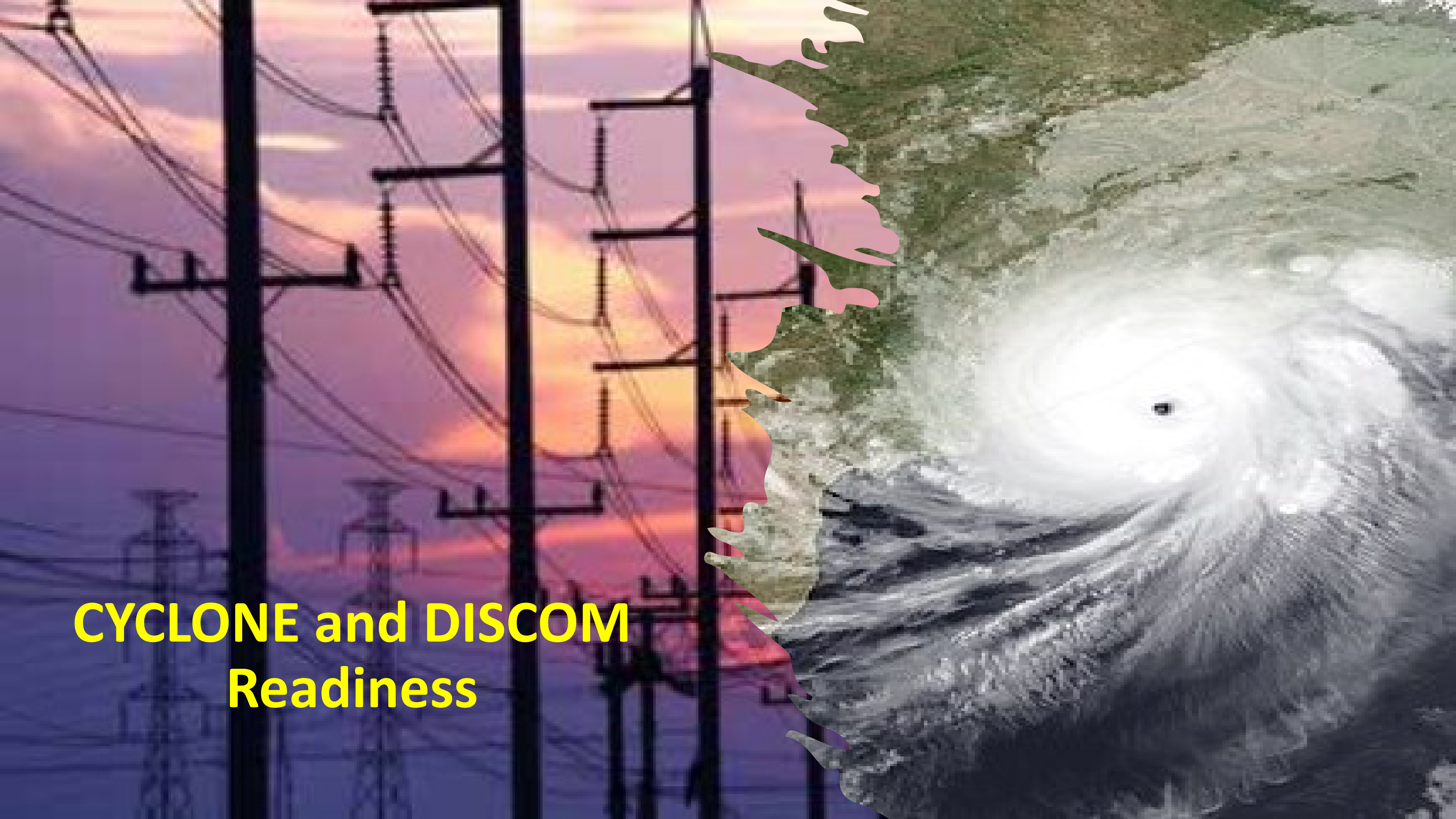
