a) of the Disaster Management Act, 2005, is the primary fund available to state governments for responses to notified disasters. The National Disaster Response Fund (NDRF), constituted under Section 46 of the Disaster Management Act, 2005, supports the SDRF when it does not have adequate funds in the face of a severe disaster. The central government contributes 75 percent of the SDRF allocation for general category states and union territories. It also provides additional support if adequate funds are not available in the SDRF. Moreover, the national calamity contingency funds are maintained by the Government of India and are utilized for emergency response, relief and rehabilitation during any threatening disaster. Also, the Departmental Disaster Management Plan of the Department of Energy, 2018 further highlights activities that enable the various agencies involved in generating, transmitting, distributing and supplying electricity to plan for timely and efficient response and restoration from the unpredicted incident.

3.1.2 Regulatory Landscape – State Level

Odisha has made significant strides in disaster management since the event of the 1999 Super Cyclone. The formation of the Odisha State Disaster Management Authority (OSDMA) marked a pivotal moment in disaster management, leading to extensive activities in the sphere ranging from disaster mitigation, relief, response and reconstruction, as well as fostering inter-agency coordination. Furthermore, pursuant to the Disaster Management Act of 2005, with the state has developed various disaster management institutions at various levels. Under this directive, the Department of Energy has also introduced its disaster management plan and outlined a clear trajectory for various institutions under it to form their respective disaster management plans.

Enhancing the resilience of power infrastructure involves a multifaceted approach. This includes developing and updating codes, standards, designs and regulations, while also integrating new technologies. Analysing and verifying the design of wind loads for structures using existing codes is crucial in India's power sector. This assessment must account for extreme conditions and align with available meteorological data to ensure accuracy.

Electricity infrastructure like substations and transmission/distribution lines are designed to operate under changing climatic circumstances throughout the year. However, climate change could pose additional unaccounted challenges.

Existing codes, standards, and regulation need to be examined because of the severity of the cyclones in the past and large-scale damages in the power infrastructures.

Improving infrastructure resilience through changes in codes and standards is imperative, bridging the gap between standards and implementation, improving O&M practices, and vegetation management.

Codes and criteria also need to fill the gaps based on dynamic changes due to climate change.

The focus on overhead transmission lines is pivotal, given their exposure to various loads, especially climatic stressors such as wind. Integrating climate resilience at the guideline level is imperative, as it sets the foundation for designing infrastructure that can withstand the evolving risks posed by climate change.

The response mechanism to climatic stressors needs a balanced approach. Immediate and short-lived measures are essential for addressing urgent issues, while a significant emphasis on long-term actions is crucial for risk reduction and strengthening resilience. These long-term measures become integral to the entire developmental process throughout the phases of disaster management. Developing a coherent approach that combines short-term and long-term measures is key to creating a power sector with increased resilience.

This approach ensures that the response to climatic stressors is reactive and proactive, contributing to the overall sustainability and robustness of the power infrastructure. This comprehensive strategy aligns with the evolving challenges of climate change, making the power sector better equipped to handle uncertainties and disruptions. Odisha Electricity Reform Act, 1995 was formulated to restructure the electricity sector, focusing on the generation, transmission, distribution and supply of electricity while actively engaging the private sector stakeholders, development and management of the electricity industry in the state efficiently. The regulatory commission became functional in 1996. Odisha Power Transmission Corporation Limited (OPTCL), under the Companies Act, 1956, has been carrying out electricity transmission business within Odisha. Any disruption in any of the phase disasters marks Odisha Electricity Regulatory Commission (OERC) and OPTCL as one of the major stakeholders. Grid Corporation of Odisha Ltd (GRIDCO), which has holdings in the four DISCOMs, acts as a crucial nodal agency for the government in disaster recovery initiatives. It acts as a centralized control room/monitoring room, channelling all necessary information to the Department of Energy. Additionally, GRIDCO consolidates disaster-related information from the four DISCOMs for government communication.

Incorporating Risk Assessments into Infrastructure Planning

The Philippines' national development plan for 2017–2022 highlights the **importance of incorporating risk assessments into infrastructure planning at all government levels to protect assets. The plan recommends a range of measures for identifying drivers of risk.** Hence, to strengthen the infrastructure in Odisha, it is important to incorporate all the line departments and risk assessment into infrastructure planning at all government levels.

The different governmental sectors that can be included are the District Management Authority, Finance Department, Energy Department, State Housing Department and DISCOMs. Identification of risk associated in terms of loss of revenue, damage to power components, flooding of sub-stations, power outages, etc. should be carried out during the pre-phase of the pre-cyclone season.

The Odisha government should include developing recent hazard maps and geospatial information (specifically of cyclone-prone districts) about climate-induced risks and hazard exposure and further develop risk estimation databases (to have an idea of loss and damage caused and hence budget allocation to be done accordingly) (to be mainly carried in collaboration of disaster, environment and energy department of Odisha). The Odisha government, with the help of disaster and state environment departments, can evaluate the nature-based solution (for instance, mangrove plantation), which can enhance the strength of the state against cyclones.

The Odisha State Disaster Management Authority, Finance Department and Energy Department can further map out and **develop a resilience index** of Odisha state based on its

- exposure to hazards,
- ability to mitigate the impact of risks and
- ability to recover from the risks if they materialize.

A base year can be fixed, and a year-on-year evaluation will be carried out. Hence, the progress can be monitored.

The state government departments, like the ***Energy Department and the Disaster Management sector, can prepare a national master plan for cyclones and the energy sector's vulnerability, emphasizing the prioritization of the affected districts, resource distribution and financial allocation.***

Source: Disaster-Resilient Infrastructure: Unlocking Opportunities for Asia and the Pacific (adb.org)

3.2 Best practices: A Global Approach towards Resilience Mechanism

Infrastructure in the power sector is diverse, increasing vulnerability to disasters. It is crucial to draw insights from Global Best Practices (Annexure A1.3.1) and international frameworks concerning the adaptation of existing policies to incorporate infrastructure resilience in the public sector, with a significant emphasis on enhancing institutional resilience.

Implementing global initiatives includes several key steps: (i) deployment of a smart grid system with upgrades to the outage management system, (ii) utilization of smart meters with the establishment of advanced metering infrastructure that offers outage notification, (iii) improved response time and (iv) enhancement of governance structure. This helps to achieve the goal of adopting a build-back better approach towards building resilient infrastructure in Odisha.

3.2.1 International Frameworks

3.2.1.1 Sendai Framework for Disaster Risk Reduction

The Sendai Framework for Disaster Risk Reduction (SFDRR) serves as an international framework that helps to enhance preparedness and resilience through a multifaceted approach by setting clear objectives and priorities and enabling the government and organizations to focus their efforts effectively. The framework encourages the active involvement of various stakeholders, including government agencies, communities and the private sector, while recognizing that collaborative efforts are vital for a comprehensive approach to disaster preparedness.

Moreover, it promotes innovative technologies for early warning systems and monitoring, emphasizing capacity building through training, education and information sharing. The framework provides a comprehensive road map for enhancing disaster preparedness and resilience.

3.2.1.2 Sustainable Development Goal 9: Industry Innovation and Infrastructure

This goal plays a significant role in supporting the development of the disaster-resilient sector by focusing on critical areas such as resilient infrastructure, sustainable industrialization and innovative infrastructure. A core component of Sustainable Development Goal 9 is crucial in disaster-prone areas as it can withstand the impact of disasters, reducing damage and ensuring the continuity of essential services during and after such events.

Innovative technologies can be used for early warning systems, data collection and efficient communication during disasters. This will allow for quicker and more effective responses. Additionally, it often requires capacity building in sectors like engineering, technology and industry to enhance resilience, with a focus on designing and constructing disaster-resilient infrastructure.

3.2.2 Interlinkages between Governance and Financial Mechanism

Cyclones, a recurrent event in Odisha, have caused damage to infrastructure and disruption in critical infrastructure activities. Each catastrophic event adds to the growing economic and physical losses, highlighting the urgent need to adopt and invest in practices and building strategies towards a resilient and holistic approach to build better mechanisms. Setting proper structural measures for critical infrastructures is important in disaster risk reduction, creating resilience with financial preparedness. Also, to be effective, they need to be rational, enforced and regularly updated to keep pace with the evolving understanding of hazards and advancements in engineering technology (Chatterjee, 2020).

Strengthening both the financial and non-financial aspects of designing and standards is essential for developing a better coping mechanism. Improper regulatory mechanisms can cause disruptions and further increase the adversities of the disaster. Implementing best practices is vital to creating resilient electrical networks that ensure uninterrupted power supply and enhance the ability of the governing body to mitigate the occurring damages and warrant economic feasibility. Standardizing equipment and materials and identifying and prioritizing vulnerable areas are prerequisites before setting up underground cables in Odisha.

The current practices indicate the necessity for a systematic and integrated approach, highlighting the interlinkage between proper governance and financial mechanisms. This further helps in strengthening resiliency. Hence, urgency towards power restoration with minimum internal disruption has become the need of the hour. States like Odisha, which are particularly vulnerable due to their geophysical complexities, must adopt upgraded and innovative technology and resources to cope with growing climate and disaster risks (Annexure A1.3.2).

In India, there are growing concerns about disaster risk, especially regarding the government's budget allocations. It is crucial to ensure that levels of public expenditure on risk are sufficient. This funding scheme for disasters was designed to give state governments a dependable source of assistance to meet their disaster response, relief, recovery and reconstruction needs.

3.2.3 National and Subnational Funding Mechanisms

As per the Disaster Management Act 2005, each SDMA (State Disaster Management Authority) is empowered to create a State Disaster Mitigation Fund (SDMF). They are responsible for reviewing mitigation works and approving disaster management plans across various departments. Over the years, disaster management has become a key aspect of union-state relations. The initial focus was dependent on disaster relief. Still, the Disaster Management Act expanded the area of concern and action of the union and state governments to a wide range of disaster management functions, including relief and response, preparedness, mitigation, and recovery and reconstruction. In India, disaster risk concerns are integrated into the government budgets to ensure adequate public expenditure on risk reduction and sufficient financial arrangements for managing residual risk. The Disaster Management Act led to the creation of a new institutional structure for disaster management, with the setting up of the National Disaster Management Authority (NDMA) and SDMAs. The Act also mandated the role of institutions and functions influencing the gradual and incremental strengthening of financial arrangements for disaster management.

3.2.3.1 State Disaster Response Fund

The SDRF is a financial resource that meets the expenses of disaster relief operations and restoration of critical infrastructure (power) for a range of specified disasters within the state. The SDRF is constituted in each state with funding from the central and state governments. As per Section 20 of the Disaster Management Act, 2005, the State Executive Committee (SEC) is responsible for determining the financing of relief measures under SDRF. In the case of Odisha, the SEC is part of the OSDMA under the Special Relief Commissioner's responsibilities.

To further facilitate and aid state government apart from national funding initiatives, various financial mechanisms such as energy resilience banks (ERBs), catastrophic bonds and multilateral development banks (MDBs) such as the European Bank for Reconstruction and Development (EBRD), the World Bank and the Asian Development Bank (ADB) are available. These institutions offer grants, loans, equity payments, or guarantees for climate-related initiatives, including innovative climate resilience measures specifically aimed at funding resilience initiatives. State governments can request loans from international financial institutions such as the World Bank, ADB, Japan International Corporation Agency (JICA) etc., to facilitate recovery and reconstruction efforts post-disaster, provided they secure the necessary approvals from the related institutions.

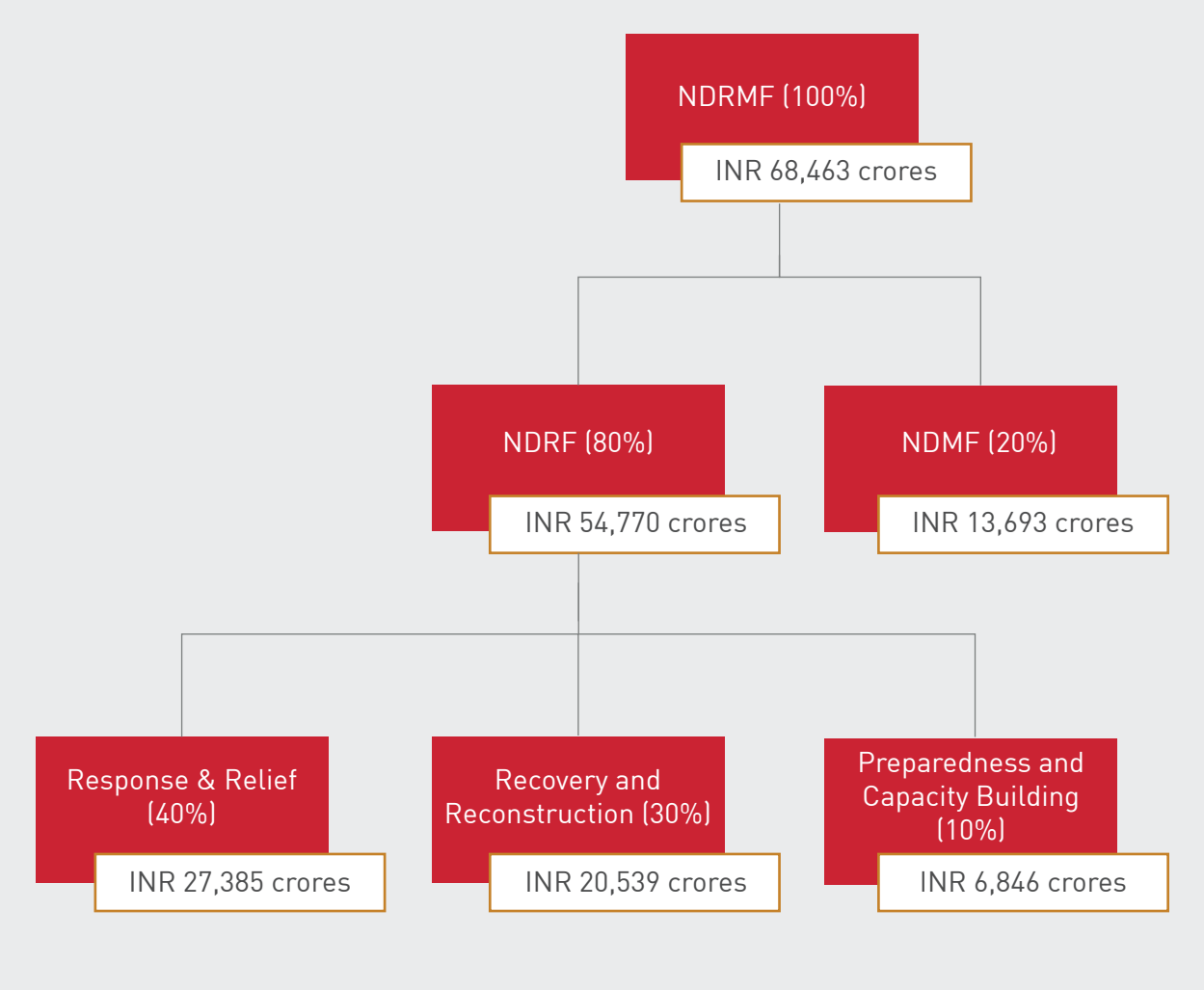
Also, as per Schedule VII of the Companies (CSR Policy) Rules 2014, companies may provide funds set up by the union government or state government for socio-economic development and relief. The governments can leverage this to develop incentives for the private sector to improve support for disaster management activities. In India, the optimal combination of regulation and incentives (both financial and non-financial) stimulates a resilient recovery. Effective government incentives can be localized depending on the regional characteristics of infrastructure and private sector capacity.

In a significant departure from the past, the report of the 15th Finance Commission (FC-XV) for the year 2020-21 recommended a new methodology, which presents a combination of capacity (as reflected through past expenditure), risk exposure (area and population), and hazard and vulnerability (disaster risk index) for determining state-wise allocation for disaster management.

3.2.4 15th Finance Commission

As per the 15th Finance Commission recommendation, the National Disaster Risk Management Fund (NDRMF) has been formed with two types of funding in disaster financing, i.e., the National Disaster Risk Fund (NDRF) and the National Disaster Mitigation Fund (NDMF). The NDRMF allocation is segregated among NDRF and NDMF in an 80:20 ratio. The NDRF allocation is further divided into response and relief (40%), recovery and reconstruction (30%), and preparedness and capacity building (10%) (see Figure 3.1).

Figure 3.1: Earmarked Funds for NDRMF as per 15th Finance Commission (2021-26)



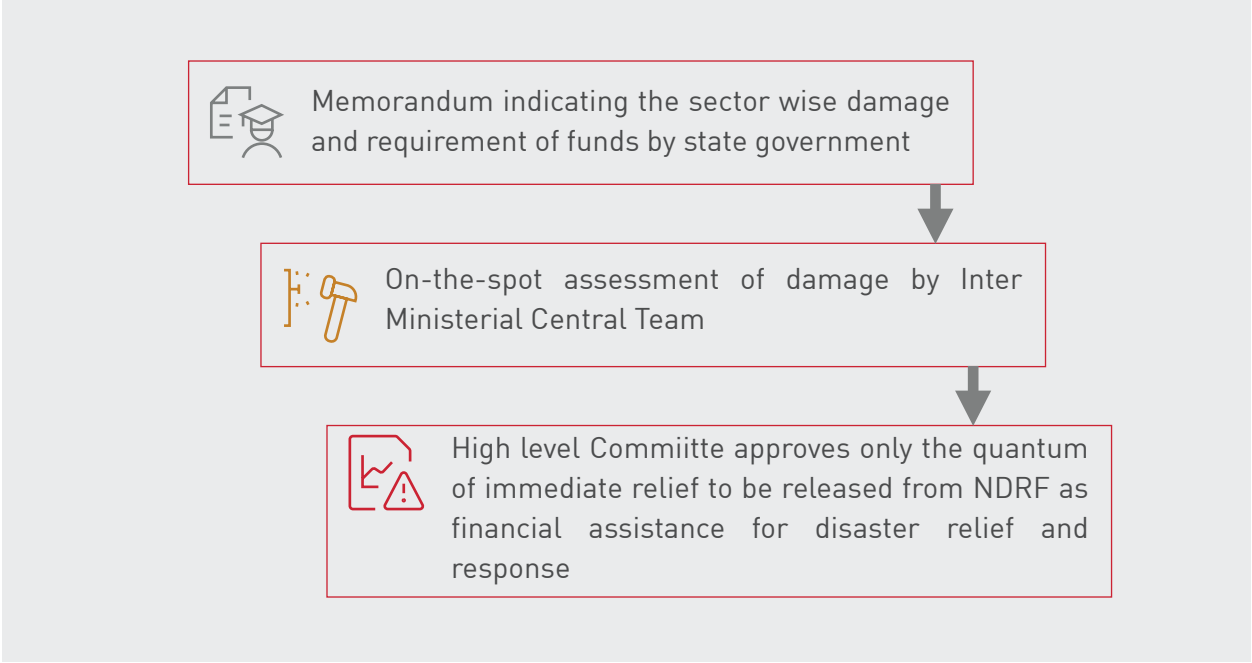
Source: KPMG Internal Analysis

3.2.4.1 National Disaster Response Fund

The state government plays a key role in managing disaster response, recovery and rehabilitation processes in the event of a disaster. During a calamity, if additional funds are required, they can be requisitioned from the National Disaster Response Fund as per the procedure (see Figure 3.2).

The Ministry of Power provides relief for repairing damaged power sector infrastructure immediately. Further assistance is given to damaged conductors, poles and transformers up to 11 kV, following the guidelines issued by SDRF and NDRF occasionally.

Figure 3.2: Procedure for Fund Allocation through NDRF



Source: KPMG Internal Analysis

Reinsurance for Infrastructure Protection and Mitigation Measures

In public finance, disasters are considered contingent liability of the state. The allocations made through the SDRF and NDRF help governments meet their contingent liabilities. However, the existing approach to meeting the contingent liabilities has two areas for improvement. First, it aims to meet the contingent liabilities and not reduce them. Governments need to invest in estimating risk exposure and taking appropriate measures to mitigate contingent liabilities. Second, the SDRF and NDRF, which function as dedicated reserve funds, are the only financial mechanisms for meeting the contingent liabilities. Infrastructure assets face significant risks from hazards, resulting in significant damage and loss during disasters. As governments are often viewed as the ultimate insurer, infrastructure protection typically lacks insurance coverage. When disasters occur, both union and state governments assist in infrastructure restoration. However, there is a pressing need for these resources to be more consistently sufficient for comprehensive restoration and reconstruction efforts.