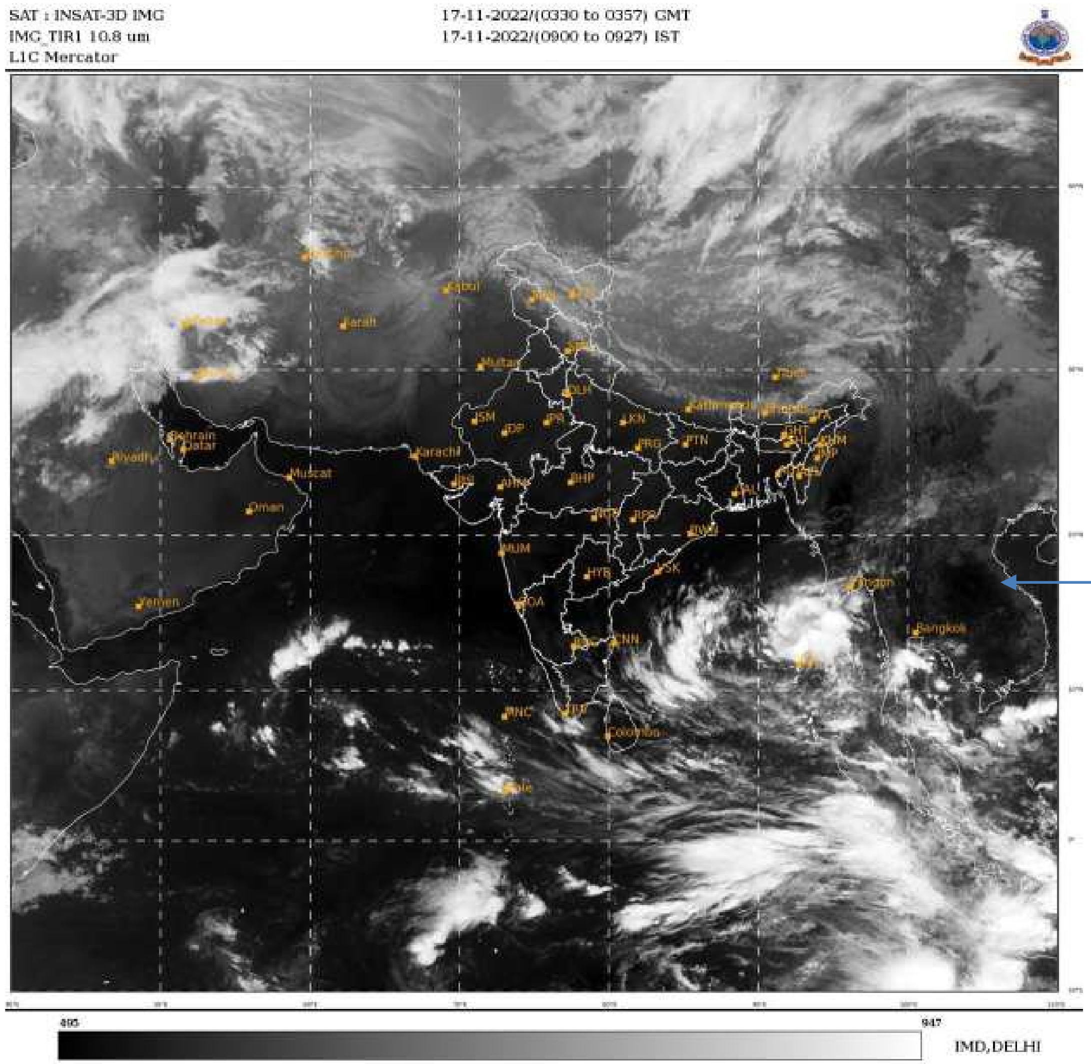