With India's increasing scale of infrastructure, there is a pressing need for significant resource allocation to ensure adequate protection. Establishing a national risk pool for infrastructure in collaboration with an insurance company could support infrastructure protection efforts. The much-needed insurance protection can be provided against risks and incentivize investment in improved standards by encouraging infrastructure companies nationwide to participate in the risk pool.

The 15th Finance Commission recommends exploring an additional layer of protection against hazard events through the international reinsurance market. This form of protection would feature a parametric structure, targeting low-frequency but high-intensity disaster events, and would offer an additional layer of security through a global risk pool. The index for such disasters could be defined based on parameters such as magnitude and severity. For instance, a significant earthquake of magnitude 8 or a super-cyclone could trigger insurance payouts.

Procuring such insurance protection would require obtaining market quotes. Given the infrequency of disasters and the availability of a global reinsurance pool, the premium for parametric risk protection could be cost-effective. International reinsurance companies will compete for this coverage based on the magnitude of the hazard and the payouts involved. This insurance protection must remain cost-effective and cheaper than alternative forms of protection.

Following thorough due diligence, insurance mechanisms should be introduced, which serve as a social safety net and complement existing financial mechanisms in collaboration with insurance companies. These mechanisms should encompass a national insurance scheme for disaster-related deaths, aligning relief assistance with crop insurance, establishing a risk pool for infrastructure protection and recovery, and accessing international reinsurance for outlier hazard events.

The Finance Commissions have traditionally utilized an expenditure-based approach to allocate funds for disaster management to state governments. However, a novel methodology was introduced in the 2020-21 Report of the 15th Finance Commission. This method combined capacity (based on past expenditure), risk exposure (area and population), and hazard and vulnerability (disaster risk index) to determine state-wise allocations for disaster management. This approach will remain in effect for the five-year award period spanning 2021-22 to 2025-26.

Additionally, the 15th Finance Commission has recommended the continuation of mitigation funds at both union and state levels – the National Disaster Mitigation Fund (NDMF) and State Disaster Mitigation Funds – to support the implementation of mitigation measures as outlined in the Disaster Management Act, 2005.

The insurance industry has witnessed significant growth over the past decade, particularly following the 2015-16 adjustment that allowed for a 49 percent foreign direct investment in the sector under the automatic route. Major global insurance firms have established operations in India through partnerships with domestic players, introducing a wide array of life and non-life insurance services and products to the market. With rising household income, the Indian insurance sector is poised for robust expansion fuelled by product innovation, competitive premiums, improved claims management and enhanced regulatory oversight.

Leveraging the insurance sector could substantially alleviate the financial burden of disaster management on households, particularly those with higher socio-economic status. These insights are drawn from the 15th Finance Commission's report. In the 15th Finance Commission report, it was noted that the union government is also overseeing the implementation of the National Adaptation Fund for Climate Change (NAFCC) to bolster the adaptation efforts of states and union territories vulnerable to the adverse impacts of climate change.

Through the NAFCC, 30 projects across 27 states have been sanctioned, targeting adaptation issues in agriculture, water management, forestry and more. The Government of India has also initiated ambitious actions in renewable energy, afforestation, energy efficiency and urban development. Moreover, the transfer of resources on such a scale was observed to potentially impact poverty and risk affecting households and communities, especially the economically disadvantaged across the nation. However, it was noted that the union government's fiscal capacity for national-level disaster management has significantly declined.

As the disaster financing system continues to evolve, there is a recognized need to diversify financial services and instruments for disaster management. While public funds play a crucial role in providing consistent support to states, it was observed that they often need to catch up. This highlights the importance of recognizing the significance of alternative funding sources and the potential role of market instruments in risk management.

The 15th Finance Commission report advocated for strengthening systems, guidelines and capacities to support the planning and utilization of resources allocated at both the union and state levels. It highlighted that investing in the governance framework was crucial for improving outcomes in this sector.

While the Finance Commissions have maintained their stance against extending insurance coverage for disasters to the entire population, there is a compelling argument for introducing insurance and risk pooling in specific areas where market-based risk management instruments can be effectively utilized. Insurance becomes feasible and practical when there are large risk pools, availability of data on damage and loss, and the ability to estimate payouts with reasonable accuracy. The feasibility of insurance services is enhanced by an expanded risk pool, which could operate at national or global levels, and by quantifying risks through a comprehensive long-term database.

Moreover, insurance instruments work best for rare disasters that can have a significant impact. Hazards that happen once every five to ten years, depending on the peril, are best absorbed by public funds such as the SDRF and the NDRF. However, severe hazards occurring every ten to hundred years are more suited to be covered by insurance policies or catastrophe bonds. In line with these principles, four insurance interventions are proposed, which require further feasibility examination by the NDMA and relevant ministries. These insurance interventions would provide an additional layer of protection to the population. They are not intended to replace existing public fund mechanisms but to supplement and reinforce them, ensuring better protection for the people involved.

However, introducing these insurance mechanisms should be approached with due diligence in collaboration with insurance companies.

As per the 15th Finance Commission, some of the proposed insurance mechanisms are outlined below:

- National Insurance Scheme for Disaster-related Deaths
- Synchronising Relief Assistance with Crop Insurance
- Risk Pool for Infrastructure Protection and Recovery
- Access to International Reinsurance for Outlier Hazard Events

Furthermore, the 15th Finance Commission acknowledges the distinct identities of the disaster response and mitigation funds. It recommends creating separate accounting heads under the SDRF and NDRF to ensure efficient utilization of allocated funds for response and mitigation efforts. The Ministry of Home Affairs, in consultation with the Department of Expenditure in the Ministry of Finance, is advised to take appropriate action to establish these new accounting heads while formulating operational guidelines and norms for SDRF and NDRF.

Accordingly, sub-major heads corresponding to minor heads under various categories such as grants-in-aid from the central government, relief on account of calamities, grants-in-aid to state governments, and general and other reserve funds should be opened before the first instalment of 2021-22 for SDRF and NDRF is released. The Controller General of Accounts and Department of Expenditure are tasked with ensuring adherence to these accounting norms, with appropriate review by the Comptroller and Auditor General.

Key Takeaways

- **Disaster Funding Methodologies:** The 15th Finance Commission introduces a fairer allocation method based on capacity, risk, and vulnerability, aiming for equitable distribution from 2021-26.
- **Continued Support for Mitigation:** Mitigation funds like the NDMF are recommended for ongoing investment in proactive disaster reduction efforts.
- **Insurance as Financial Buffer:** The growing insurance sector, with increased foreign investment, can help alleviate disaster financial burdens, particularly for wealthier households.
- **Diverse Financial Mechanisms:** There is a push for diverse financial tools, including insurance for disaster-related deaths, aligning relief with crop insurance, and establishing risk pools for infrastructure protection, alongside accessing international reinsurance for rare events.

3.2.5 Paucity of Funds

In accordance with the established procedure, a three-tier system is followed to determine additional financial assistance from the NDRF. An inter-ministerial central team (ICMT), which includes representatives from sectoral ministries and departments and officials from the respective state, conducts assessments on the spot. The ICMTs report is then reviewed by the Subcommittee of the National Executive Committee (SC-NEC), which is presided over by the union home secretary and representatives from various relevant ministries. Subsequently, the SC-NEC's recommendations are then reviewed and approved by the high-level committee chaired by the Honourable Union Home Minister, including the Union Finance Minister, Union Agriculture Minister and the Vice Chairman of the NITI Aayog. As members approve, it is disposed of from the NDRF following HLC's approval. Figure 3.3 provides an insight regarding the bifurcation of SDRF funds.

Figure 3.3: Example of Allocation of SDRF

Name of the state	Allocation of SDRF (Rs. In Crore)		
	Central Share	State Share	Total
Andhra Pardesh	987.20	328.00	1315.20
Bihar	1248.80	416.00	1664.80
Gujarat	1168.00	388.80	1556.80
Maharashtra	2841.60	947.20	3788.80
Odisha	1415.20	471.20	1886.40
Uttar Pardesh	1705.60	568.00	2273.60

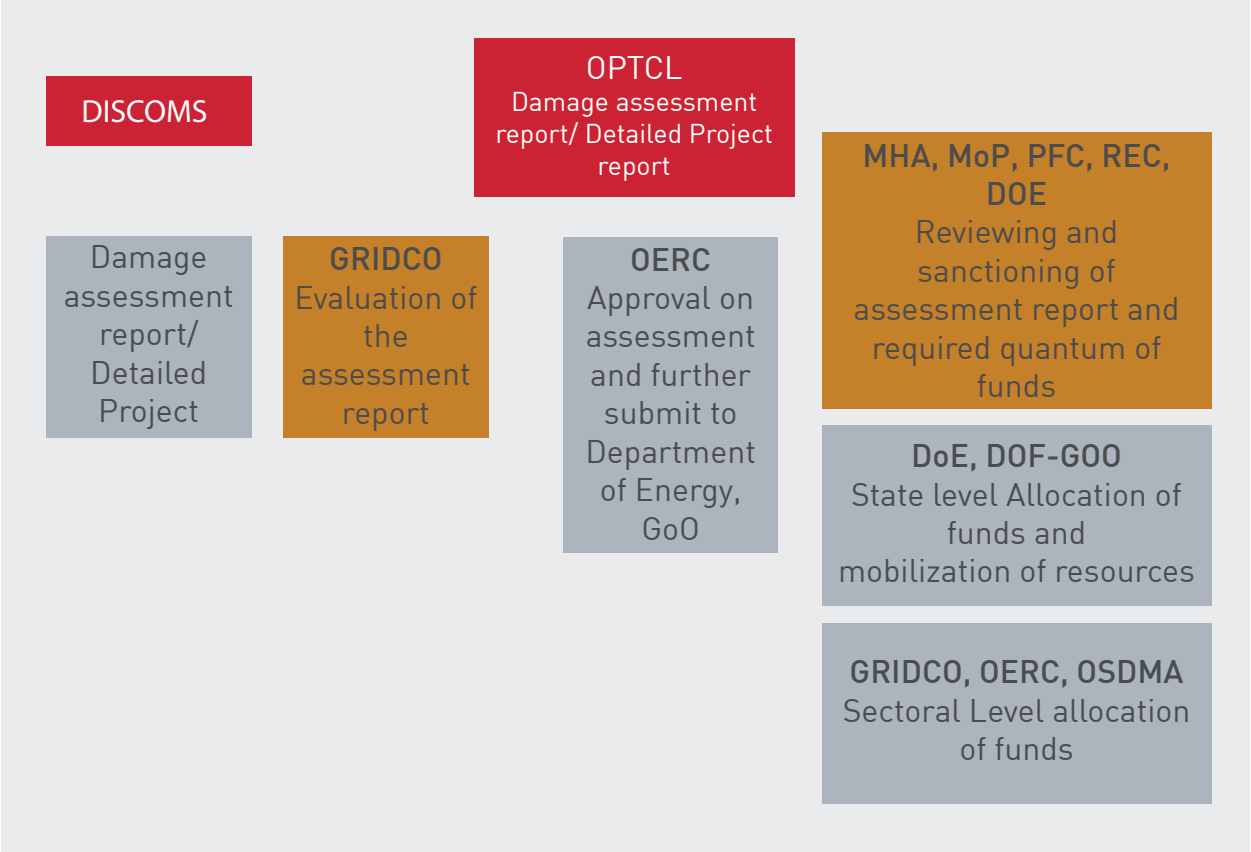
Source: Press Information Bureau (pib.gov.in)

Despite the best efforts to reduce infrastructure and livelihood losses, Odisha remains susceptible to cyclones and heavy rainfall. Being highly vulnerable to disasters, the power infrastructure in the state demands immediate mitigatory measures. The disruption of the electrical grid has far-reaching consequences affecting the critical components even more during such events, leading to the increased need for systematic investments.

3.3 Financial Arrangements: Role of Major Stakeholders

For fund allocation, DISCOMs and other stakeholders can submit a detailed assessment report, which is further reviewed by concerned state and central agencies. Once the report is approved, mobilization of funds is carried out (see Figure 3.4).

Figure 3.4: Disaster Financial Landscape of Odisha Power Sector



Source: KPMG Internal Analysis

3.3.1 Fund Mobilization

To facilitate the restoration activities post-disaster management, power utilities can request funding from NDRF/SDRF to immediately repair damaged power infrastructure, such as damaged conductors, poles and transformers up to 11 kV. Both power utilities/state governments can mobilize funds for response during/after a disaster by entering arrangements with financial institutions.

For effective pre-disaster fund mobilization, components and revisions need to be made in the existing schemes like the Revamped Distribution Sector Scheme (RDSS) scheme, which operates under nodal agencies like Power Finance Corporation (PFC) and Rural Electrification Corporation (REC). At present, the 'resilience' component is absent in most of the schemes at the national and subnational levels and adding such a component to the existing funding mechanisms will go a long way in achieving the long-term needs of the state in terms of disaster preparedness and mitigation.

To understand more about how the 'resilience' component could become an indispensable part of such schemes, let us look at the case of RDSS and how it has been catering to the financial needs of the projects in the power sector of India.

Future-Proofing Power Infrastructure: Disaster-Resilient Policy Development Frameworks

In the revised guidelines of the RDSS in 2023, a notable emphasis was placed on disaster resilient infrastructure (DRI) works. These initiatives are aligned with the disaster management plan (DMP) for the power sector issued by Central Electricity Authority (CEA) in January 2021 and subsequent revisions, as well as those outlined by NDMA. As a result, these initiatives are eligible for financial assistance under the scheme for DISCOMs. RDSS, with its focus on fortifying the distribution system, enhancing operational efficiency and ensuring quality power supply, has underscored the importance of resilience within the Indian power sector.

Through the RDSS initiative, utilities, primarily DISCOMs, crafted action plans to harness the scheme's benefits. These plans aim to strengthen the distribution system, improve overall performance and enhance operational resilience. While the current focus predominantly centres on reducing aggregate technical and commercial losses, there is a recognized urgency to expand these efforts, particularly in vulnerable regions such as coastal and high mountain areas, where critical infrastructure faces heightened risks.

The results evaluation framework within RDSS has been instrumental in guiding DISCOMs, incorporating crucial parameters like ACS-ARR gaps, and aggregating technical and commercial losses. However, to effectively address utility challenges related to disaster resilience, there is a growing need for more granular climate-risk data and implementing impact-based solutions and tools.

Looking ahead, as initiatives like RDSS evolve, it becomes imperative to maintain a robust disaster resilience component. This ensures that future schemes not only address operational and financial gaps but also prioritize resilience-building measures. By proactively integrating DRI into planning and financing strategies, utilities can enhance their ability to withstand and recover from disruptions, thus safeguarding power supply reliability.

It is important to note that even under the current scheme, areas with inadequate communication infrastructure face challenges in conducting energy audits. In such cases, utilities may need industrial solution providers/private sector assistance.

Under the Make in India and Atma Nirbhar Bharat Abhiyan initiatives, the Ministry of Power is recommended to collaborate with the CEA to streamline the process for Transmission and Distribution sector utilities to access funds for developing DRI), with special attention to vulnerable coastal and high-mountain regions. In this process, if DISCOMs have limited involvement in the standard bidding documents process, it would be beneficial if nodal agencies like PFC Consulting and REC Transmission Projects Company Limited are recommended to take proactive measures to facilitate easier fund releases for utilities.

CDRI's recent study on disaster risk financing is fully committed to bolstering the national infrastructure pipeline (NIP) in its pivotal objective of ensuring disaster resilience within the public infrastructure. The study is designed to support NIP projects by seamlessly integrating disaster and climate resilience considerations throughout their entire lifecycle, from conceptualization and design and extending to maintenance.

As part of this comprehensive approach, the study will meticulously evaluate standard agreements and contracts associated with infrastructure financing, proposing necessary adjustments to incorporate resilience features effectively. This includes a detailed examination of model concessional agreements for various line ministries and asset classes alongside standardized bidding documents and other relevant policy frameworks for both public-private partnership and engineering procurement construction project modes.

Additionally, the study will develop a specialized cost benefit analysis toolkit tailored specifically to assess resilience investments. By strengthening the resilience and sustainability aspects within these contractual documents, the overarching aim is to enhance project bankability, attract increased private sector investment and ultimately contribute significantly to successfully realizing NIP's vision for building resilient and robust infrastructure across the nation.

For the consequent implementation of the above in the power sector, discussions are recommended to involve the Ministry of Power, the CEA, and other relevant departments and agencies like Central Transmission Utility, PFC Consulting, REC Transmission Projects Company Limited and Central Power Research Institute for consultations.

Sources

1. RDSS FAQs - https://www.ipds.gov.in/RDSS_Docs/Letter_FAQ_RDSS_17082021.pdf

2. NERC, "Perspective on Resilience", October 2018 - https://usea.org/sites/default /files/event/NERC%20perspective%20on%20resilience%20-%20USEA%202018.pdf

3. RDSS Revised Guidelines, 2023 - RDSS Guidelines (6th Version, August 2023 - https:// recindia.nic.in/uploads/files/co-pmd-rdss-guidelines-om-version6-dt180823.pdf)

Fund mobilization can be made for specific activities under the disaster management plan, like project financing, creating disaster-resilient infrastructure and upgrading technologies. These efforts are essential for enhancing power infrastructure resilience during a calamity. To effectively build this resilient infrastructure, particular policy, institutional, design and financial considerations should be incorporated into the reconstruction plans of the Department of Energy, Odisha.

Table 3.1: Financial Assessment Conducted by Various Governing Departments

Departments / Stakeholders Involved	Detailed Damage Assessment Report/Detailed Project Report	Approval on Assessment	Approval on Quantum of Funds	Allocation and Mobilization of Funds -State-level Sectoral Distribution
MHA		✓	✓	
MoP		✓	✓	
CEA		✓		
REC			✓	
PFC			✓	
DoE	✓			✓
DoF			✓	✓
OSDMA/SDMA	✓			✓
GRIDCO	✓			✓
OERC	✓			✓
OPTCL	✓			✓
DISCOMs	✓			✓

Source: KPMG Internal Analysis

4 Early Warning System and Disaster Response Activities

4. Early Warning System and Disaster Response Activities

In the context of disaster management related to transmission lines, the primary focus revolves around tower damage and the resulting power outages from this damage, which can lead to significant economic losses. Areas within 60 km of the coast are the most severely affected. From the disaster management perspective of transmission lines, tower damage stands out as the key issue. While a severe cyclone has the potential to lead to flooding, floods/flash floods can exacerbate the situation further by leading to electrical outages. For instance, the flooding of transmission and distribution substations has resulted in service interruptions in the regions served by those substations.[2]

Therefore, it is crucial to establish mechanisms that minimize these losses for the state. This underscores the importance of implementing effective early warning systems and response measures to address such situations. A proper risk identification, estimation and early warning mechanism should be designed to mitigate the damages occurring and further build resilience.

'Early' signifies the time before the arrival of a hazard while there is still time to act upon and diminish the potential harm or loss. A 'warning' is a communication protocol, a statement, or an event that warns of something or is a cautionary example. A 'system' is a standardized set of principles or procedures according to which something is done or an organized scheme or method.[3] Timely dissemination of early warning information to vulnerable districts is necessary for effective mitigatory measures.

The early warning dissemination system is a robust communication infrastructure designed to bridge the current gap in effectively transmitting disaster warnings. It aims to enhance emergency response operations within the state. An early warning dissemination system is vital in disaster management as it provides timely alerts, reduces risk, aids in evacuation planning, allocates resources efficiently, promotes preparedness and resilience, safeguards the economy and encourages global collaboration. It plays a crucial role in minimizing damage and building resilient communities prepared to face various disasters.

Climate-Risk Data Collection and Access for Power Sector Stakeholders

[2]Disaster Management Plan for the Indian Power Sector, 2021

[3]https://unece.org/fileadmin/DAM/energy/se/pdfs/CSE/com-m28.2019/room_documents/CSE_28_2019_INF.10_-_Early_Warning_System_Concept.pdf

In the realm of climate change adaptation, governments worldwide are grappling with the imperative to revise their regulatory frameworks to address emergent environmental risks effectively. California is an illustrative case study within its electric power regulatory sector. From the meticulous planning of electric grid reliability to the intricate mapping of wildfire hazards and the strategic siting of coastal generators, California's approach shows the complexities inherent in integrating climate-relevant data into technical proceedings. Despite these challenges, there is optimism that policymakers, regulators and planners can learn valuable insights from California's three decades of climate adaptation efforts to formulate more resilient and transparent regulatory strategies.

Despite the notable expansion in climate research overseen by the California Energy Commission (CEC) since 2003, progress in adaptation initiatives remained limited. One significant development was the establishment of the California Climate Change Centre (CCCC) by the CEC in June 2003, serving as an online repository for the state's climate research. Additionally, the CEC initiated an annual conference on climate change research in 2004, further fostering collaboration and knowledge dissemination in the field. With the support of the CCCC and the CEC's PIER programme, publication outputs experienced a substantial increase, jumping from 6 papers published in 2004 to 40 papers in 2005 and maintaining an average of about 30 studies annually in the following years.

Regarding data management and collection for climate change, the focus primarily remained on generating research output rather than emphasizing the integration of findings into actionable policies for adaptation. Despite the wealth of data generated, more systematic efforts were needed to translate research insights into practical strategies to mitigate the impacts of climate change. This disjointed approach hindered the effectiveness of the research endeavours in informing adaptation initiatives at the policy level. To address these shortcomings, there is a clear need for improved coordination and integration between research efforts and policy development. Stakeholders advocated for a more cohesive approach prioritizing utilizing research findings to inform evidence-based adaptation strategies. Consequently, efforts were directed towards enhancing collaboration between researchers, policymakers and practitioners, facilitating the translation of research outcomes into policy-relevant recommendations. Through enhanced communication channels and strategic partnerships, there was a concerted effort to bridge the gap between climate research and adaptation policy development, thereby maximizing the utility of available data to address the challenges posed by climate change.

The CCAS highlighted the challenges inherent in translating climate research into actionable policy, particularly regarding data management and decision-making processes. While it laid the groundwork for future policy development, its shortcomings underscored the importance of clear goals, rigorous evaluation criteria and inclusive stakeholder engagement in shaping effective climate adaptation strategies. Through subsequent initiatives like the CCAAP/Pacific Council on International Policy (PCIP), efforts to advance climate risk data management and policy development in California continued to evolve, aiming for greater coherence and effectiveness in addressing the complex challenges posed by climate change.

Between 2005 and 2009, California's climate adaptation leadership underwent several shifts, leading to fragmented efforts and a lack of cohesive policy direction. However, in 2009, the PCIP organized a Task Force on Adaptation to Climate Change, which Governor Schwarzenegger subsequently appointed as the Climate Adaptation Advisory Panel. This marked a turning point in California's approach to climate adaptation, as PCIP's report introduced a comprehensive and policy-oriented vision for guiding adaptation efforts.

The PCIP report emphasized the importance of a coherent and science-based approach to adaptation, advocating for anticipatory data gathering, centralized climate risk assessment and integration of climate analysis into planning processes. Unlike previous efforts, the PCIP report focused on creating conditions for effective policy resolution rather than attempting to answer all criteria-level questions immediately. It recommended establishing a credible entity for assessing climate risks, integrating climate change analysis into all long-term planning processes and exploring mechanisms for funding adaptation actions.

The significance of the PCIP report lies in its departure from fragmented and reactive approaches to climate adaptation. By prioritizing anticipatory data gathering and centralized risk assessment, it provided a framework for informed decision-making and proactive adaptation measures. Additionally, its emphasis on integrating climate analysis into planning processes ensured that adaptation considerations were systematically incorporated into development initiatives. Following the PCIP report, the Governor's Office of Planning and Research issued the Adaptation Planning Guide in September 2012.

While primarily descriptive, the Adaptation Planning Guide built upon the PCIP's recommendations and strengthened the state's capacity for adaptation policymaking. It provided valuable insights and suggestions based on existing practices in various jurisdictions, facilitating knowledge-sharing and collaboration among local and regional organizations. The California experience offers valuable lessons for developing countries like India grappling with climate risk management. First and foremost, adopting a proactive and integrated approach to climate adaptation is essential. By prioritizing anticipatory data gathering and centralized risk assessment, policymakers can make informed decisions and allocate resources effectively. Additionally, integrating climate analysis into planning processes ensures that adaptation considerations are mainstreamed into development initiatives, enhancing resilience and sustainability. Furthermore, fostering collaboration and knowledge-sharing among stakeholders is crucial.

The PCIP report and subsequent guidance documents demonstrate the importance of leveraging existing practices and experiences to inform adaptation efforts. Developing countries can benefit from similar initiatives that facilitate learning and exchanging local, regional and national best practices. The California experience underscores the importance of proactive leadership, strategic planning and collaboration in addressing climate risks. By drawing upon these lessons, developing countries like India can enhance their climate adaptation efforts and build resilient communities capable of mitigating the impacts of climate change.

Key Takeways

1. **Integrated Data Management:** California's experience emphasizes the importance of integrating climate data into policy and planning processes for effective adaptation strategies.

2. **Stakeholder Engagement:** Collaboration between researchers, policymakers, and other stakeholders is crucial for informed decision-making and the development of comprehensive adaptation initiatives.

3. **Policy-Oriented Vision:** The Pacific Council on International Policy's report provides a framework for proactive adaptation measures, advocating for anticipatory data gathering and centralized risk assessment.

4. **Learning and Knowledge Sharing:** Developing countries can benefit from exchanging best practices and experiences with regions like California to enhance their capacity for climate risk assessments and build resilient communities through integrated data collection, access, and management across utilities and nodal agencies.

4.1 Information Mapping for the Power Sector

In the case of cyclones and floods, risk identification and estimation are undertaken by the Indian Meteorological Department (IMD) and Central Water Commission (CWC), respectively, which involves collecting historical time weather data to estimate the frequency of hazards. This information is disseminated by different central state agencies along with line departments (see Table 4.1).

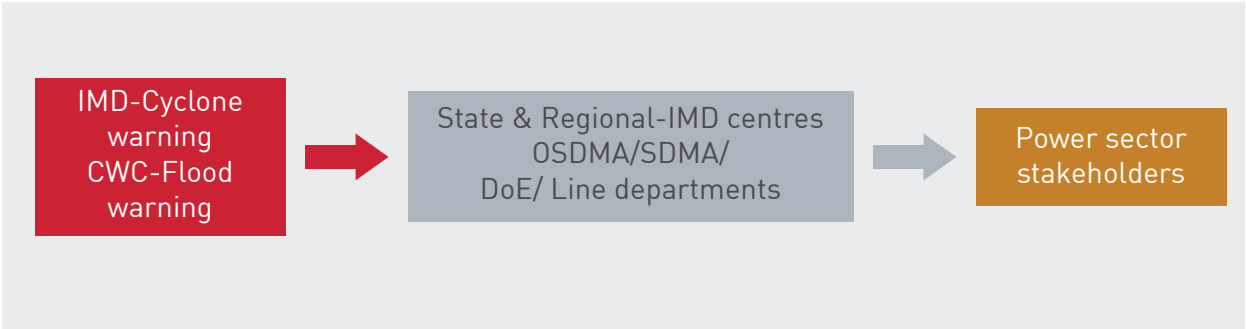
Table 4.1: Agencies Involved in Disseminating Information on Cyclones and Floods at the Central Level

Hazard	Ministry	Agency
Cyclone	Ministry of Earth Sciences	India Meteorological Department Regional Specialized Meteorological Centre Tropical Cyclone Warning Centres for different regions
Floods	Ministry of Jal Shakti	Central Water Commission

Source: DMP for Power Sector, 2021

The state-level agencies include institutional arrangements involving offices of IMD (State Meteorological Centres and regional centres), State Disaster Management Authority (SDMA), DM Commissioner and other line departments for sectoral dissemination of cyclone impact in protecting the infrastructure[4] (refer to Figure 4.1).

Figure 4.1: Schematic flowchart for Cyclone/Flood Information Dissemination at the State Level



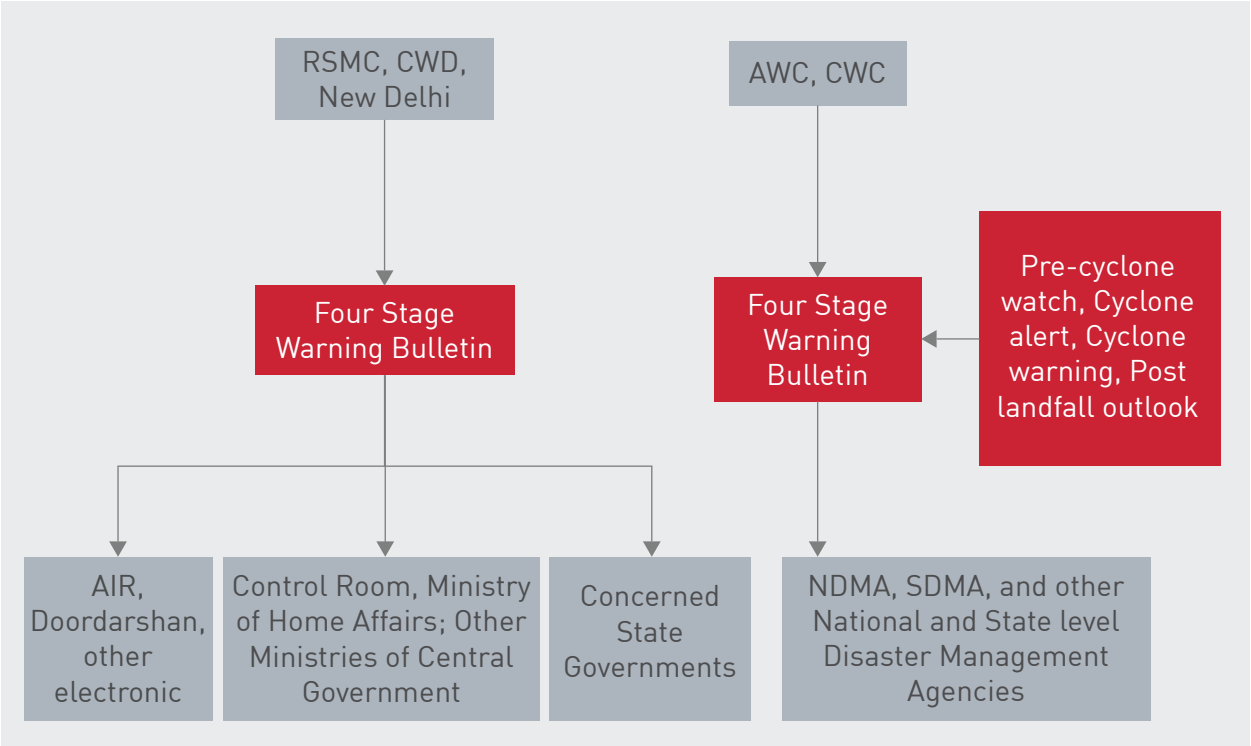
Source: DMP for Power Sector, 2021

4.2 Institutional setup for Cyclone and Flood early warning system

To improve the efficiency of locating targets and ensuring quick preparedness for power restoration during emergencies like cyclones and floods, an institutional mechanism has been set up to disseminate warnings and alerts. Cyclone operations are carried out by the IMD in alignment with the Regional Specialized Meteorological Centre (RSMC) at the central level to disseminate warnings. A four-stage warning bulletin (Figure 4.2) has been developed. It is distributed to control rooms of MHA and other concerned ministries (at the national level) as well as to SDMA's and allied departments (state level). This is accomplished through various communication channels, aiming to mitigate the impact of such disasters. Similarly, an institutional mechanism has been set up for the flood warning system (refer to Figure 4.3), ensuring effective information dissemination at national and state levels.

[4]https://nidm.gov.in/PDF/pubs/NDMA/4.pdf

Figure 4.2: Institutional Setup for the Cyclone Warning System

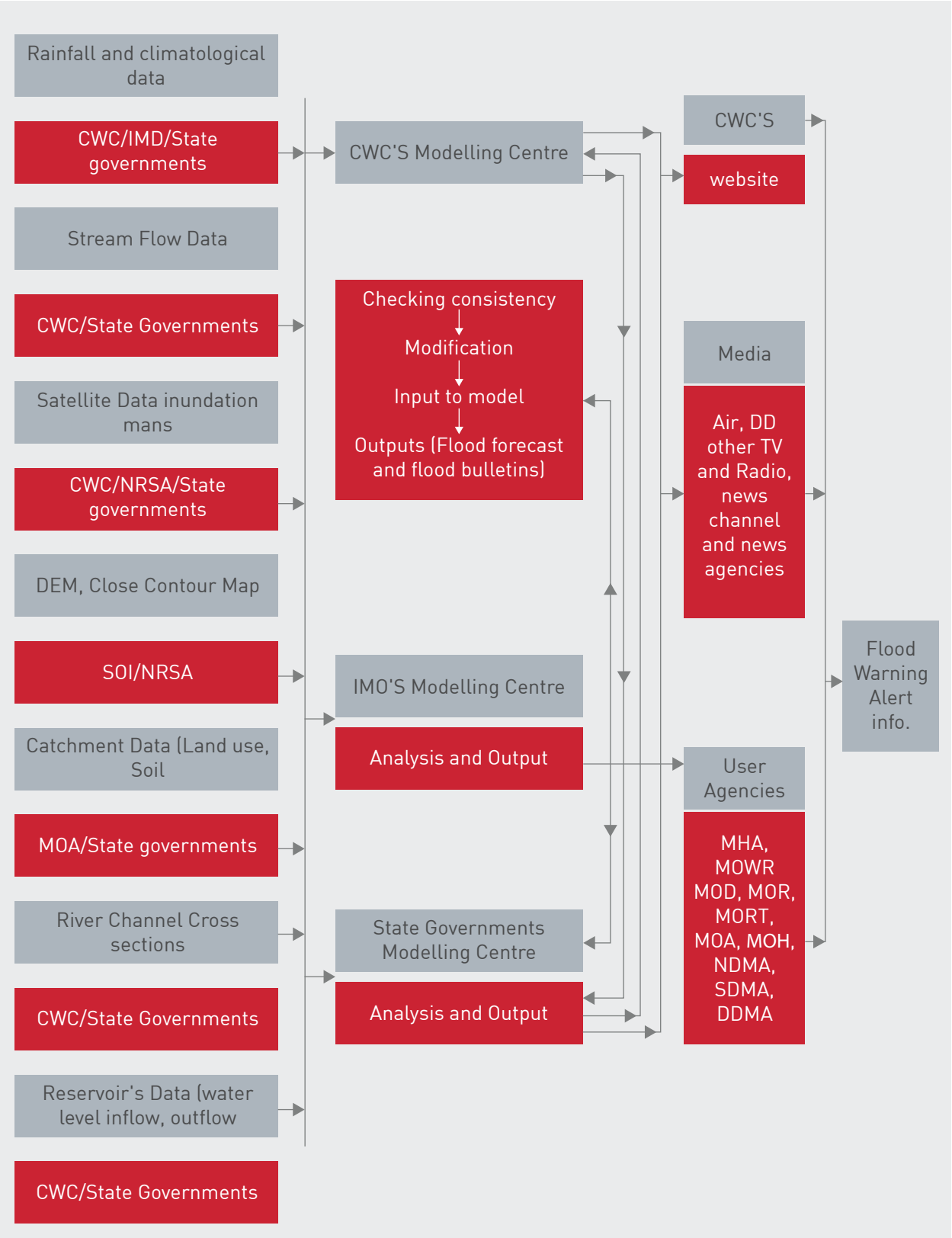


Source: DMP for Power Sector, 2021

On the ground level, the cyclone response structure will be activated upon receiving a cyclone warning from the IMD. The occurrence of a cyclone may be reported by the IMD to the Commissioner of Relief/Gujarat State Disaster Management Authority (GSDMA). as soon as possible. The Commissioner of Relief (CoR) will activate all the Departments for Emergency Response, including the State Emergency Operation Centre (EOC), District EOC and ERCs. CoR will further issue instructions to include the following details:

- Specify the exact resources (in terms of human resources, equipment and essential items from key stakeholders) required.
- The type of assistance to be provided.
- The time limit within which assistance is needed.
- Details of other task/response forces through which coordination should occur.
- The State EOC, ERCs and other control rooms at the state level, as well as district control rooms, should be activated with full strength.

Figure 4.3: Institutional Setup for Flood Warning System



Source: DMP for Power Sector, 2021

Case Study 4.1: Hurricane Simulation Model - Texas, United States

In India, stakeholders across different levels face challenges due to the lack of comprehensive ground-level data availability. To address this, there is a critical need for a robust framework ensuring the integrity of data collection processes. Without reliable data, it becomes challenging to accurately assess the economic impacts of power interruptions and to consider other societal impacts, as observed in the case study of Hurricane Harvey in Texas.

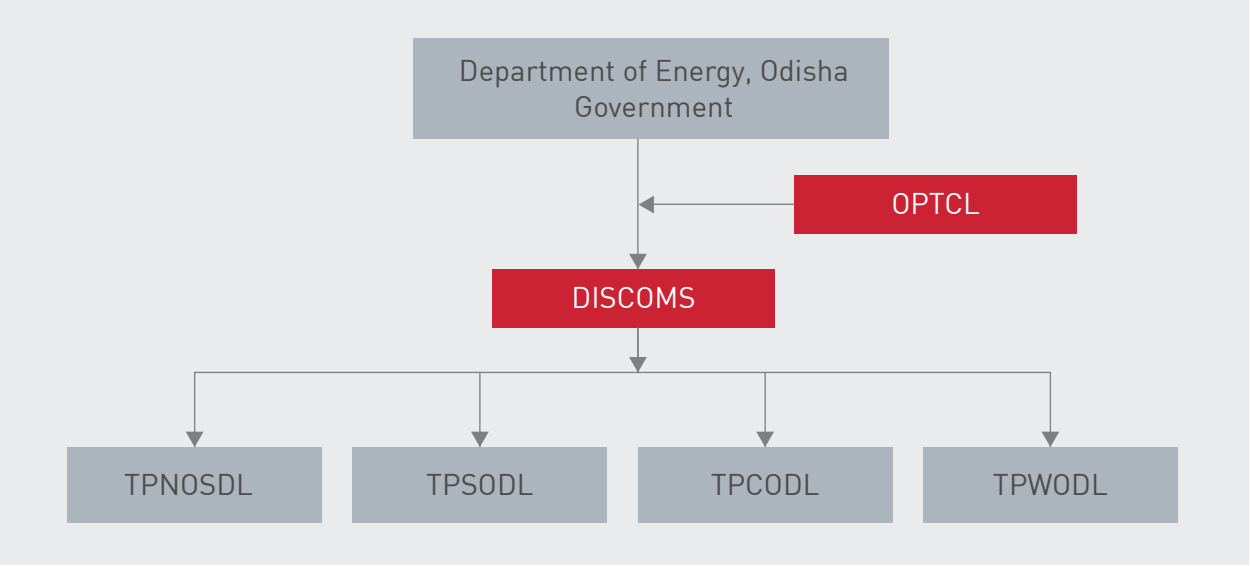
To improve preparedness, Indian utilities can learn from the approach taken in Texas, where a hurricane simulation model was utilized to evaluate the costs and benefits of storm-hardening activities. This model simulated hurricane scenarios, projecting infrastructure damage and guiding decision-making on post-storm actions. Indian utilities could adopt similar models tailored to local conditions, facilitating proactive measures such as hazard tree removal and targeted infrastructure hardening. Additionally, enhancing post-storm data collection processes is crucial for informing effective responses and improving resilience against extreme weather events.

Source: https://emp.lbl.gov/publications/case-studies-economic-impacts-power

4.3 Power Sector Stakeholders (Transmission and DISCOMs): An Overview of their Disaster Risk Identification, Preparedness and Response Processes

The Department of Energy, Odisha government has public sector undertakings such as Grid Corporation of Odisha Limited (GRIDCO), Odisha Power Transmission Corporation Limited (OPTCL), Odisha Hydropower Generation Corporation Limited (OHGC) and Odisha Power Generation Corporation Limited (OPGC) (Figure 4.4). The power sector is one of the most affected sectors due to cyclones and floods in Odisha that, in turn, gravely impact the economy of DISCOMs and transmission companies.

Figure 4.4: Major Stakeholders of Power Infrastructure in Odisha



The institutional management of different organizations under the Department of Energy for disaster management is described in the following sections.

4.3.1 Odisha Power Transmission Corporation

OPTCL is the main transmission company in Odisha. The density of the network is higher in the coastal belt and around industrial areas. As the system deals with only bulk power transmission, extra high tension (EHT) towers with associated lines, interconnecting transformers, autotransformers, power transformers and grid S/S are the most important infrastructures of the organization. These infrastructures are most likely to be affected by cyclones, tsunamis and floods, which, if afflicted on a large scale, may lead to disaster in terms of disruption of power supply to large areas.