CYCLONE and DISCOM Readiness

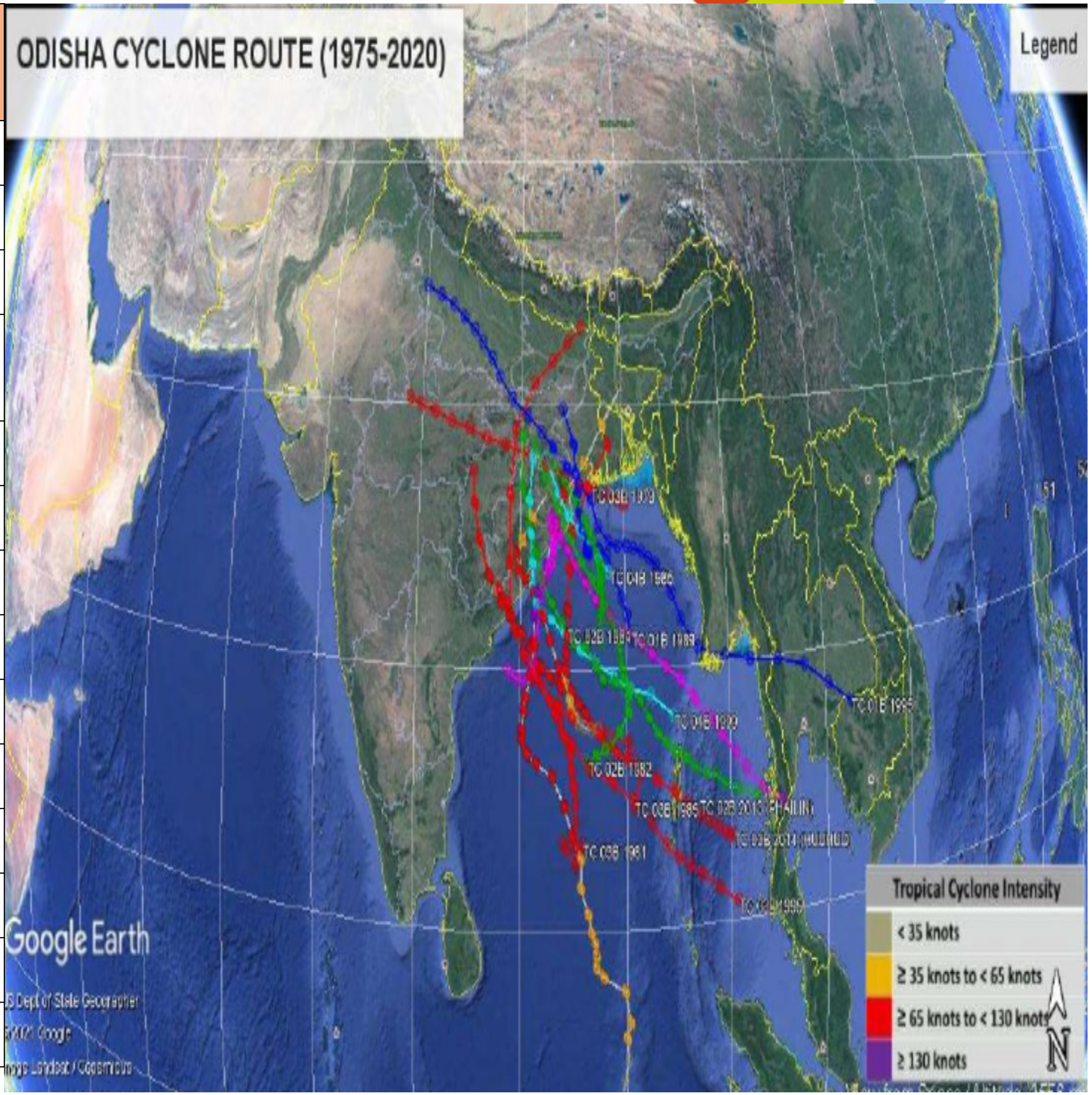
18th November...



Low Pressure Area

Cyclones in last decade

S. No	Name of Cyclone	Date	States Affected	Severity Class
1	Sitrang	October, 2022	Odisha, West Bengal	Tropical Storm
2	Asani	May, 2022	Andhra Pradesh, Odisha	Severe Cyclonic Storm
3	Jawad	December, 2021	Andhra Pradesh, Odisha and West Bengal	Cyclonic Storm
4	Gulab	September, 2021	Andhra Pradesh and Odisha	Severe Cyclone
5	Yaas	May, 2021	Odisha and West Bengal	Very Severe Cyclonic Storm
6	Nivar	November, 2020	Tamil Nadu, Andhra Pradesh & Puduchery	
7	Nisarga	June, 2020	Maharastra	Severe Cyclonic Storm
8	Amphan	May, 2020	Odisha, West Bengal & Andmans Island	Super Cyclonic Storm
9	Bulbul	November, 2019	Odisha & West Bengal	Very Severe Cyclonic Storm
10	Fani	May, 2019	Odisha & Andhra Pradesh	Extremely Severe Cyclonic Storm
11	Gaja	November, 2018	Tamil Nadu, Andhra Pradesh & Puduchery	Very Severe Cyclonic Storm
12	Titli	October, 2018	Odisha, Andhra Pradesh and West Bengal	Very Severe Cyclonic Storm
13	Phailin	October, 2014	Andhra pradesh, Orissa, West Bengal, Jharkhand, Chattisgarh	Extremely Severe Cyclonic Storm
14	Hudhud	October, 2013	Andhra Pradesh,Orissa & Andaman & Nicobar Islands	Extremely Severe Cyclonic Storm



Risk to Distribution Sector due to any Disaster

Power Sector is one of the most important infrastructure of the country, as growth of this sector is directly correlated with the economic growth of the country. Any disruption in Power Sector due to Crisis / Disaster creates hardship to the human beings, as every aspect of human life is directly or indirectly associated with the electricity.

- In Odisha the density of the power distribution network is higher in the coastal belt and in industrial areas.
- As a result, the chance of disruption is higher in the coastal zone.
- It is evident that the Lines and Transformers installed in Coastal area are at higher risks then in Interior geography.

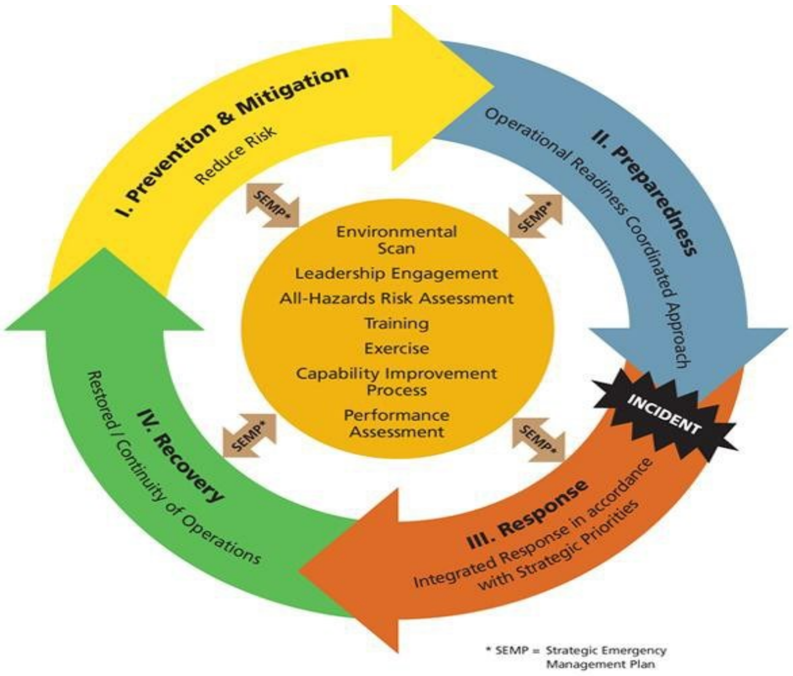
Lets have a look at ..how network is exposed to risk for any disaster, be it Cyclone, flood, lightening etc

The impacts of the cyclone & Flood brought into focus the need for disaster and climate resilient power infrastructure systems in Odisha

DMP the first need….

Construction of Cyclone Resilient network in coastal area is much costly and long term project. But a good Disaster Management Plan is a MUST to ensure the restoration process is done to minimize the public discomfort & revenue loss to the DISCOM

- ❖ Assessment of the Situation and impact of the likely to be Disaster.
- ❖ Declaration of the L1, L2, L3 alert depending upon the criticality.
- ❖ Have a prepared check list for pre cyclone work
    - ❖ Tree trimming
    - ❖ Men, material & Tools planning
    - ❖ DG sets / ***Mobile Sub Stations***
- ❖ Activation of Control Room and Disaster Management Cell.
- ❖ Regular Review of DMP



Inventory of spares is key to restoration during the severe Cyclones
Prioritising the installations like Hospitals, Key Gov installations, Data Centers etc

Need to build a Disaster Resilient NW

TPCODL

Wind Speed Study

Study of Winds & local zones : A comprehensive study of the high intensity winds & effects on existing Poles & Lines has been carried out. Highest wind speed of 260Kmph was recorded by IMD in the coastal areas.

- Historical data related to Cyclones/HIW, from IMD and other Govt. sources, have been analyzed.
- The distance of the identified TPCODL divisions from the coast with respect to corresponding wind speed intensity, is considered the basis for the Wind zoning classification of the TPCODL distribution area.
- The TPCODL divisions will be classified into the following zones:

  a) Very High Intensity wind zone (0 to 60 KM from Coast)

  Wind speed 250 to 300kmph

  b) High Intensity wind zone (60 to 100 KM from Coast)

  Wind speed 200 to 250kmph

  c) Moderate Intensity wind zone (100 to 150 KM from Coast)

  Wind speed 140 to 200kmph

Distance from Coast Line (km)	Maximum Wind speed recorded in this zone or beyond this zone	Basic Wind Speed (V_b) m/s	Wind Parameters	Design Wind speed (V_d) as per IS 875 Part 3 2015 (kmph)	Remarks
Up-to 10	260	50	k_1=1.08 k_2=1.05 k_3=1.0 k_4=1.3	265.36	
10-20	260	50		265.36	
20-30	260	50	k_1=1.08 k_2=1.05 k_3=1.0 k_4=1.3	265.36	
30-50	260	50		265.36	
50-60	260	50		265.36	
60-70	260	50	k_1=1.08 k_2=1.05 k_3=1.0 k_4=1.0	204.12	V_d < Experienced wind speed
70-100	203	50		204.12	
70-100	203	44		179.63	
100-150	140	50		204.12	
100-150	140	44		179.63	
150-175	100	50		204.12	
150-175	100	44		179.63	
> 175	100	44		179.63	

Network Condition susceptible to Cyclones

TPCODL

Existing Electrical Network and its resiliency

- Existing Distribution Lines and Structures are not designed as per wind 250 Km/hr.
- Substations are located at low laying areas in coastal region, hence flo
- DP mounted Distribution substations are not designed to withstand win
- Due to lengthy span, conductor load couple with wind pressure becomes more on the supports bending or twisting due to heavy wind pressure.