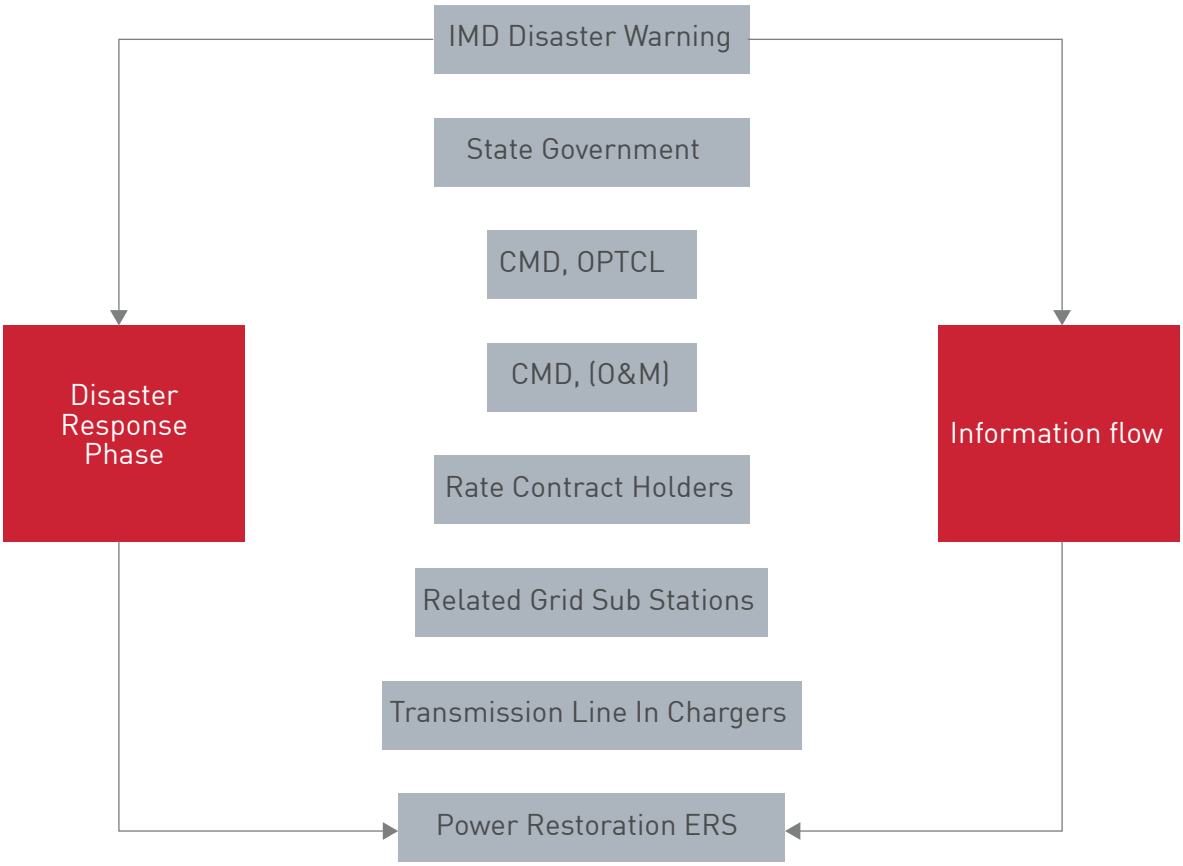
According to the Odisha Department of Energy Disaster Management Plan,[5] the main emerging concern for OPTCL is the increase in the number of cyclones originating in the Bay of Bengal, which can be attributed to El-Nino effects, natural variability and global warming effect. This increases the frequency and impact of cyclones, presenting a daunting challenge to OPTCL for safeguarding the transmission network within 60 km of the coastal belt where the density of habitation, load and EHT wires network is very high.

[5]Odisha Department of Energy DMP 2018

In the event of an impending disaster, the warning is issued by the IMD and passed on to the state government. The information is then relayed to the control room at corporate DISCOM's office to the Chief Managing Director (CMD) (see Figure 4.5). The CMD then informs the Chief General Managers (CGM) about the disaster and its probable implications. The CMD also provides instructions on required preparedness for any contingencies, which may differ from case to case according to the nature of severity. CGM, primarily CGM (O&M), intimates all concerned field engineers to prepare human resources and materials according to the checklists already provided. A 24/7 control room is enacted in the CGM (O&M) office and acts as the main control centre to track events and forward directives.

The communication is carried out through the control room via landline, mobile phones and hotline communication through the State Load Despatch Centre (SLDC) via Optical Ground Wire (OPGW). After that, the rate contract holders mobilize to provide the workforce to demobilized zones with vehicles, food, fuel and T&P. They act as the main source of logistics support during such situations. The related grid substations act as mini control rooms for facilitating communication, and transmission line in-chargers are asked to assess the towers for any damage and/or to replace missing workers. Substation and line materials are released to their site to create buffer stock.

Figure 4.5: OPTCL Institutional Structure for Disaster Management



4.3.2 Distribution Companies

Odisha has four major distribution companies (DISCOMs), namely Tata Power Northern Odisha Distribution Limited (TPNODL), Tata Power Southern Odisha Distribution Limited (TPSODL), Tata Power Western Odisha Distribution Limited (TPWODL)[6] and Tata Power Central Odisha Distribution Limited (TPCODL). All these four DISCOMs are incorporated as a joint venture of Tata Power (51%) and Odisha government (49%) on the public-private partnership (PPP) model. All these four DISCOMs have their own organizational structure and processes to incorporate hazard data in their Business Continuity and Disaster Management Plans. Table 4.2 discusses the vulnerabilities and damage caused to various DISCOMs by cyclones. Table 4.3 discusses resilience preparedness and post-disaster response at stakeholder level.

Table 4.2: Vulnerabilities and Damage Caused to Various DISCOMs by Cyclones

DISCOMs	Vulnerabilities towards cyclone
TPSODL	Tata Power Southern Odisha Distribution Ltd (TPSODL) distributes electricity in the southern coastal part of Odisha. The company operations span across Ganjam, Boudh, Malkangiri, Rayagada, Gajapati, Kandhamal, Nawrangpur and Koraput. The most affected areas are Ganjam, Gajapati and Kandhamal. Only Ganjam district falls under the very high damage risk zone – B (wind speed 50 m/s) for cyclones. The remaining districts fall in wind zones of 44 m/s and 39 m/s wind speeds, which are relatively low-risk areas. Damage has been caused mainly to substations, low-tension lines, conductors and DTR lines.
TPCODL	Tata Power Central Odisha Distribution Ltd (TPCODL) distributes electricity in the eastern coastal part and the capital region of Odisha. Its operation spans Cuttack, Puri, Dhenkanal, Angul, Khurda, Kendrapara, Nayagarh, Jagatsinghpur and Jajpur. According to the IMD report, Puri, Khurda, Cuttack, Jagatsinghpur and Kendrapara remain the five most affected districts due to the onslaught of cyclones. This makes TPCODL highly vulnerable courtesy of its operation in these worst-affected districts due to cyclones.
TPNODL	In Tata Power North Odisha Distribution (TPNODL) Ltd operates in Kendujhar, Mayurbhanj, Balasore, Bhadrak and Jajpur. Out of which Balasore and Bhadrak are affected and supporting materials of lines and S/s along with DTRs and PTRs are highly damaged.

[6]Being least prone to cyclone, TPWODL has not been taken into consideration.

Table 4.3: Resilience Preparedness and Post-Disaster Response at Stakeholder Level

Stakeholder	Risk Identification and Resilience Enhancement Preparedness	Post-disaster Response
OPTCL	OPTCL has undertaken the risk management in the following ways: » Integration of data from the risk identification process for the decision-making process forresilience enhancement. » In OPTCL, most of the grids are interconnected, but still, some of them are in radial networks; hence, plans are formulated to convert these radial networks to a complete three-stage ring system at 400 kV, 220 kV and 132 kV levels, which will eliminate the risk of blackouts during disaster to a great extent. Also, owing to the proneness of the structure, more attention is given to safeguarding the EHT lines during disastrous situations. » Strengthening existing lines and reducing the span length by providing interposing towers are also put on the agenda for disaster resilience. » Introduction of new technology to enhance the preparedness of OPTCL to tackle risks emerging from cyclones, floods and other disasters i.e., Live line maintenance, modern testing equipment, implementation of ERP and GIS.	After receiving the information from IMD, primarily CGM (O&M) intimates all concerned field engineers to get ready with men and material according to the checklists already provided to them. A 24/7 control room is enacted in the CGM (O&M) office and acts as the main control centre to track events and forward directives. The communication is carried out through the control room via landline, mobile phones and hotline communication through the State Load Despatch Centre (SLDC) via Optical Ground Wire (OPGW). After that, the rate contract holders are mobilized to provide manpower to different zones with vehicles, food, fuel and T&P. Mock drills are conducted intermittently to refresh different activities and procedures adopted during the erection of these towers. To complement the Emergency Restoration System (ERS), measures to strengthen the response of OPTCL have been carried out, for instance, the deployment of an emergency restoration group, power system stability, emergency inventory stock, under frequency relay, DG sets.

Stakeholder	Risk Identification and Resilience Enhancement Preparedness	Post-disaster Response
DISCOMs (TPSDOL, TPCODL and TPNODL)	» TPSODL's Business Continuity and Disaster Management Plan (BCDMP) identifies and reduces the risk exposures and proactively manages the contingency. ISO Standard defines Disaster Recovery Management as an integral part of BCDMP.	The Emergency Management Team plays an important role at the circle level in assisting the local field operations team. The members of this team are pre-identified and drawn from various functions and will be on standby for deployment on invocation of L2 and L3 level disasters.

4.4 Global Frameworks Towards Building Resilience

Disasters have proved that no organization is immune to crises. While the impact of the disaster has no bound and demarcation, it could adversely impact the flow of the economy internally and externally, harming commerce, economy, customers and supply chain. Whenever a disaster strikes, nodal agencies, such as infrastructures, networks and other essential services, get disrupted. To manage the unforeseen current and future threats to the organization, a proactive approach should be taken to mitigate the impact of the hazard. The inclusion of some of the benchmarking standards used in other countries must be evaluated to increase institutional preparedness.

A few of the globally used standards (Annexure A1.3.5) focusing on business continuity and minimum disruptions are mentioned below, specifically focusing on disaster preparedness and mitigation.

1. ISO/PAS 22399:2007 Societal Security: Guideline for Incident Preparedness and Operational Continuity Management

2. ISO 22301:2012 Business Continuity Management

3. BS 65000:2022 Organizational resilience. Code of Practice

While incidences of severe disruptions have been observed in the power sector, measures to improve and enhance resilience have also been carried out. The unavailability of equipment and inaccessible geographical locations for restorations reduced the efficiency of proper restoration.

Although response and recovery measures have been taken to mitigate the impacts of cyclones and floods on disaster events, more emphasis on risk governance and preparedness must be focused. Recovery and reconstruction should constitute short- and long-term efforts, including timely restoration of disrupted utility services and deployment of skilled human resources by enhancing capacity building. It has also been observed that a lack of skilled and technical human resources increased the response time.

4.5 Post-Disaster Response, Recovery and Reconstruction (3R) in Odisha

The **response** to a disaster includes measures taken immediately after receiving an early warning from the relevant authorities to reduce the fatalities and damages incurred to infrastructure. It includes the temporary restoration of key infrastructure and the quick allocation and mobilization of resources. The **recovery** efforts aim to explore short-term to long-term reconstruction options. It involves immediate relief assessment, infrastructure restoration and economic rehabilitation. Owing to the vulnerabilities faced by the power sector, effective and timely response relies on disaster preparedness. Long-term reconstruction focuses on building resilient environmental considerations in capacity building. Together, response, recovery and reconstruction aim to restore and finance communities with better preparedness for future cyclonic events.

For the power sector, it is important to have a proper understanding and clarity of plans, course of actions, line of commands, steps and guidelines on roles and responsibilities to have efficient responses (see Figure 4.6). The general response action for the power sector in a catastrophic event is as follows:

1. Assessment of the temporal and spatial extent of the hazard
2. Immediate deployment and mobilization of teams and resources
3. Control strategies – Black start facilities, etc.
4. Restoration of the electricity grid

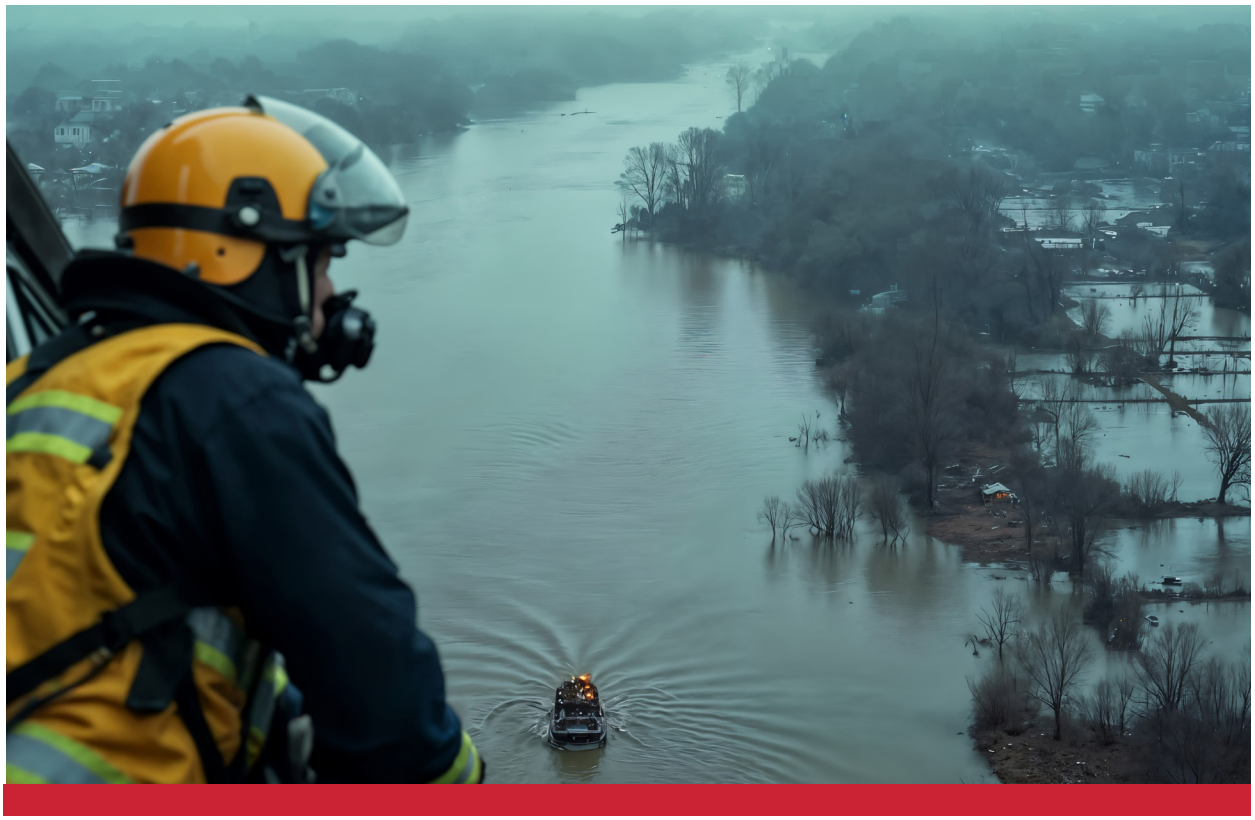
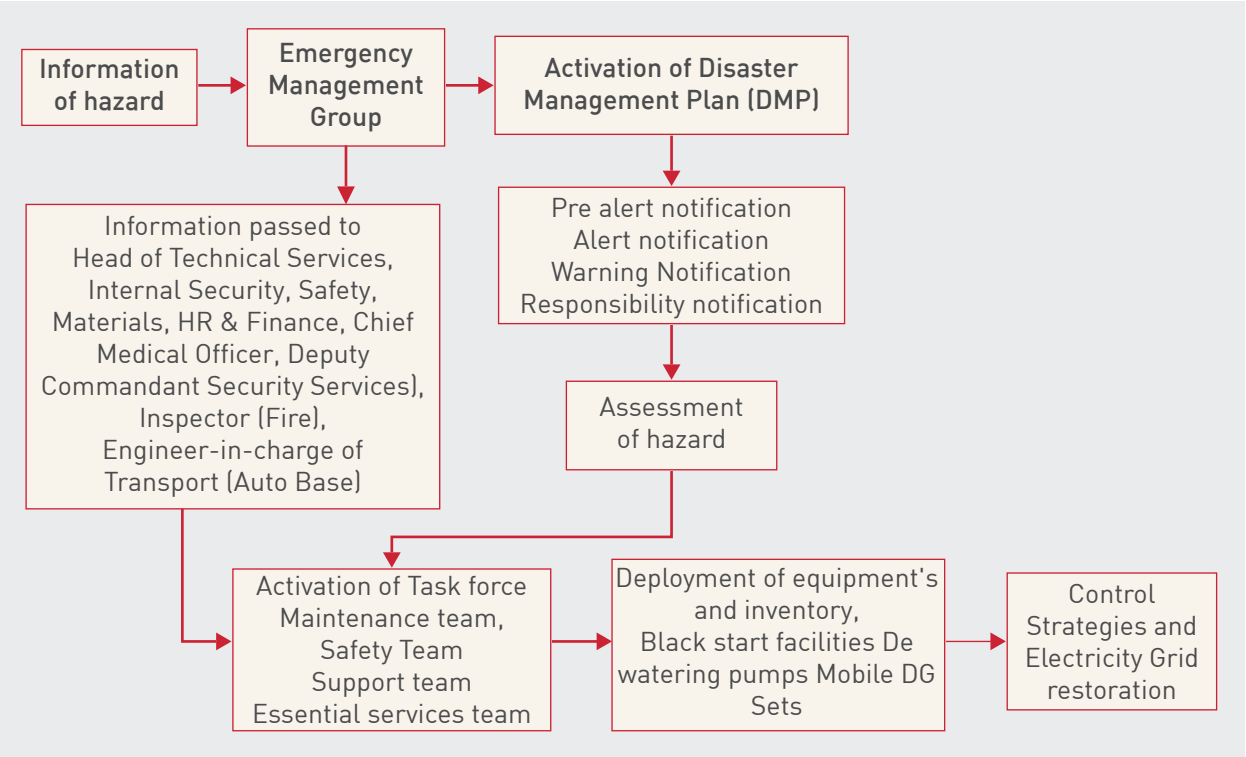


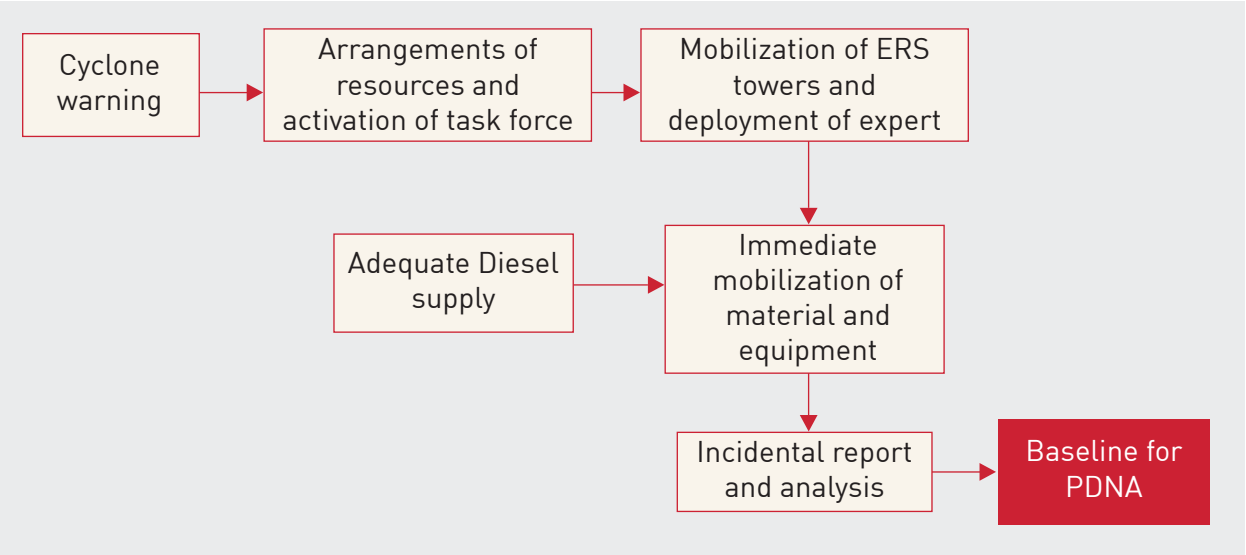
Figure 4.6: Disaster Response Action for Power Sector Following a Hazard



Source: DMP for Power Sector, 2021

Apart from the general course of action, additional plans are also needed during a cyclone, as mentioned in Figure 4.7.

Figure 4.7: Response Action for Power Sector w.r.t Cyclone



Source: KPMG Internal Analysis

As the first responders, local authorities provide an immediate response during any disaster. It is further supplemented with the support of state government departments. In addition, the central government complements the efforts by providing financial and non-financial aid. Effective coordination of responses and institutional arrangements from central and state levels are deployed and further communicated to the concerned lines in departments.