Whether to go for Resilient and robust network with least damage

Allow damage to some extent and restore the system as early as Possible

Risk to Distribution Utilities

- Reconstruction / rectification of damaged power infra after cyclone is a challenging task.
- Huge funds requirement to bringing back to normal condition within very li
- During restoration period, it is difficult to maintain the quality of work.
- Due to power outage for long period, utilities incur huge revenue loss
- Huge Impact on the economic and emergency activities in addition to pub

Cost associated with each option will be different

Strategic Approach of Design

TPCODL

Need for Strategic Approach

- The origin and direction of cyclonic storms are difficult to predict in terms of probability, timing, and severity.
- The Key focus of climate resilience efforts is to address the vulnerable distribution network and sketch a plan for time graded sustainable mitigation measures.
- A multipronged approach, which encompasses the change in design philosophy, better planning and adoption of modern technological solutions, is required to safeguard the Distribution network infrastructure from natural disasters and to increase resilience, reliability and availability of the system.

Preventive and mitigation measures for minimizing the damage to Power Distribution Network:

- Measures to design Cyclone resilient network in all new future construction. Preferred in 1st 20 Km from Coast.
- Retrofitting of existing Distribution network infrastructure to increase their resiliency to Cyclone. Preferred in 20 – 60 Km to optimize the cost of making resilient network.
- Design of new material like pole structures, Civil structure, line accessories which can sustain to climatic changes and have better resiliency in the coastal area.

Strategic Approach of Design

TPCODL

Design Approach

- In urban areas, 33 kV and 11kV overhead lines should be converted to underground cable system within 20km of coast line in order to provide reliable & uninterruptible power supply during cyclone
- Construction of **Indoor Substation** instead of Outdoor switchyard arrangement.
- Splitting of Larger network sections into the smaller section to ensure faster restoration.
- **Refurbishment of existing lines by use of rail poles / joist / Spun Poles** and introduction of additional poles in between span to strengthening the existing line should be taken up.
- Double Pole **(DP) structure with Air Break (AB) Switch should be introduced after every 10 no. of poles** to reduce damage to distribution infrastructure during Cyclone by limiting the damage to the affected section.
- **Pre-casted foundation can also be used for early restoration** of the distribution line post cyclone. These **pre-casted foundations also eliminate the concern of poor workmanship**.
- Sufficient Stock of **Mobile Substations** to restore the Power supply in case of massive damage

Different Pole design and its susceptibility during Cyclone

TPCODL

STAAD Pro Analysis of existing Poles : All existing Poles are failing in Wind zone 1 (0-60 Kmph)

Sl no	Section	Height, m	conductor			Zone (0 to 60 km)		Zone (60 km to 100 km)		
			Area, mm2	Dia mm	Span, m	Design wind pressure, N/m2	utilisation ratio	Deisgn wind pressure	Utilisation ratio	Economic section
1	ISMC 200 (H POLE)	9.2	100	12.78	40	3880.09	1.356	2933.91	0.891	-
2	ISMC 200 (H POLE)	9.2	232	19.7	50	3880.09	2.22	2933.91	1.2	-
4	160 X 152	9.2	100	12.78	40	3880.09	5.235	2933.91	3.964	ISMC 200 (H POLE)
5	160 X 152	9.2	232	19.7	40	3880.09	6.316	2933.91	4.247	IISMC 200 (H POLE)
6	160X150	9.2	80	11.43	35	3880.09	3.8	2933.91	2.97	ISMC 200 (H POLE)
7	150X150	13	80	11.43	35	3880.09	8.09	2933.91	6.596	ISMC 200 (H POLE)

Rebar Lacing Pole - Cyclone Resilient yet Cost Effective

Rebar Lacing Pole for 11 & 33 KV lines : TPCODL has developed a **Low Cost** pole which can **withstand winds upto 300Kmph.** Depending upon the various applications & situations the span length can be 60 to 80 meter.

RLP is Type tested at CPRI lab: Pole was designed jointly with TCE, Fabricated locally in Odisha & Type tested in CPRI Bangalore.

RLP Design: RLP design is very simple. It uses a box frame made of ISAs supported by MS rod welded connections from inside. It can be fabricated in one piece or two pieces. Uses suspension insulators.

RLP Foundation: Foundation design can be selected based on soil condition. A prefab STUB will be buried / embedded in foundation & The RLP has detachable bolted connection with the STUB.

Pilot project near Konark Beach : 15 RLP being installed under the pilot project to test the real field performance in cyclonic conditions.

RLP with CICA : TPCODL has developed low cost Composite Insulated Cross Arm which will be used on RLP & will help in improving the overall reliability to very high level.

Flood – Preparedness and Response

The river system of Odisha comprises of nine major river systems and their tributaries and distributaries. Monsoon season witnessed spates of heavy to very heavy rainfall in different parts of the Odisha State. Especially, almost all the districts received substantial rainfall due to Low pressure over Bay of Bengal and active Monsoon. Heavy rainfall occurred in the upstream catchment area of river system and same period heavy rainfall in downstream area of river caused flood in Odisha state several districts.