4.6 Institutional Arrangement for Reconstruction Activities in Odisha

Odisha has integrated a robust institutional arrangement to structure reconstruction activities in the state compared to other states in the country. The reconstruction phase plays an important role as it provides a way forward to decide the different structural mitigation approaches to be opted for by the state. For instance, during this stage, decisions can be made about retrofitting buildings or implementing underground cabling.

In the Odisha State Disaster Management Plan (DMP), it has been mentioned that the state government departments are responsible for carrying out relief, reconstruction and rehabilitation activities under the supervision of the Office of Special Relief Commissioner (SRC) and the Collector at the state level and the district level, respectively. The SRC coordinates with districts/departments for quick relief and rescue operations, reconstruction and rehabilitation work. The Odisha State Disaster Management Authority (OSDMA) is mandated to take up not only mitigation activities but also relief, restoration, reconstruction and other measures. OSDMA is responsible for facilitating coordination with the line departments involved in reconstruction. At the district level, the district administration is responsible for undertaking post-disaster rehabilitation and reconstruction activities by coordinating with district-level line departments and Panchayati Raj Institutions (PRIs). PRIs and urban local bodies (ULB) support the district administration, office of the SRC and OSDMA in reconstruction and disaster management activities. The Odisha government has proposed and undertaken multiple projects to reconstruct power infrastructure in consultation with various developmental organizations. To enhance the resilience of power infrastructure, the Odisha government has also formulated reconstruction projects with the collaboration of OSDMA, the United Nations agencies, the World Bank and the Asian Development Bank.

4.7 Recovery and Reconstruction: An Opportunity to Build Back Better

The recovery phase starts shortly after the response phase, aiming primarily at infrastructural assets. It emphasizes providing recovery assistance and aid while addressing both structural and non-structural vulnerabilities. The goal is to establish sustainable pathways to improve resilience and enhance the capacity of different sectors to withstand damages, paving the way for long-term recovery. To minimize the losses that occur in the power sector, it is essential to implement small-term and long-term recovery interventions. These interventions aim to improve policymaking and implementation, improve governance mechanisms and mobilize resources efficiently and effectively. Incorporation of specific timelines and prior implementation leads to mitigation before the onset of disasters such as cyclones and floods, thus reducing disruptions.

To mitigate further damages and disruptions, efficient regulatory governance and institutional mechanisms should be opted for. This approach focuses on sectors vulnerable to various catastrophic events, aims towards multi-sector recovery and builds an integrated approach to make a recovery inclusive of disaster risk reduction (DRR).

Integrating the Build Back Better approach with effective streamlining of available resources and defined roles and responsibilities of all stakeholders is crucial to enhancing power sector resilience. Ensuring robust outcomes during the recovery phase requires improved standards and infrastructure specification and the inclusion of global best practices.

The recovery task includes pre-defined strategies and policies to facilitate the recovery action chain. Recovery is a dynamic process that involves periodic reviews and assessments, as well as monitoring and evaluating budget and resource allocation towards the road to recovery.

Generally, the recovery process includes three stages:

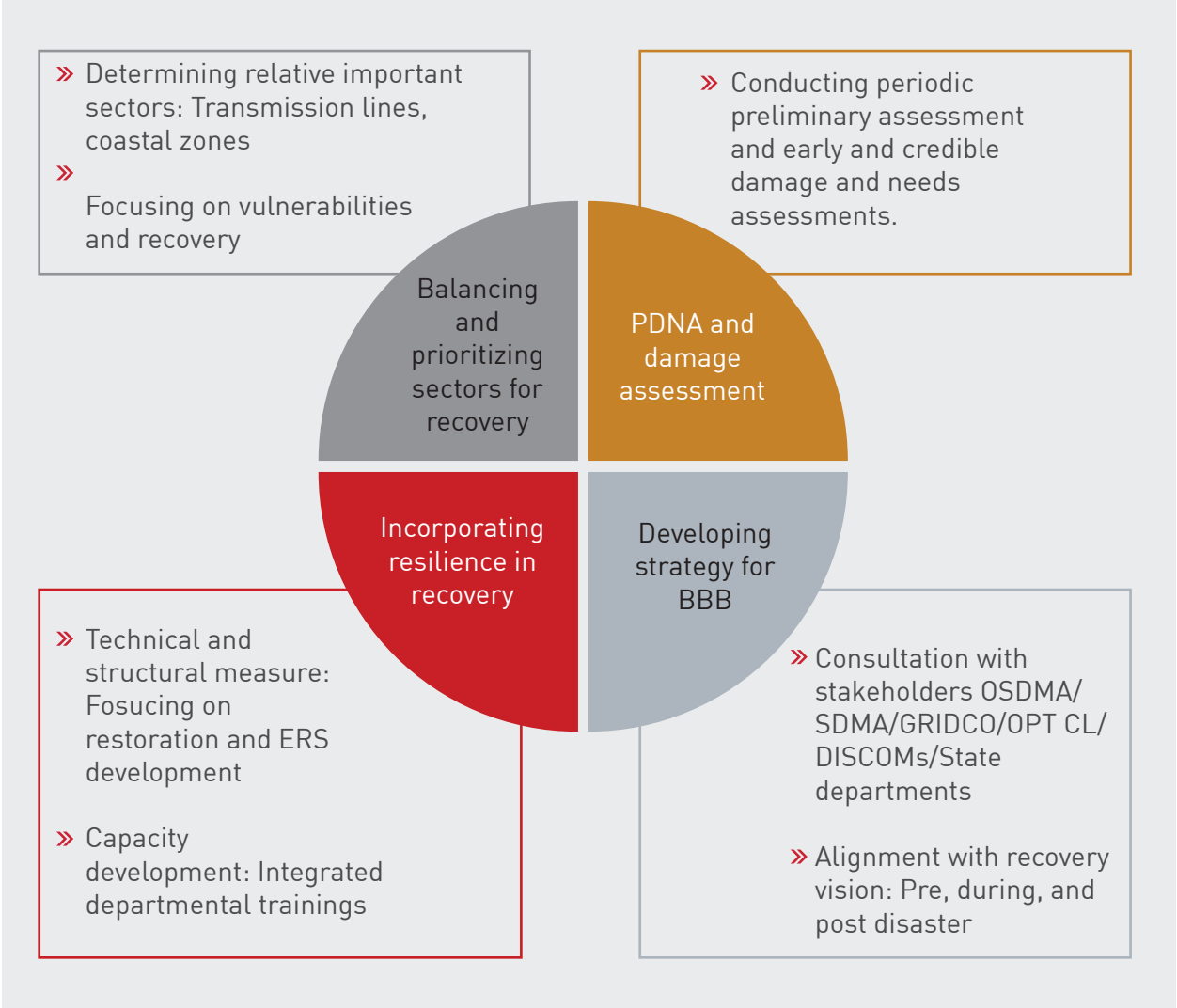
1. **Damage assessment:** An incidental report performed by the Emergency Management Group serves as baseline data for initial damage assessment to assess the impact of the disaster on power infrastructure. The extent and type of damage, as well as the financial aid and assistance required, are evaluated.

2. **Post-disaster gap analysis:** The fap analysis provides an analysis to identify voids and find resilient steps to improve the response and preparedness process.

3. **Inclusion of DRR for resilient infrastructure (i.e., reconstruction):** It includes Build Back Better measures in developmental plans and policies to construct a resilient infrastructure.

While the recovery and reconstruction expenditure of any disaster is limited to disaster financing, loans from national and international agencies can be incorporated owing to the principles of risk. The allocation of funds and mobilization of resources from the central agencies to the state government under disaster relief should be assessed and allotted based on factors such as exposure, severity, impact need assessment, and the actual expenditure that occurred in the past experiences. The major steps of recovery involved are mentioned in Figure 4.8.

Figure 4.8: Steps for Recovery Process w.r.t Power Sector

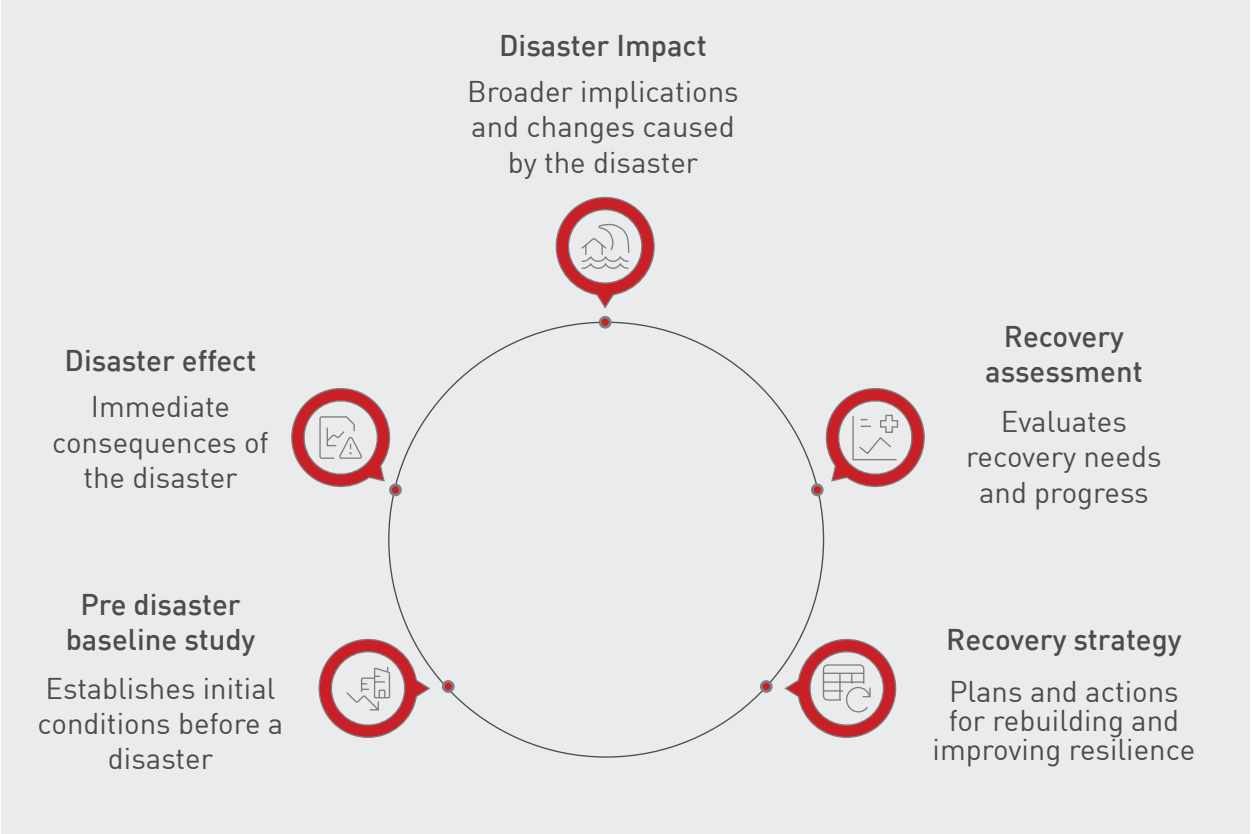


Source: NIDM

4.8 Post-Disaster Needs Assessment

Post-disaster needs assessment (PDNA) helps assess the social and financial consequences of a catastrophic event. It identifies the gaps and further provides a way forward to build recovery pathways and strategies for the rational distribution of financial and technical skills. PDNA helps assess a disaster's overall impact on the key development parameters. The post-disaster setting requires a quick and comprehensive overview, addressing the most crucial task of assessing humanitarian needs and providing relief for the same (see Figure 4.9).

Figure 4.9: PDNA Methodology



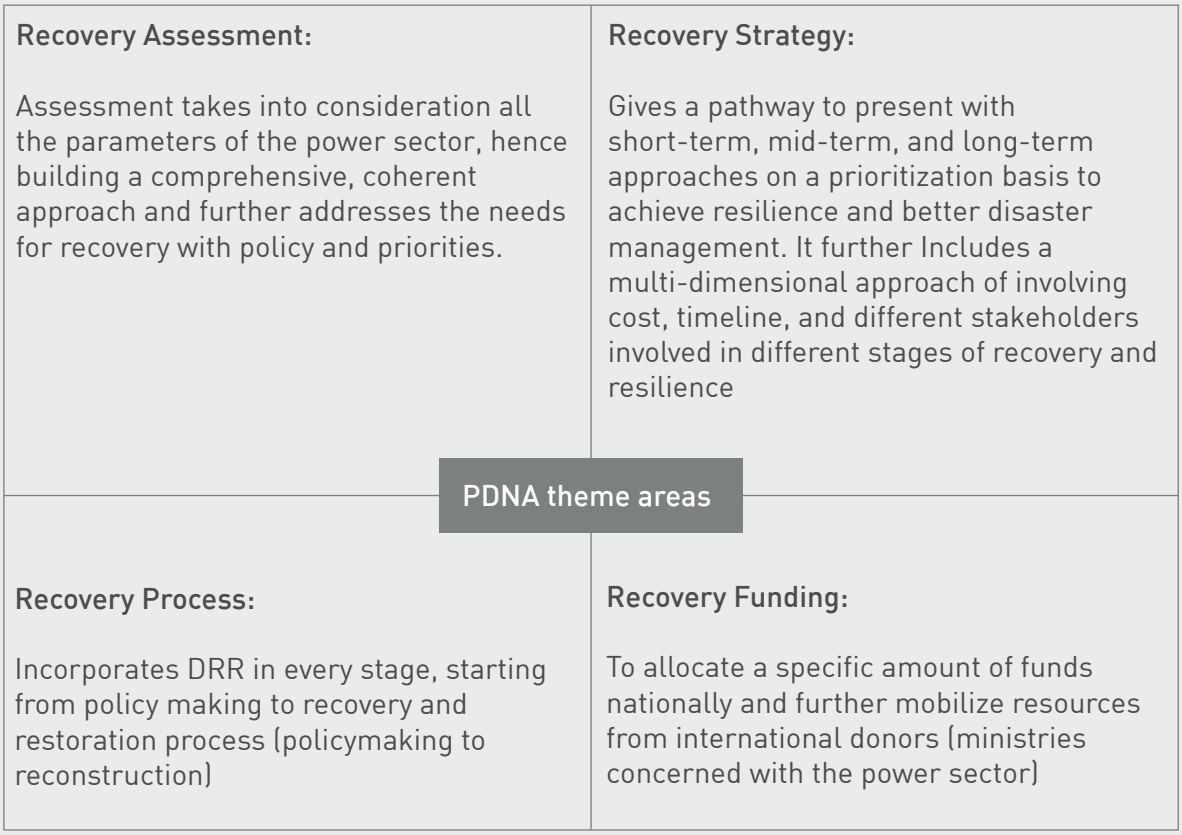
Source: UNDP: An overview of PDNA

Disasters such as cyclones have a greater impact on states like Odisha, adversely affecting its revenue-earning capacity. The power sector, vulnerable to cyclones and floods, demands interventions that commit to sustainable recovery and reconstruction of structural and non-structural measures. PDNA focuses on assessing the loopholes and rebuilding the post-disaster macro-economic structure with existing state finance standards and parameters.

PDNA evaluates various sectors across different geographical regions. It focuses on strengthening and further increasing the resilience of the institutional arrangement, including financial parameters. This, in turn, offers constant monitoring and evaluation of all the sectorial parameters with all the stakeholders involved, such as central and state agencies, international organizations and line departments. The PDNA focuses on rebuilding better, advocating for a more holistic and integrated strategy. The assessment includes recovery needs from socio-cultural, economic and environmental perspectives, addressing the needs of every sector of society (see Figure 4.10). Additionally, Annexure 1.3.3 includes a case study of PDNA that encompasses all the phases of the DM cycle.

PDNA assesses the damages caused along with the loopholes present and gives a holistic approach towards better management and recovery of society. The process is crucial for regularly updating critical risk assessments for vulnerable sector managers, helping them avoid temporary shocks to structural capacity developments.

Figure 4.10: PDNA Theme Areas Pertaining to Power Sector



4.9 Recovery Stages for Power Sector

The recovery stages provide a way forward to include disaster risk reduction and develop a strategy for building back better. Disaster recovery is divided into three phases (Table 4.4) short, medium and long term-based on the course of action taken and the timelines allotted.

Table 4.4: Recovery Stages for Power Sector

Stages	Timeframe	Description
Short term	3 – 18 months	To start restoring the temporarily restored transmission lines
Mid term	Up to 5 years	Pre-defined reconstruction plans (central and state governments) 1. Financial and Non-Financial 2. Structural and Non-Structural
Long term	Within 10 years	Integration with long-term developmental plan, policies and SOPs

Source: DMP, 2021

While the path of recovery and reconstruction may be constrained by financial implications, it also helps to identify the different technological and methodological challenges and limitations the sector faces.

District-level risk-based governance and resource allocation for disaster-preparedness

In Section 2 (i) of the Disaster Management Act, 'mitigation' is defined as measures to reduce the risk, impact, or effects of a disaster or potential disaster. Mitigation encompasses various measures, including large-scale interventions such as constructing coastal walls and flood embankments. However, it has been advised that such resource-intensive measures should ideally be integrated into regular development schemes rather than solely relying on mitigation funds. The report also proposed channelling the mitigation fund for local and community-based interventions that reduce risks and promote environmentally sustainable settlements and livelihood practices.

In contrast, it was observed that states with lower initial allocations and expenditures experienced a proportionally smaller increase in their allocations. This divergence in allocations between these state groups was projected to widen progressively, resulting in a highly asymmetric scenario.

The new methodology, replacing the expenditure-driven approach, was characterized as more inclusive as it integrates capacity (as indicated by expenditure), risk exposure (area and population), and hazard and vulnerability (risk index). For instance, regarding the development of district-level drought mitigation plans, it is advised that INR 100 crores be allocated to each of the 12 most drought-prone states, which includes Odisha, over five years. This allocation would total INR 1,200 crores throughout the 15th Finance Commission's award period (2021-26). The proposed National Disaster Mitigation Fund (NDMF) could be crucial in facilitating this support. The insights gained from developing these district-level drought mitigation plans, and allocation strategies can be extrapolated to address similar geographies and disaster events across the country. By adopting these lessons, efforts can be made to ensure the resilience of power infrastructure at the grassroots level nationwide.

As per the 15th Finance Commission report, consultations with state governments have previously addressed the issue of establishing separate district-level funds. Several practical concerns arise regarding the implementation of such funds.

- First, these funds may need to be utilized more in districts where disasters do not occur, leading to inefficient resource allocation.
- Second, pooling resources across districts within a state to respond to disasters in specific areas would pose challenges.
- Third, the overlap in jurisdiction between state-level and district-level funds raises questions about the distinct utilization of district-level funds compared to state-level funds.

Empowering district administrations is crucial for enhancing disaster preparedness at the local level. District administrations and local governments can support disaster management preparedness and implementation only when they have adequate resource devolution. Although setting up district-level disaster funds may be challenging, it is recommended that state governments allocate resources to districts annually for preparedness and mitigation efforts. Thus, the current practices of state governments managing funds exclusively at the state level need reconsideration.

State governments should devise methodologies for allocating these resources, considering factors such as district expenditure under these funds in subsequent allocations. Given the potential inadequacy of resources provided by the SDRF and NDRF in various situations, both union and state governments may need to explore additional sources for disaster funding. These could include reconstruction bonds, contingent credit or standby facilities with international financial institutions, crowdfunding platforms and corporate social responsibility initiatives. Setting up effective financial mechanisms and instruments before disasters would enable governments to identify and select more cost-effective options. Additionally, the 15th Finance Commission advises union and state governments to thoroughly examine these mechanisms and instruments and consider applying them in times of crisis.

5 Gap Analysis and Recommendations

5. Gap Analysis and Recommendations

The section aims to provide a brief evaluation and gap analysis across all the spectrums of the power sector and further reflect the plausible interventions needed. The nature of enhancing coordinated disaster resilience across all the stakeholders is presented concisely in the recommendation section in alignment with the Disaster Management Plan (2021) developed by the Central Electricity Authority (CEA). The power sector requires sustained efforts to develop resilience across all the phases of disaster management. Considering the various challenges faced by the power sector in Odisha, recommendations are developed based on appropriate technological, financial, institutional and policy mechanisms to have a robust investment in disaster preparedness and response.

The section provides a detailed framework assessment of the overall gaps in risk-based governance for the power sector of Odisha, illustrated based on different thematic areas (Table 5.1).