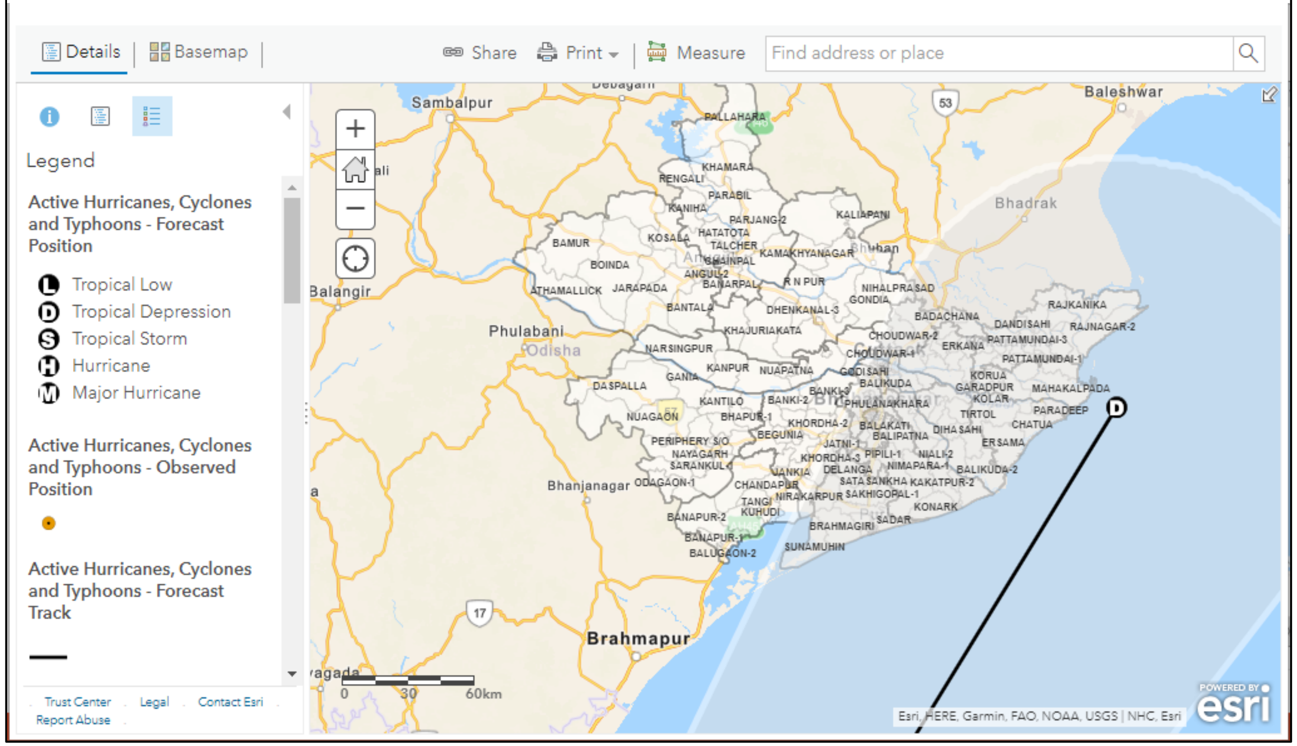
Design Approach

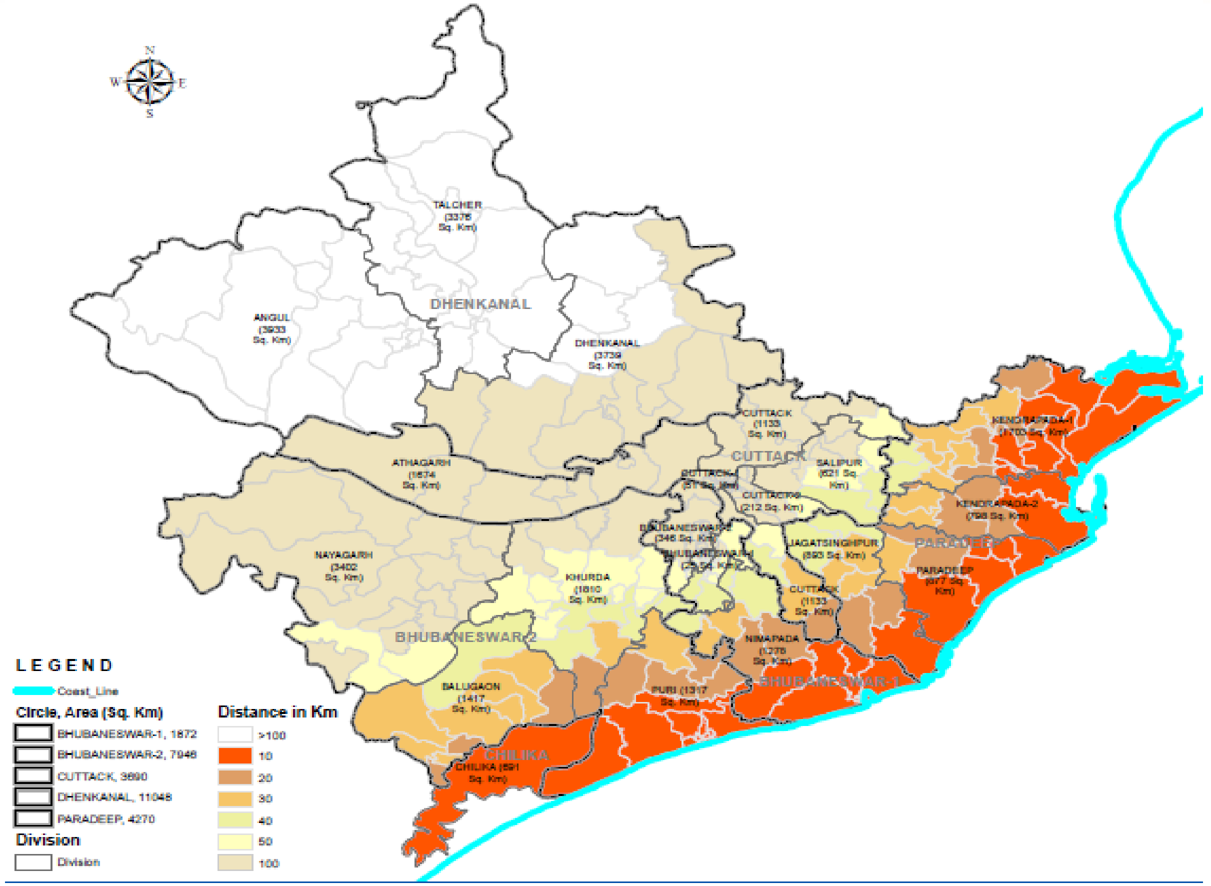
- All electrical equipment to be installed at place higher than the HFL.
- Distribution Transformers to be installed on elevated plinth
- Substation to be constructed above the road level and with proper drainage system.
- Appropriate grade of concreting to be used for construction of Pole and / or tower foundations.

MAN & material deployment using GIS

TPCODL

Use of ESRI Web solution for Weather prediction analysis on TPCODL Sections





Leveraging web based solution for likely to be affected sections on GIS platform for better Man & Material Deployment.

1. Basis on the alert and trajectory shared by IMD, highlight the likely to be affected sections.
2. Using the distance of the section from the coast line and estimated wind speed, plot the severity of the impact on the GIS maps.
3. Deploy the Man & Material in proportionate to the severity of the impact in the identified sections.

Affect of high ambient temperature on Distribution Network

TPCODL

Climate change may constrain future electricity supply adequacy by reducing Distribution network capacity and increasing electricity demand. Impact of high ambient temperature of Distribution System, are:

- Reduced ampacity of the Distribution Lines
- Overloading of the system due to increase in Consumer Load demand
- Drop in system voltage causing low voltage in the system
- Increase in the Conductor sag resulting into lower vertical clearances
- Reduced efficiency of PV Solar Cells
- Slower dissipation of heat thus putting strain on the Transformer’s cooling system.
- Narrow down the band of Operational stability and safety.

Procurement design

3. CLIMATIC CONDITIONS OF THE INSTALLATION:

1	Maximum ambient temperature	50 deg C
2	Max. Daily average ambient temp	35 deg C
3	Min Ambient Temperature	0 deg C
4	Maximum Humidity	100%
5	Average Annual Rainfall	150cm
6	Average No. of rainy days per annum	120
7	Altitude above MSL not exceeding	1000m
8	Wind Pressure	300 Km/hr
9	Earthquakes of an intensity in horizontal direction	Equivalent to seismic acceleration of 0.3g
10	Earthquakes of an intensity in vertical direction	equivalent to seismic acceleration of 0.15g (g being acceleration due to gravity)

TPCODL service area has **heavy saline conditions along the coast and High cyclonic Intensity winds with speed upto 300 Kmph**. The atmosphere is generally laden with mild acid and dust in suspension during the dry months and is subjected to fog in cold months.