Table 5.1: Gap Analysis

Thematic areas	Gap Identification	Probable Interventions
Disaster Preparedness (Policymaking and Allocating Funding Sources)	Lack of integration of climate risk with hazard risk vulnerability capacity assessment (temporal and spatial scale)	Climate risk alters the extent, frequency and intensity of hydro-meteorological hazards. Hence, planning that includes disaster risk reduction and climate risk adaptations should be enhanced in state plans.
	Financial blockages and lack of diversion of key funds for disaster response activities. Lack of monitoring funding mechanism for resilience-enhancing plans for the sector	Establishing coordination with participating actors (concerned stakeholders) and their respective roles/responsibilities. Establishing mechanisms for proper channelization of funds for building resilient power infrastructures. (The concerned state departments, along with coordination of central agencies, activate the actions to be carried out, and the same has been mapped in Tables 7 and 8.)
	Strengthening of non-structural measures	Implementation of appropriate laws, guidelines, policies mechanisms and techno-legal regimes to incorporate disaster risk reduction should be strengthened.

Thematic areas	Gap Identification	Probable Interventions
Disaster Response (Decision making, Communication + (Implementation)	Lack of baseline data and sectoral assessment	Inter-agency coordination leads to the strengthening of disaster risk governance. Hence, increasing institutional adequacy with an operationalized chain of command is recommended. To implement, enforce and monitor disaster mitigation strategies effectively at all levels of governance, mapping has been conducted for various stakeholders as shown in Table 6.)
	Lack of integrated stakeholder approach Institutional inadequacy	
Disaster Recovery (Relief, Restoration)	PDNA/DLNA/RDNA	Investing in infrastructure and facilities with the implementation of standards and codes. Methodological evaluation and assessment of damage and loss incurred. It has been further recommended from short-term to long-term time framework and is mentioned in Table 5.2.
	Implementation of codes and standards	
Disaster Resilience (Strengthening and Retrofitting of Infrastructure, Reconstruction)	Lack of implementation of structural measures Technical adaptations	Ensure that cyclone-resistant features are incorporated in the planning and execution of power infrastructure.
Disaster Mitigation (Capacity Building, Gap Assessment, Maintenance and Monitoring)	Lack of training modules	Targeted awareness campaigns/FGDs among stakeholders. Apart from general training programmes, thematic training (PDNA, gender inclusion, etc.) and specialized training (fire response, disaster response and more technical aspects) are to be conducted aiming at different workforce. To enhance capacity building by conducting training programmes, awareness generation, regular mock drills and disaster response exercises.
	User knowledge /awareness Lack of knowledge of relevant actors who would undertake disaster related actions	
	Structural mitigatory measures	

The recommendations are further refined and organized into short-term, medium-term and long-term interventions that can be proposed to the Government of Odisha. These interventions will align with the suggestions outlined in the Disaster Management Plan 2021, provided by the CEA (see Table 5.2).

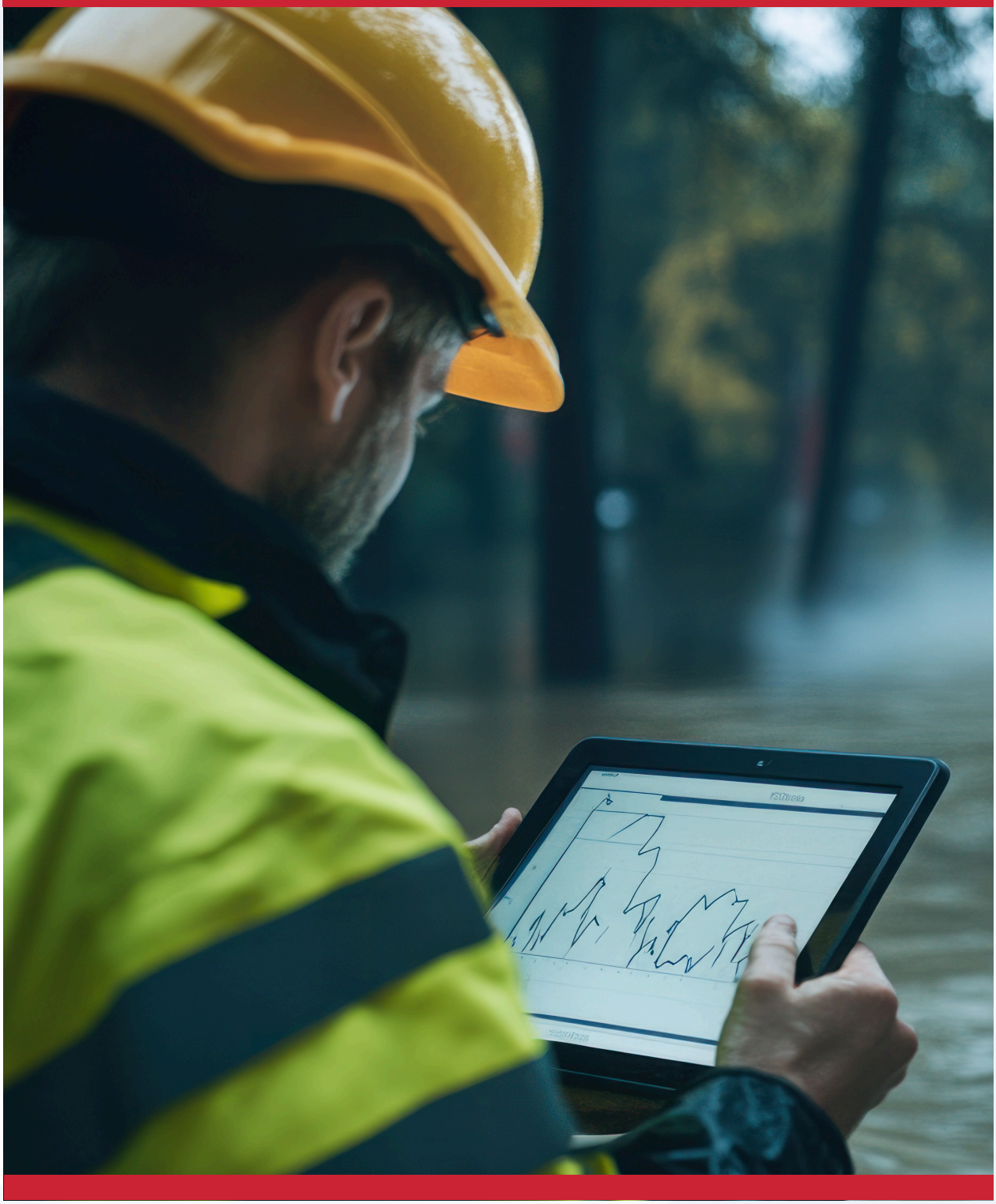
Table 5.2 Recommendations

Thematic areas	Short term	Mid term	Long term
Disaster preparedness	a) Carry out risk zonation/mapping of climate change impacts considering various sea-level rise and shoreline change scenarios. b) Develop GACC impact scenarios that affect cyclonic activity and sea surges. c) Promote the planning and execution of emergency drills by all ministries and in all states/union territories. d) Joint planning and execution of emergency drills. e) Constitute state-level coastal advisory. f) Carry out the mapping and related studies. g) Studies on vulnerabilities and capacities cover social, physical, economic and ecological aspects. h) Provide technical support and guidance for comprehensive HRVCA.	a) Develop a database management system for Global Agreement on Climate Change (GACC) impacts. b) Coordinate among central and state agencies for (i) revised/updated rules, norms, (ii) adoption of new/updated standards, (iii) enact/amend laws, regulations and (iv) adoption/review policies. c) Ensure facilities and infrastructure implement adequate access to information to at-risk sectors.	a) Provide technical support and guidance for comprehensive HRVCA considering GACC impacts. b) Promote state-specific studies on vulnerabilities, capacities and risks under GACC impact scenarios. c) Assess the risk, vulnerability and capacity changes under GACC impact scenarios. d) Ensure that cyclone-resistant features are incorporated in planning and execution of power infrastructure.

Thematic areas	Short term	Mid term	Long term
Disaster preparedness	i) Undertake HRVCA as part of preparing and periodic revision of DM plans and for development planning. j) Constitute/ strengthen the mechanisms for consultation with experts and stakeholders.		
Disaster Response	k) Provide technical support and guidance for comprehensive HRVCA.		
Disaster Recovery		d) Document state-specific GACC impacts and coping mechanisms.	e) Replace existing overhead distribution system with the underground cable system in cyclone-prone areas where the underground system cannot be adopted. The bare overhead conductor should be converted to ABC cables.
Disaster Resilience	l) Create Training-of-Trainers teams for different trades relevant to cyclone-resistant construction. m) Develop training and orientation programmes for state government staff and other direct stakeholders.		f) Design structures considering the wind loads and their effect on the structures as per the IS 875 Part-III Code.

Thematic areas	Short term	Mid term	Long term
Disaster Mitigation	n) Assess enhanced risks (economic, social, etc.) under different GACC impact scenarios.	e) To mitigate the effects of increased wind speeds on power transmission, climate risk must be integrated.	

6 Summary of Recommendations



6 Summary of Recommendations

6.1 Climate-Risk Data Collection, Management and Access

1. Data collection, management and access for all

a. **Prioritize proactive and anticipatory data gathering:** Emphasize the importance of collecting **climate-relevant data** before disasters strike. The approach is crucial for informing effective infrastructure planning and risk management strategies. **Anticipatory data gathering** enables policymakers to identify vulnerabilities, assess risks and allocate resources efficiently to build disaster-resilient power infrastructure.

b. **Foster integration and coordination of data management efforts:** Promote collaboration and integration among various stakeholders involved in data collection, management and access. By establishing clear channels of communication and coordination, ensure that **data collected from diverse sources are standardized and accessible** to support informed decision-making for disaster-resilient power infrastructure development across all stakeholders involved in the planning process.

2. Climatic-risk data collection, management and access

- **Analysis of climate variations** to be carried out to fill the voids of data gaps **concerning climate change impacts on different temporal and spatial scales.**

- Develop strategies to mitigate the negative impacts of climatic variations by including disaster risk reduction (DRR) planning and implementation.

3. Redefining/expanding vulnerability criteria in the face of climate-change-induced variations

- Hazard vulnerability assessments focus on the components immediately exposed to vulnerabilities. Although vulnerability has been defined for >20 km, 20-60 km and <60 km along with percentage of exposure, it is important to reflect percentage change for +5 years and +10 years (owing to climatic variations).

- On average, six to seven districts are highly affected by disasters such as cyclones/floods, which can vary on temporal and spatial scales. A broader mitigation approach must be opted by using remote sensing (RS)- and geographic information systems (GIS)-based applications and carrying out hazard and risk vulnerability capacity assessment (HRVCA).

4. Conducting HRVCA and other assessments for tracking past disaster occurrences for future policy development

- It is recommended to keep track of all the disasters that occurred in the last two decades to identify the loopholes in terms of financial arrangements, governance, updating of codes and standards, geographical complexities and climatic variations.

- Mapping of the voids and loopholes on temporal and spatial scale provides a pattern of the landfall of a cyclone, which helps to effectively disseminate equipment and materials, facilitating restoration and mitigating the impacts and the financial shortcomings.

- **Assessment of the availability of resources, equipment, vehicles and materials to be enhanced by a baseline diagnosis.**

6.2 Risk-Based Governance and Institutional Mechanisms

5. Integrated governance structure and well-defined institutional mechanisms

- Governance consisting of planning, social well-being, execution of laws, legal frameworks and economic **responsibilities**, often neglected, t**o be included in every phase of disaster management** for critical infrastructure as inclusive of part of preparedness.

- For better preparedness measures, **a defined line of command, including different nodal heads and agencies, should be demarcated.**

- For immediate response and recovery, the information channel must be laid out from its activation at the national level to its operationalization at the regional level.

6. Governance mechanisms for adopting codes and standards

Adoption and adherence to updated **building codes** following standards (NBC 2016) and global frameworks (ISO ISO/PAS 22399:2007, ISO 22301:2019), security and resilience along with BS 65000:2022 organizational resilience must be kept in mind during retrofitting. **Additionally, establishing a code of practice for integrating new features and designs into existing systems can help reduce costs.**

7. Risk-based policy development for better capacity-building and Training mechanisms

An integrated capacity-building programme (concerning technological aspects and human resources) **must be conducted with specific training consisting of representatives from various organizations before** the monsoon and retreating monsoon period. The **training needs to be imparted to trainers in two phases: basic** (Training of Trainers or **ToT**) **and advanced** (Master Trainer or **MT**), as outlined by the Department of Energy/OSDMA and the stakeholders. The training materials will be disseminated, and trainers will receive regular updates on the new equipment usage, materials used, etc. This approach will equip the workforce with technical expertise to constantly track cyclogenesis and take proactive measures. **It is advisable to include web-based technologies and use RS GIS software.** In addition, immediate recovery after disaster post-disaster needs assessment (PDNA) will be carried out, including vulnerability analysis on the temporal and spatial scale, sectoral assessment and recovery needs.

8. Adopting global frameworks

The integration of a global framework in the long-term vision will enable building not only a resilient sector but also one that accelerates the organization's business continuity and further reduces the organizational threats posed by various disasters on critical infrastructure. To further inculcate the best practices, it is essential to keep a constant baseline and merge the recommendations and practices.

9. Adopting a disaster resilience inventory approach

- **A proper inventory should be developed and disseminated among the different stakeholders,** including the technical specifications necessary for the power sector to strengthen the infrastructure.

- **A 'Build Back Better' approach incorporated with 'Make it Right' should focus on enhancing disaster resilience.** For instance, engaging in consultation and coordination with neighbouring states for logistics supply to strengthen the response phase and mitigate the damage caused.

10. Assessment of climate and disaster risk across investment planning

Incorporation of climate and disaster Risk (CDR) in planning and investment with respect to power infrastructure is essential for further embedding sustainable solutions to increase structural resilience. **A paradigm shift towards integrating and managing climate and disaster risk in the preparedness phase should be opted for.** The same can be done by carrying out risk assessment and impact estimation and developing adaptive measures by constant monitoring and evaluation.

6.3 Financial Governance and Policy Development

Although funds are available under different national and state heads, there is a pressing need for better allocation. It is essential to outline **proper financial governance with different thematic phases of disaster management.** Identifying priority areas for investment before disasters strike is crucial. Emphasis should be placed on preparedness, mitigation and recovery.

11. Structural and non-structural measures

Enhance preparedness and improve resilience by strengthening the structural and non-structural measures attributed to the physical sector and the policy implementation part of disaster management.

- To have adequate institutional arrangements (SOP/DMP/action plan/nodal centre and nodal head) to put forward a standard mechanism for all the power stakeholders.

- The non-structural measures should include recovery measures for the lack of financial mechanisms targeting disaster resilience construction.

12. Insurance and reinsurance

a) **Financial protection and risk transfer:** Insurance policies cover potential damages and losses incurred due to disasters, such as storms, floods, or earthquakes, reducing the financial burden on power infrastructure operators and investors. Reinsurance further spreads this risk across a broader pool of insurers, ensuring that catastrophic events do not lead to insolvency within the insurance industry.

b) **Facilitating investment and financing:** Insurance and reinsurance enable investors and lenders to finance power infrastructure projects with reduced risk. This assurance encourages greater investment in critical infrastructure development, supporting the expansion and modernization of power systems to meet growing energy demands.

c) **Ensuring business continuity:** In the event of a disaster, insurance coverage helps ensure the continuity of power supply by facilitating rapid repair or replacement of damaged infrastructure components. This minimizes downtime, mitigates economic losses associated with service disruptions, and helps communities recover more swiftly from the impact of disasters.

d) **Encouraging innovation and efficiency:** Insurance companies incentivize risk reduction measures and innovative technologies that enhance the resilience of power infrastructure. By offering lower premiums for investments in resilient infrastructure and operational practices, insurers promote the adoption of cost-effective measures to mitigate potential risks and improve system reliability.

e) **Insurance and reinsurance to support community recovery initiatives:** Insurance companies incentivize risk reduction measures and innovative technologies that enhance the resilience of power infrastructure. By offering lower premiums for investments in resilient infrastructure and operational practices, insurers promote the adoption of cost-effective measures to mitigate potential risks and improve system reliability.

6.4 Conclusion

Effective collection, management and access to climate-risk data are crucial for building disaster-resilient power infrastructure. Integration and coordination among stakeholders, proactive data gathering and adherence to global frameworks are essential strategies regarding this.

Moreover, prioritizing risk-based governance mechanisms, including developing policies informed by risk assessment and capacity building, is vital in enhancing resilience. Financial governance and policy development that incorporate insurance and reinsurance mechanisms provide crucial support for investment in resilient infrastructure.

It is important to highlight that this report serves as a key policy tool for stakeholders, equipment manufacturers and practitioners in the power sector. By prioritizing both structural and non-structural measures, such as implementing insurance for business continuity and community recovery, we can build a more resilient power sector capable of withstanding the challenges posed by climate change and disasters.

This comprehensive approach ensures sustainable development and fosters the resilience needed to safeguard power infrastructure and communities against future threats. In essence, the report serves as a practical guide, equipping stakeholders with the insights and strategies needed to navigate the complexities of building resilient power infrastructure in an ever-changing climate landscape.

Annexure

A.1 Stakeholder Consultation Details

A.1.1 Stakeholder Consultation Status

Table A.1 List of Stakeholders

S.No	Dept.	Name	Contact Details	Virtual Meeting Date	Remark(s)
1	TPCODL	Chintamani Chitnis Dipankar Bahera Pourush Garg (09971395283) Sayantani Das (7980889649) Biplabrajan Swain Khajan Bhardawaj	Chintamani.chitnis@tpcentralodisha.com; Dipankar.bahera@tpcentralodisha.com; pourush.garg@tpcentralodisha.com; sayantani.das@tpcentralodisha.com; biplabranjan.swain@tpcentralodisha.com; Khajan.bhardwaj@tpcentralodisha.com	May 6, 2022	Contacted Sayantani Das to arrange a meeting
2	TPSODL	Manish Pandey Rajan Kumar SK Md Azam (9717710364)	mk.pandey@tpsouthernodisha.com; azam.sk@tpsouthernodisha.com	March 15, 2022	
3	OPTCL	Santosh Das (9438907316)	dir.operation@optcl.co.in	March 17, 2022	
4	TPNODL	Harsh Negi (HOD – Network Planning) Manish Kriplani (09799495503) Harish Kumar Gupta (9971320624)	manish.kriplani@tpnodl.com; harish.kumargupta@tpnodl.com	March 9, 2022	

S.No	Dept.	Name	Contact Details	Virtual Meeting Date	Remark(s)
5	OSDMA	Meghanand Behara B N Mishra	meghanad.behera@gmail.com/Phone no - 8144512855 bnmishra.osdma@gmail.com/9437106251	March 9, 2022	No response
6	GRIDCO	Ajay Nanda	9853813610	July 4, 2022	
		Gagan Swain, Director (Finance& Corporate Affairs)			In-person meeting
7	OERC	Priyabrata Patnaik		July 5, 2022	In-person meeting

A.1.2 Stakeholder Consultation Questionnaires

Odisha State Disaster Management Authority Questionnaire

1. Do both OSDMA and SDMA function in disaster management in Odisha? What are the main differences between the roles and responsibilities of OSDMA and SDMA?

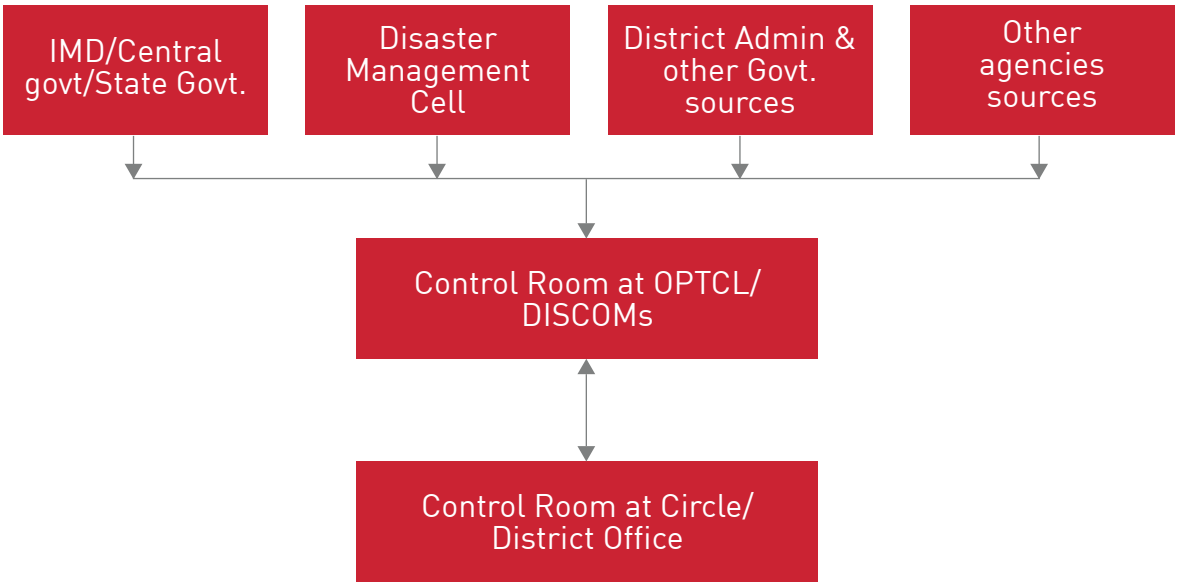
2. Are any Odisha power sector-specific disaster mitigation strategies being developed by OSDMA? Is there any designated nodal body within OSDMA to deal with disaster management situations in the power sector?