Transformers

23	Permissible Temperature Rise over ambient temperature of 50 deg C	
	a) Of top oil measured by thermometer.	45 Deg C
	b) Of winding measured by resistance.	55 Deg C

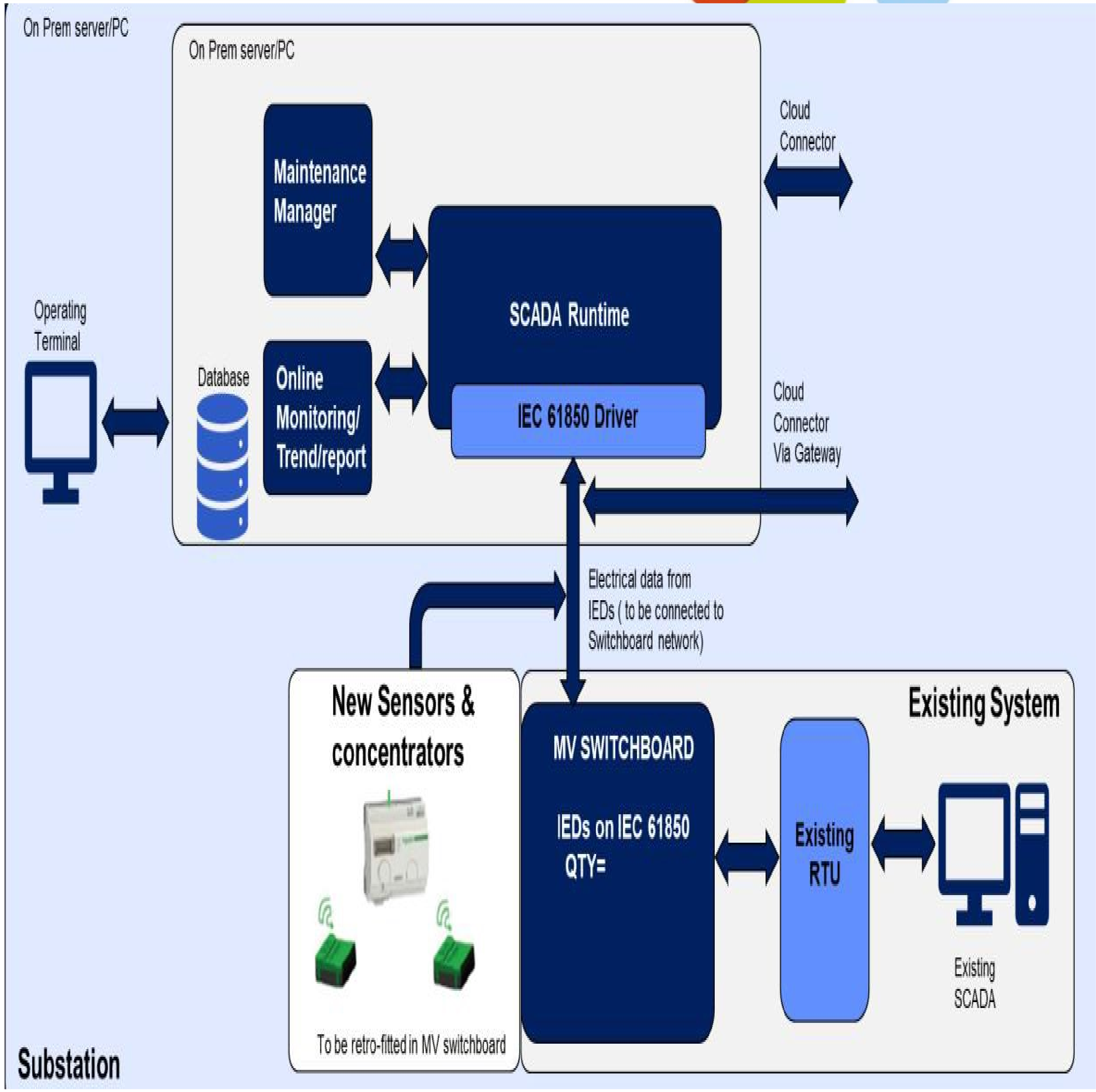
LT ACB & MCCB

16	Max. Permissible temp. rise	80°C at terminals with an ambient temperature not exceeding 40°C

New technologies for managing real time temperatures in ADMS / NMS

Condition Based Asset Monitoring System for MV Switchboard

- Equipment critical connections with wired/wireless, continually transmitting **temperature sensors**, **environmental sensors** to monitor ambient conditions & **HMI/SCADA to display alarms** and indication when absolute temperatures exceeding a threshold with status indicators
- **Electrical Asset management System (EAMS)** with online condition monitoring, Asset health monitoring, data storage, reporting and maintenance support, health prediction of electrical distribution network/ plant assets spread across the various locations, allow engineers/ managers to gather data and insight that allows them to make more informed decisions about asset health.
- **Installation of different sensors in the switchboard** and setup the communication with on premise EAMS PC/server. Various type of sensors (temperature and humidity) shall be mounted at near bus bar chamber, bus bar joint at circuit breaker and cable link with one no. sensor per phase of MV (11kV) switchboard.



New technologies for managing real time temperatures in ADMS / NMS

- Asset Condition Monitoring & Performance Management for Power Transformers
  - Temperature data from WTI and OTI to SCADA (from Transformer to CRP to RTU) for online monitoring. WTI and OTI should be communicable with CRP/RTU.