3. Are other institutions in OSDMA responsible for coordinating different agencies to facilitate response, recovery, reconstruction and capacity building in disaster management situations in the power sector?

4. What channels and protocols are used to transmit information concerning disasters between IMD, state government and state disaster management agencies?

5. Are there any protocols or frameworks (policy or regulatory) for risk identification, particularly for power infrastructure?

Figure A1.1 Existing arrangements for information collection and dissemination as given in the Department of Energy Disaster Management Plan 2018



6. Figure A1.1 represents the existing arrangements to facilitate information regarding disasters between various stakeholders of central, state and DISCOMs/transmission-level companies. Can you please give some details about stakeholders responsible at the state level for participating in this information flow?

7. What is the constitution of the disaster management cell? Who represents OSDMA in this cell?

8. Can you tell us what control rooms at various levels function for disaster management in the power sector? Does the State Load Despatch Centre function as a control room as well?

9. What are the roles of the Central-Level Disaster Management Group (CDMG), Regional-Level Disaster Management Group (RDMG), State-Level Disaster Management Group (SDMG) and Plant-Level Emergency Management Group (EMG) in Power Sector Disaster Management?

10. The Plant-Level Emergency Management Group (EMG) was mentioned in Odisha's power sector disaster management plan in 2015 and 2018. However, minimal details concerning its roles and responsibilities specific to Odisha have been documented. Could you kindly point us towards detailed documentation on the same?

11. Under the Disaster Management Plan for the power sector, SDMG would involve the coordination of the Department of Energy and the umbrella of institutions under it (DISCOMs, power generating companies, Police, Fire Department, Health agencies, etc.). Is such a coordinating mechanism in existence under the OSDMA framework? Could you point us towards details on the same?

12. What are the institutional or workforce arrangements for reconstruction and restoration activity, and what is the dependency on the third parties?

13. What are the damages assessment strategies after a disaster, and what finance options are adopted for recovery and reconstruction?

14. Are there any specific institutional monitoring and assessing disaster-related training at the state and local levels?

15. Are there any good practices you would like to highlight within the domain of disaster management in the power sector that has been taken up in the state in recent years? Something that would serve as an example to other states and locations in Odisha.

16. Are any funds allocated for preparedness, recovery and reconstruction of the power sector allotted by OSDMA?

17. Kindly provide contacts (in case any) for relevant stakeholders/organizations that have actively participated in disaster preparedness, recovery and reconstruction for the power sector.

OPTCL Questionnaire

1. According to the Odisha Department of Energy DMP 2018, all departments must update their DMPs annually. What is the latest revision of OPTCL DMP?

2. What channels and protocols are used to transmit information concerning disasters between IMD, state government, state disaster management agencies and OPTCL?

3. How is the communication concerning risk identification, disaster response and recovery carried out between OPTCL and DISCOMs/generating agencies?

4. What are the various hazard risk and vulnerability assessment procedures in cyclones and floods? How is the mapping done for critical installations?

5. What Disaster Response centres were set up by the Energy Department of the Government of Odisha in 2016-17? What are their constitution, roles and responsibilities concerning disaster management?

6. How is the human resource availability and capacity mapping done for various stages of disaster management, viz., the pre-disaster, response and recovery stages?

7. What capacity development activities are undertaken under p revention or mitigation for disaster risk reduction, effective preparedness, response and recovery, and building back better?

8. How is the curriculum developed for training and capacity-building activities? Is there any institutional coordination with central agencies like NIDM, CEA and NPTI?

9. Is any policy or framework adopted for resilient reconstruction after cyclones and floods?

10. What are the damages assessment strategies after disasters and finance options adopted for recovery and reconstruction?

11. Are any structures in place for sharing good practices between DISCOMs, OPTCL and GENCOS?

12. How is knowledge transfer concerning the good practices in disaster management facilitated from central agencies to OPTCL?

13. Are there any programmes to promote a culture of disaster risk prevention, mitigation and better risk management among the public?

14. What is the frequency of training programmes and mock drills? In which topic/situation has it been conducted, and what are the targeted participants?

15. What are the procedures to execute and plan the training exercises, and what members are involved in executing the same?

16. Are there any developed methods to assess the training programme?

17. What were the operational and financial flexibility protocols at different levels that enabled preparation and response activities for Cyclone Fani?

18. What was the disaster response centre's role during the Cyclone Fani event?

19. How was the fund allocation done for disaster preparedness, response and recovery during and after the impact of Cyclone Fani?

20. How was the fund allocated for various disaster activities utilized?

21. What systemic bottlenecks created gaps between fund allocation and fund release?

TPCODL Questionnaire

1. The latest available plan of the TPCODL here is the 2021 DMP of TPCODL. Are there any other plans or sources of information available?

2. What channels and protocols are used to transmit information concerning disasters between IMD, state government, state disaster management agencies and TPCODL?

3. How is the communication concerning risk identification, disaster response and recovery carried out between TPCODL and other DISCOMs/OPTCL/generating agencies?

4. What are the various hazard risk and vulnerability assessment procedures in cyclones and floods? How is the mapping done for critical installations?

5. What Disaster Response centres were set up by the Energy Department of the Government of Odisha in 2016-17? What are their constitution, roles and responsibilities concerning disaster management situations?

6. How is the human resource availability and capacity mapping done for various stages of disaster management, viz., the pre-disaster, response and recovery stages?

7. What are the various capacity development activities undertaken under areas of prevention or mitigation for disaster risk reduction, effective preparedness, response and recovery, and building back better?

8. How are the training and capacity development programmes conducted for hazard risk and vulnerability assessment in case of cyclones and floods?

9. What damage assessment protocols are in place after cyclones and floods? Are there any training programmes conducted to these ends?

10. How is the curriculum developed for training and capacity-building activities? Is there any institutional coordination with central agencies like NIDM, CEA and NPTI?

11. Is any policy or framework adopted for resilient reconstruction after a disaster?

12. What are the damages assessment strategies after disaster and finance options adopted for recovery and reconstruction to date?

13. Are any structures in place for sharing good practices between DISCOMs, OPTCL and GENCOS?

14. How is knowledge transfer concerning the good practices in disaster management facilitated from central agencies to TPCODL?

15. Are there any programmes to promote a culture of disaster risk prevention, mitigation and better risk management among the public?

16. What is the frequency of training programmes and mock drills? Which topic/situation has been conducted, and what are the targeted participants?

17. What are the procedures to execute and plan the training exercises, and which members are involved in executing the same?

18. Have any methods been developed to assess the training programme?

19. What were the operational and financial flexibility protocols at different levels that enabled preparation and response activities for Cyclone Fani?

20. What was the role of the Disaster Response Centre during the Cyclone Fani event?

21. How was the fund allocation done for disaster preparedness, response and recovery during and after the impact of Cyclone Fani?

22. How was the fund allocated for various disaster activities utilized?

23. What systemic bottlenecks created gaps between fund allocation and fund release?

TPNODL Questionnaire

1. What Disaster Response centres were set up by the Government of Odisha Energy Department in 2016-17? What are their constitution, roles and responsibilities with respect to the management of disaster management situations?

2. What is the role of NLDC, SLDC, RLDC and local-level control in disaster management?

3. How is the human resource availability and capacity mapping done for various stages of disaster management, viz., the pre-disaster, response and recovery stages?

4. What capacity development activities are undertaken under prevention or mitigation for disaster risk reduction, effective preparedness, response and recovery, and building back better?

5. How are the training and capacity development programmes conducted for hazard risk and vulnerability assessment in case of cyclones and floods?

6. What damage assessment protocols are in place after cyclones and floods? Are there any training programmes conducted to these ends?

7. How is the curriculum developed for training and capacity-building activities? Is there any institutional coordination with central agencies like NIDM, CEA and NPTI?

8. Is any policy or framework adopted for resilient reconstruction after a disaster?

9. What are the damages assessment strategies after disaster and finance options adopted for recovery and reconstruction to date?

10. Are any structures in place to share good practices between DISCOMs, OPTCL and GENCOS?

11. How is knowledge transfer with respect to the good practices in disaster management facilitated from central agencies to TPNODL?

12. Are there any programmes to promote a culture of disaster risk prevention, mitigation and better risk management among the public?

13. What is the frequency of training programmes and mock drills? Which topic/situation has it been conducted, and what are the targeted participants?

14. What are the procedures to execute and plan the training exercises, and what members are involved in executing the same?

15. Are there any developed methods to assess the training programme?

16. What were the operational and financial flexibility protocols at different levels that enabled preparation and response activities for Cyclone Fani?

17. What was the Disaster Response Centre's role during the Cyclone Fani event?

18. How was the fund allocation done for disaster preparedness, response and recovery during and after the impact of Cyclone Fani?

19. How was the fund allocated for various disaster activities utilized?

20. What systemic bottlenecks create gaps between fund allocation and fund release?

TPSODL Questionnaire

1. The latest available plan of the TPSODL here is the 2021 DMP of TPSODL. Are there any other plans or sources of information available?

2. What are the channels and protocols through which information with respect to disasters is transmitted between IMD, state government, state disaster management agencies and TPSODL?

3. How is the communication with respect to risk identification, disaster response and recovery carried out between TPSODL and other DISCOMs/OPTCL/generating agencies?

4. What are the various hazard risk and vulnerability assessment procedures in cyclones and floods? How is the mapping done for critical installations?

5. What Disaster Response centres were set up by the Energy Department, Government of Odisha, in 2016-17? What are their constitution, roles and responsibilities with respect to the management of Disaster Management situations?

6. How is the human resource availability and capacity mapping done for various stages of disaster management, viz., the pre-disaster, response and recovery stages?

7. What are the various capacity development activities undertaken under areas of prevention or mitigation for disaster risk reduction, effective preparedness, response and recovery, and building back better?

8. How are the training and capacity development programmes conducted for hazard risk and vulnerability assessment in case of cyclones and floods?

9. What damage assessment protocols are in place after cyclones and floods? Are there any training programmes conducted to these ends?

10. How is the curriculum developed for training and capacity-building activities? Is there any institutional coordination with central agencies like NIDM, CEA and NPTI?

11. Is any policy or framework adopted for resilient reconstruction after a disaster?

12. What are the damages assessment strategies after disaster and finance options adopted for recovery and reconstruction to date?

13. Are any structures in place for sharing good practices between DISCOMs, OPTCL and GENCOS?

14. How is knowledge transfer with respect to the good practices in disaster management facilitated from central agencies to TPSODL?

15. Are there any programmes to promote a culture of disaster risk prevention, mitigation and better risk management among the public?

16. What is the frequency of training programmes and mock drills? Which topic/situation has been conducted, and who are the targeted participants?

17. What are the procedures to execute and plan the training exercises, and what members are involved in executing the same?

18. Are there any developed methods to assess the training programme?

19. What were the operational and financial flexibility protocols at different levels that enabled preparation and response activities for Cyclone Fani?

20. What was the role of the Disaster Response Centre during the Cyclone Fani event?

21. How was the fund allocation done for disaster preparedness, response and recovery during and after the impact of Cyclone Fani?

22. How was the fund allocated for various disaster activities utilized?

23. What systemic bottlenecks create gaps between fund allocation and fund release?

Department of Energy, Government of Odisha Questionnaire

1. What are the channels and protocols through which information with respect to disasters is transmitted between IMD, state government, state disaster management agencies, OPTCL, DISCOMs and generating agencies? What is the role of DOE in facilitating this process?

2. What Disaster Response Centres were set up by the Government of Odisha Energy Department in 2016-17? What are their constitution, roles and responsibilities with respect to the management of Disaster Management situations?

3. What was the role of the disaster response Centre during the event of cyclones and other disasters?

4. Are there any standard operating protocols that the Department of Energy issues for various GENCOs, DISCOMs and other stakeholders to map their human resource availability vis-a-vis disaster management?

5. What are the various capacity development activities undertaken under areas of prevention or mitigation for disaster risk reduction, effective preparedness, response and recovery, and building back better? What is the role of the Department of Energy in facilitating these processes?

6. How is the curriculum developed for various departments under the Department of Energy for training and capacity-building activities? Is there any institutional coordination with central agencies like NIDM, CEA and NPTI?

7. What is the frequency of training programmes and mock drills? Does DOE have recommendations in place for being carried out by various departments? Which topic/ situation has been conducted, and what are the targeted participants?

8. What are the procedures to execute and plan the training exercises, and what members are involved in executing the same?

9. Has the Department of Energy developed any methods to assess the training programme?

10. Are there any structures in place that are established for the sharing of good practices between various DISCOMs, OPTCL and GENCOS? Does DOE recommend any such protocols?

11. How does the Department of Energy in Odisha facilitate knowledge transfer from central agencies?

12. How does the Department of Energy engage with electricity users to increase their resilience?

13. Are there any programmes of the Department of Energy to promote a culture of disaster risk prevention, mitigation and better risk management among the public?

14. What were the operational and financial flexibility protocols at different preparation and response activity levels for Cyclone Fani? What was DOE's role in providing this enabling environment?

15. What was the role of the Disaster Response Centre during the Cyclone Fani event?

16. How was the fund allocation done for disaster preparedness, response and recovery during and after the impact of Cyclone Fani?

17. How was the fund allocated for various disaster activities utilized?

18. What systemic bottlenecks create gaps between fund allocation and fund release?

OERC Questionnaire

1. To understand the existence of Disaster Management Protocols of OERC and GRIDCO.

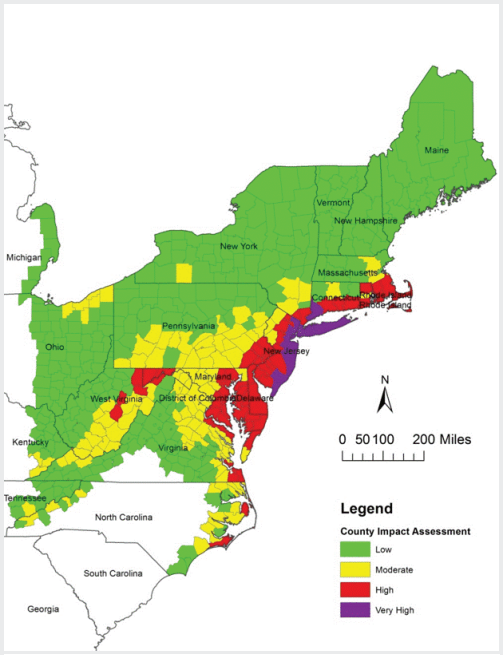
2. Since OERC and GRIDCO are engaged in the business of bulk purchase and bulk sale of power to the four distribution companies inside the state and trading of surplus power through traders to promote the exchange of power with neighbouring states, do they play any role in situations of restoration of power supply in cases of disaster?

3. Are there any provisions in place for the promotion of co-generation and generation of electricity from renewable energy sources to facilitate better preparedness and quick recovery in disaster scenarios? Does OERC play any role in facilitating investment in the disaster-resilient infrastructure in the power sector?

A1.3 Case Studies

A1.3.1 Global Best Practices

Case Study A.1: Hurricane Sandy Rebuilding Strategy, USA, 2013



Hurricane Sandy made landfall in New Jersey and New York on 29 October 2012. The results were tragic and devastating. The office towers of Lower Manhattan were left powerless and dark.

Recommendations

In August 2013, the Hurricane Sandy Rebuilding Task Force issued the 'Hurricane Sandy Rebuilding Strategy' to support the rebuilding of the region affected by the 2012 hurricane. The report contains policy recommendations on ensuring a regionally coordinated and resilient approach to infrastructure investment. It aimed to build back smarter and stronger infrastructure by aligning federal funding with local rebuilding visions, reducing excessive regulation, coordinating the efforts of the federal, state and local governments with a region-wide approach to rebuilding, and ensuring the region's climate change and disaster resilient rebuilding (OECD, 2014a).

Outcomes

Hurricane Sandy marked the first full implementation of the NDRF in a large-scale disaster. Also, the Task Force and Department of Energy provided technical assistance to New York and New Jersey to help them evaluate and develop pilot projects, financial mechanisms, and policy and market development tools and to generally promote cost-effective investments in resilient energy generation and storage using Sandy recovery funds.

Best Practices

Smart grid investments made by the U.S. Department of Energy's Smart Grid Investment Grant in some of the states hit by Sandy lessened the impact for thousands of electric customers. For example, in Philadelphia, roughly 186,000 smart meters were up and running by the time Sandy hit. The Philadelphia Electric Company (PECO) estimated that about 50,000 customers experienced shorter outages due to its new smart grid systems, including upgrades to its outage management system (OMS). PECO observed more than 4,000 instances where smart meters could remotely determine when power was restored, saving PECO and its customers time and money. With smart meters and Advanced Meter Infrastructure (AMI) connecting roughly 425,000 homes, PEPCO received 'no power' signals that allowed them to pinpoint outage locations quickly.

Source: https://www.oecd.org/environment/cc/policy-perspectives-climate-resilient-infrastructure.pdf

https://www.energy.gov/sites/prod/files/2013/08/f2/Grid%20Resiliency%20Report_FINAL.pdf)

[Image source: Dong, Han & Halem, Milton & Zhou, Shujia. (2013). Social Media Data Analytics Applied to Hurricane Sandy. Proceedings – SocialCom/PASSAT/BigData/EconCom/BioMedCom 2013. 963-966. 10.1109/SocialCom.2013.152.]

Case Study A.2: Hurricane Irene, North Carolina, 2011

Hurricane Irene made landfall near Cape Lookout, North Carolina on 27 August 2011, as a category one hurricane and then continued north-eastward, making a second landfall near Atlantic City, New Jersey. Irene's most significant impact was on the mid-Atlantic states through New England with the heaviest damage occurring in New Jersey, Massachusetts and Vermont due to inland flooding (Avila and Cangialosi, 2011). In all, 2.3 million people were mandatorily evacuated in advance of Irene's devastation (U.S. DOC, 2011).

More than 6.5 million people in the United States lost power during Hurricane Irene, which includes over 30 percent of the people living in Rhode Island, Connecticut and Maryland (U.S. DOE, 2011).

Preparedness Measures Taken

Smart grid investments made before Irene's landing lessened the storm's impact on thousands of electric customers. Investments in advanced metering infrastructure (AMI) improved outage notification and response time, greatly reducing the duration of outages. In Pennsylvania, the Pennsylvania Power & Light's smart grid investments in distribution automation technologies made a difference for 388,000 customers who lost power.

Source:
(https://www.energy.gov/sites/prod/files/2013/08/f2/Grid%20Resiliency%20Report_FINAL.pdf)

(Image Source: https://www.usgs.gov/centers/spcmsc/news/aerial-phographs-outer-banks-show-coastal-damage-hurricane-irene)

Case Study A.3: Opting for Best Practices Towards Governance for Myanmar

Myanmar is exposed to many hazards, such as earthquakes, floods, cyclones, windstorms, landslides and tsunamis. As per the INFORM index, Myanmar is the twelfth most risk-prone country to disasters in the world. Myanmar also took third place in the list of countries impacted by extreme climate events in the last two decades (Global Climate Risk Index 2018). Cyclone Nargis (2008), one of the deadliest disasters in the history of Myanmar, caused havoc to the country killing an estimated 140,000 people and damaging more than 800,000 houses, 75 percent of health facilities and almost 4000 schools in the affected townships (Post Nargis Joint Assessment, 2008). The cyclone also left more than 1.8 million people with damaged roads, uprooted electricity supply networks, damaged communication systems, etc., which also impacted the capacity to provide timely responses to the affected communities. The total economic loss was estimated at over US$ 4 billion, equivalent to 21 percent of the national GDP in 2007.

Good Practices Carried Out

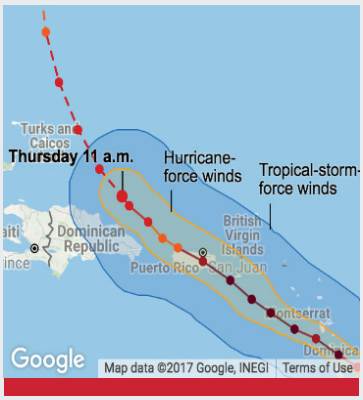
Myanmar has actively adopted the 'Build Back Better' approach after any disaster, which helps to improve the resilience of housing and other infrastructure to protect them from future disasters. A holistic and multi-sectoral approach to developing a resilient infrastructure system was adopted. Emphasis was laid on urban infrastructure as it is more complex; building resilient infrastructure was focused on avoiding systems failure, which may have both direct and indirect losses.

(Source: https://www.preventionweb.net/news/need-and-opportunity-invest-disaster-and-climate-resilient-infrastructure-myanmar)

(Image source: https://www.starnewsonline.com/story/news/2008/05/05/cyclone-kills-more-than-350-in-myanmar/30449348007/)

A1.3.2 Inter-linkages Between Governance and Financial Mechanism to Enhance Resilience

Case Study A.4: Hurricane Maria, Puerto Rico



After Hurricane Maria in Puerto Rico in 2017, most of the power grid was down. One year and tens of billions of dollars later, some customers were yet to be reconnected to the main grid. Furthermore, the power system is a special infrastructure due to the heterogeneity of the generation assets and its wide spatial distribution. The latter means that power systems are often exposed to hazards and sometimes to more than one hazard, leading to high repair costs when disasters strike.

Ageing equipment, lack of maintenance, rapid expansion of the grid and insufficient generation capacity are all factors that reduce the reliability of service in general – but also increase the system's vulnerability to shocks. During any hazard, three main types of incidents can lead to system breakdowns: transmission and distribution grid failure, generation plant failure, and fuel and maintenance supply chain failures.

Practices Adopted

Hence, the mitigation strategy included an emphasis on proper governance framework which describes how emergency preparedness and disaster recovery encompass not only technical aspects, like asset strengthening or criticality analysis, but also 'softer' skills, like governance, regulatory or capacity building and education.

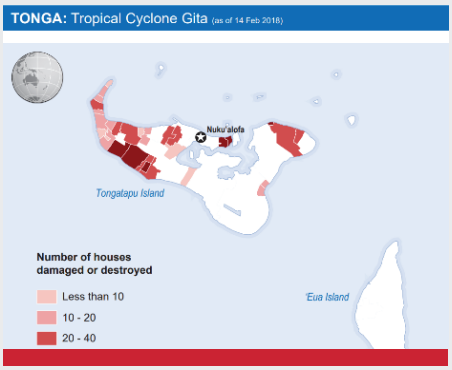
Strategic Recommendations

A further way forward was provided by focusing on strategies to increase power sector resilience. The first set of strategies is intended to increase the robustness of infrastructure by hardening it and improving its design – via power sector planning. The second set of strategies aims to improve network flexibility and adaptability to ensure that the system can react as smoothly as possible when disasters strike. Finally, the third set of strategies concerns how operations can be improved to better cope with hazards and minimize their consequences. Prominence on improving the robustness of power infrastructure seems like an obvious, albeit sometimes costly, way to increase the resilience of the power sector. Building more robust infrastructure with higher design standards would allow the system to withstand bigger shocks while reducing repair costs, system interruption costs and maintenance costs, and will increase the structure's resilience.

(Source: https://documents1.worldbank.org/curated/en/200771560790885170/pdf/Stronger-Power-Improving-Power-Sector-Resilience-to-Natural-Hazards.pdf)

(Image source: https://www.starnewsonline.com/story/news/2008/05/05/cyclone-kills-more-than-350-in-myanmar/30449348007/)

Case Study A.5: A Resilient Choice for Tonga, Oceania

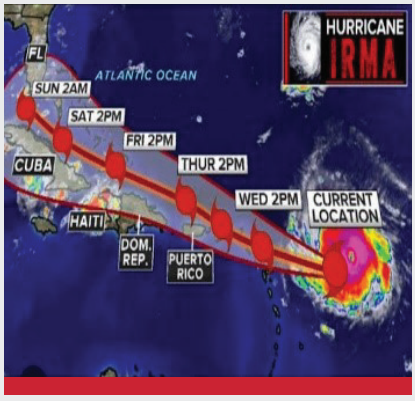


Outcomes

Tonga, which is highly exposed to cyclones, began to upgrade its grid by replacing its low-voltage overhead network with aerial-bundled conductors (ABCs), installing underground service cables to customer premises and installing new smart meters. The project was undertaken for its technical benefits (to reduce losses and outages) and to improve resilience to hazards (Tonga Power Limited 2016). An estimated 54 percent of the network had been upgraded (GoT 2018) when Tropical Cyclone Gita landed in Tongatapu, Tonga. The cyclone damaged 45.9 percent of the power grid that had yet to be upgraded, compared to only 4.7 percent of the upgraded segments (ADB 2018).

(Source: https://www.adb.org/sites/default/files/project-documents/52129/52129-001-rrp-en.pdf)

Case Study A.6: Puerto Rico: Time for 'Build Back Better'



Hurricane Irma, a Category 5 storm, landed in Puerto Rico on 6 September 2017, leaving 70 percent of electricity customers without power and damaging critical infrastructure (Campbell, Clark and Austin 2017; New York Power Authority et al 2017). On 20 September 2017, a second hurricane, Maria, landed on the island as a Category 4 storm with wind speeds of over 250 km/h. The consecutive storms caused catastrophic damage, especially to the electrical grid. Damage was so extensive that even undamaged generators could not supply power (U.S. Energy Information Administration 2018). The disaster resulted in electrical power outages to 90 percent of the island, loss of housing and infrastructure, and contamination of potable water. The cost of the damage is estimated in the tens of billions of dollars (Central Intelligence Agency 2018).

Gap Analysis

Because of poor maintenance and vegetation management, transmission lines and towers in the centre of the island were severely damaged by high winds: approximately 101 transmission line segments, 636 poles and 673 conductors/insulators were damaged by the storm. In early October 2017, only 20 percent of all transmission lines in Puerto Rico were functioning (Ferris 2018). Virtually 100 percent of Puerto Rico Electric Power Authority customers were without power for over a week following the storm, and the slow pace of recovery meant that many customers were left without power for several months (U.S. Department of Energy 2018).

Strategic Mitigation Measures

As repairs and rebuilding continue, Puerto Rico Electric Power Authority has evaluated resilience options. Results show that the cost of building back better, compared to baseline estimates, varies considerably based on the component. For example, hardening the transmission grid (lines, poles, circuits) generally has relatively low incremental costs (around 10%), while solidifying the distribution system (replacing wood poles with tubular steel poles) has much higher incremental costs (around 100%). In Puerto Rico, upgrading transmission and distribution infrastructure to withstand Category 3 hurricanes would increase costs by 3 to 40 percent, while upgrading to withstand Category 4 hurricanes (210-250 km/h sustained wind speeds) would raise costs by 24–70 percent (Schweikert, et al. 2019).

(Source:https://documents1.worldbank.org/curated/en/200771560790885170/pdf/Stronger-Power-Improving-Power-Sector-Resilience-to-Natural-Hazards.pdf)

A1.3.3 PDNA

Case Study A.7: Cyclone Phailin, 2013- Rapid Damage and Needs Assessment

Phailin, the severe cyclone of the year 2013, made landfall on the Odisha coast, causing severe disruption to infrastructure. Out of 30 districts, 18 were severely affected by storms and floods from torrential rains. RDNA provides a rapid and immediate estimation of the funds and extent of damages required for corresponding recovery and reconstruction needs. The RDNA was carried out in two phases:

1. Damage Assessment

2. Recovery Needs

Based on the estimated cost, the reconstruction needs are defined and incorporated in restoring damages for 'Build Back Better'. Hence, it is the first attempt to address immediate recovery needs. RDNA evaluates the immediate situation after the disaster has occurred. It identifies the areas of interventions and priorities which must be addressed immediately. It outlines the detailed steps to be taken in long-term recovery options.

The recovery needs to focus on incorporating disaster-resilient infrastructure and updated designs to ensure protection and mitigation of the damage caused.

Case Study A.8: Cyclone Fani, 2019 – Damage, Loss and Needs Assessment

Cyclone Fani made landfall in Odisha in 2019, severely affecting the power and telecommunication sector. IMD being the nodal agency, disseminated early warning to both concerned central and state government agencies to assess the level of preparedness for effective and timely response after the landfall. NDRF and SDRF carried out a rigorous search and rescue operation. The workforce was also mobilized from the neighbouring states of West Bengal and Andhra Pradesh to restore power services. The power infrastructure was greatly disrupted and impacted 14 districts of 500 substations and 1,10,000 distribution transformers. The damages and losses incurred by different sectors were assessed by conducting aDamage, Loss and Needs Assessment (DLNA). A stepwise approach of DLNA to evaluate the loss and need assessment for Cyclone Fani was opted in the following manner*:

Steps	Description
1. Pre-disaster context (i) Baseline data (ii) Sectoral preparedness	The pre-disaster context of disaster provides background information to compare further the results of the DLNA conducted. The background study consists of the baseline data indicating the power scenario of the state, its capacity, agencies and departments involved, along with the institutional arrangement. After providing an overview of the power scenario, a sector preparedness inventory must be conducted to indicate the materials, manpower, machinery and equipment available to compare further and evaluate the mobilization of resources in the response stage.
2. Post-disaster context (i) Damage assessment (ii) Increased sectoral risk	Assessment is to be carried out during and after the response phase of disaster reflecting the physical damages that occurred on the field and comparing them with the baseline data. The causes and the extent of damage are also evaluated. Along with this, the loss of revenue and damage caused to consumers because of power outages are also assessed. Factors and network structures exposed to greater vulnerabilities and further enhanced risk associated with the components are also assessed.
3. Damage and loss estimation (i) Estimate of revenue losses	This assessment reflects the losses incurred by transmission and DISCOMs regarding damages and losses on the field. The loss assessment is based on income loss to meter readers and bill collectors, as well as the non-supply of power, which reflects the estimated revenue loss incurred by the power sector.

4. Recovery needs	It is divided into short-term, mid-term and long-term scenarios. The immediate recovery needs to address having a proper framework to retrofit the existing designs by opting for more resilient designs and foundations, which are cost-effective but not long-lasting. The mid-term approach indicates addressing the need to build and integrate an upgrading of the power sector's materials and equipment and increasing resilience towards climatic adaptations. The long-term recovery approach is to change the existing system with a resilient infrastructure.
5. Impact analysis on development goals	An analysis reflecting the adoption of best practices further strengthens the structural and non-structural aspects of the power sector. A robust network of uninterrupted power supply and improved recovery measures (temporal and spatial) should be conducted.
6. Sector recovery strategy, policy and recommendations	The strategy aims to build and enhance Odisha's resilience capacity. Although the state focuses on reducing the damages caused and ensuring constant power supply, the recovery strategy aims to carry out hazard vulnerability zonation, build resilient critical infrastructure withstanding various calamities and further provide recommendations.
7. Sector assessment methodology (i) Data collection process (ii) Extrapolation of data (iii) Field visits (iv) Assumptions made from cost estimations	This involves data collection from various stakeholders involved and compared with the actual fund. Hence, cost estimation has been done by comparing the variation with the actual cost.

Steps	Description	Roles and Responsibilities
8. Pre-disaster context (i) Baseline data (ii) Sectoral preparedness	Conduct baseline data indicating the power scenario of the state, its capacity, agencies anddepartments involved, along with the institutional arrangement.	OSDMA, Department of Energy, Odisha, GRIDCO, DISCOMs

Steps	Description	Roles and Responsibilities
9. Post-disaster context (i) Damage assessment (ii) Increased sectoral risk	Assess physical damages that occurred on the field and compare them with the baseline data and the extent of the damage. Evaluate the loss of revenue and damage caused to consumers by a power outage. Assess factors and network structures exposed to greater vulnerabilities and the risk associated with the compnents.	DISCOMs, GRIDCO, Energy Department, OERC, Finance Department
10. Damage and loss estimation (i) Estimate of revenue losses	Evaluate the losses incurred by transmission and DISCOMs regarding damages and losses on the field. Evaluate losses based on income loss to meter readers, bill collectors and non-supply of power, reflecting the estimate of revenue loss incurred by the power sector.	OSDMA, Finance Department, DISCOMs, Energy Department
11. Recovery needs	Divided into short-term, mid-term and long-term scenarios.	Energy Department, Finance Department, SDMA
12. Sector recovery strategy, policy and recommendations	The strategy aims to build and enhance the resilience capacity of Odisha. Policy development	Energy Department, SDMA

(*The same method can be opted by the power sector for carrying out DLNA.)

(Source: https://www.preventionweb.net/publication/cyclone-fani-damage-loss-and-needs-assessment)

For Odisha

A1.3.4 Valuable Lessons from Other States

Case Study A.9: Enhancement and Modernization of Grid Infrastructure: Lessons Learnt from Cyclone Amphan, West Bengal

To withstand the damages caused in West Bengal, it was suggested that electricity distribution be improved, and grid infrastructure be modernized to reduce damage to the electricity infrastructure. The World Bank further provided loans to sustain rapid economic growth and power structure in West Bengal. A total of 135 million loans were approved by the World Bank from the International Bank for Reconstruction and Development (IBRD) to West Bengal to improve the operational efficiency and reliability of electricity supply in selected areas and further help to provide immediate response to similar crises and emergencies. The project aims to support network investments to reduce losses, increase the capacity of the distribution network to meet the growing load demand, improve the system's overall reliability, make the network resilient to climate disasters and improve the institutional capacity of WBSEDCL.

Response Measures Taken

After Cyclone Amphan in 2020, the strategic outcomes resulted in the approval of the loan to strengthen the distribution network, lessen the strain on the finances of electricity distribution companies, and further help to invest in smart grid technology and ensure the financial sustainability of West Bengal State Electricity Distribution Company Limited (WBSEDCL). The aim is to restore operational efficiency, reduce losses and augment practices like cable replacement to minimize the damages caused.

The ongoing project works on the following indicators:

1. Move distribution lines under the ground to reduce exposure to storm and tree damage.
2. Focus on enhancing training provided to WBSEDCL staff.
3. Increase distribution transformation capacity.
4. Reduce aggregate technical and commercial (AT&C) losses in selected districts.
5. Reduce the System Average Interruption Frequency Index in selected towns.

(Source: https://projects.worldbank.org/en/projects-operations/project-detail/P170590 and https://www.worldbank.org/en/news/press-release/2021/11/29/indian-state-of-west-bengal-gets-135-million-world-bank-loan-to-improve-efficiency-reliability-of-electricity-supply)

Case Study A.10: Way Forward to Strengthen Structural Measures Ahead of Cyclone Titli, Andhra Pradesh, 2018

Cyclone Titli caused heavy damage, and property worth thousands of crores was damaged, including power infrastructure, roads and crops.

Recommendations by State Government

The government emphasized enhancing the power utilities to create a disaster-proof power system that can withstand the impact of cyclones. The need to build GI substations, mobile substations, emergency restoration towers, procuring polls, transformers, cranes and modernization of electricity substations to face any challenge and avoid inconvenience to the people during cyclones was highlighted to overcome the upcoming disaster. Also, emphasis was laid on following SOPs at all times to ensure minimum loss of life and damage to infrastructure.

Case Study A.11: Lessons Learnt - Good Practices, Gaps and Recommendations, Cyclone Hudhud, Andhra Pradesh, 2014

It was observed that power cables/lines and supporting poles were uprooted, disrupting the power supply;restoration in most localities took appreciable time. However, it was recommended that underground power lines along the seacoast be installed to develop disaster-resilient power infrastructure.

Good Practice

Field staff was deployed in advance to cyclone-prone areas (coastal substations) to attend to rectification and repair works. A proactive approach was taken rather thana responsive one.

Gap Analysis

Sufficient numbers of diesel generators were not in place. Had they been available, their use could have led faster to a state of normalcy.

Recommendations

IMD issued early warnings to prepare, disseminate and activate the early warning and mobilization of resources, as well as further enhancement in techno-legal requirements to predict the actual wind velocity and gusting speed to enhance the timely and efficient preparedness measures. To develop a proper inventory and resource kit for all the stakeholders for a coordinated response after receipt of early warming.

This and the distribution centre should be waterproof to be effective during cyclones wherein flooding results from heavy rain.

Various recommendations provided were as follows:

- Inventory of electrical requirements for quick restoration may be listed for use during the cyclone.
- Storage of electric transformers and poles at strategic locations for quick replacement after a cyclone will help restore early power.
- Wireless sets, power saws and power restoration materials with transport facilities may be provided to each team pre-positioned for power restoration at various locations.
- Pruning of tree branches, which may damage electrical lines, may be initiated within 1 hour of receiving early warning.
- Cranes for speedy assembly of poles should be placed at various strategic locations.
- A plan to prioritize lifelines and critical infrastructure, such as hospitals, communication stations and water works in maintaining/restoring electricity, needs to be in place. This should also be tested during the mock exercises.

A1.3.5 Global Standards

ISO/PAS 22399:2007 Societal Security: Guideline for Incident Preparedness and Operational Continuity Management

In 2007, the International Organization for Standardization (ISO) published the first internationally ratified benchmark document addressing incident preparedness and continuity management for organizations in both public and private sectors i.e., ISO/PAS 22399:2007 Societal security—Guideline for incident preparedness and operational continuity management. All the organizations are exposed to uncertainty and risks. The aim should be to design a strategic mitigation approach to avoid suspending critical operations during disruptions. Further emphasis should be laid on how to cost-effectively manage the risk while rapidly resuming the functionalities of the infrastructure[7].

ISO/PAS 22399:2007 (International Organization of Standardization/Publicly Available Specification) guides the public and private sectors to design incident preparedness, operational continuity and management systems. It establishes the process, principles and terminology of **Incident Preparedness and Operational (Business) Continuity Management (IPOCM)** within societal security.It gives guidance to understand the various risks the firm is exposed to, evaluate the mitigation strategies, and further allows the organization to survive the mishap and enables them to take actions important for the organization's continued viability.With changing climate risks, the sector must proactively prepare for potential and probable incidents and disruptions to avoid suspensions of critical operations and services

[7] Hamidovic, Haris. (2011). An Introduction to Incident Preparedness and Operational Continuity Management Based on ISO/PAS 22399:2007. ISACA. III.

Hence, ISO/PAS 22399:2007 helps to design a framework to develop incident and emergency response, continuity response and recovery measures. However, it excludes specific emergency response activities following an incident, such as disaster relief and social infrastructure recovery, that are primarily to be performed by the public sector under relevant legislation. ISO/PAS 22399:2007 has been developed to address the global awareness that the public and private sectors must proactively prepare for unexpected, disruptive incidents.

(Source: https://www.iso.org/standard/50295.html and
https://www.isotc292online.org/ published-standards/isopas-22399/)

ISO 22301:2012 Business Continuity Management

ISO 22301 helps to identify and prioritize threats across the organization. This Business continuity management standard enables them to be ready to respond and recover from threats with the least disruptions. The aim of ISO 22301 differs from that of ISO/PAS 22399:2007 as it focuses on reducing the likelihood of occurrence and being prepared when incidents arise.

The same has been revised to ISO 22301:2019 Security and Resilience — Business Continuity Management Systems. This document applies the Plan (establish), Do (implement and operate), Check (monitor and review) and Act (maintain and improve) (PDCA) cycle to implement, maintain and continually enhance the effectiveness of an organization's BCMS. It further provides a greater alignment with all the other ISO Standards. ISO 22301:2019 requires organizations to develop high-level strategies and define solutions to handle specific risks and impacts relevant to continuity, including financial and resource availability while planning the same.

(Source: https://www.isms.online/iso-22301/ https://www.iso.org/obp/ui#iso:std:iso:22301:ed-2:v1:en)

BS 65000:2022 Organizational resilience. Code of Practice
The British Standard Guidance on Organizational Resilience

To increase the organization's resilience, it should be adaptive, agile and robust to withstand the impact of hazards. BS 65000 guides organizations in developing a strategic objective to increase their resilience against various threats. Any organization can anticipate and carry out preparedness to be ready for timely response and further adapt to incremental changes.

BS 65000 gives guidance to achieve organizational resilience. It further indicates the benefits and process of building the same. It helps to identify characteristics and capabilities that will further improve the firm's resilience. It provides guidelines on building resilience with more detail on principles and characteristics. It helps to improve management and investment decisions. It aids in developing the firm's resilience skillset, improving efficiency and growing sustainably.

(Source: https://knowledge.bsigroup.com/products/guidance-on-organizational-resilience/ standard)

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7 References

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