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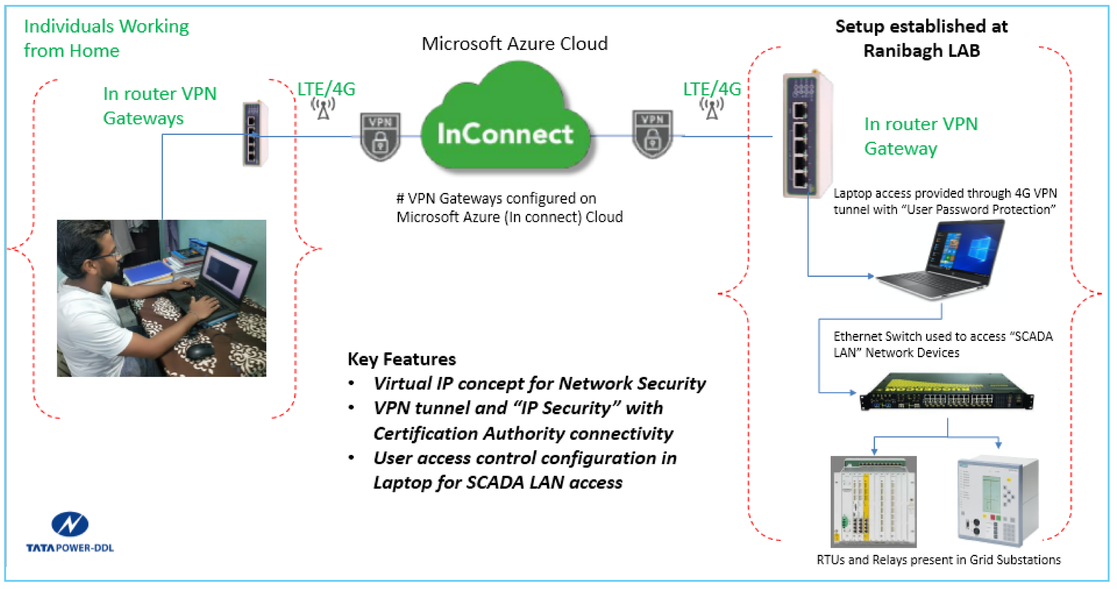
Remote Parameterization of IEDs, RTUs, FRTUs at Tata Power-DDL through IIOT Platform During COVID-19 to Provide 24x7 Support to Power System Control

Remote configuration of IED to ensure automation performance index in Sub Transmission Network & Distribution Network

- Emergency Support to PSC team during COVID-19 through remote configuration of IED & RTU and ensure business continuity in Sub Transmission & Distribution Network.
- An IIOT Cloud-based wireless connectivity solution devised which securely connects to SCADA LAN network remotely to access the IEDs, RTUs & FRTUs.
- Attend emergency breakdowns and carry out critical maintenance or project activities sitting at remote locations.
- Cloud-based Modem/ Gateway installed at Ranibagh LAB which is connected to a centralized Laptop/PC system which subsequently connects to SCADA LAN network.
- Real-time monitoring of RTU, fetching relay FDR through remote and ensuring 24*7 support to field crew.

IIOT Cloud-Based Remote Access of SCADA LAN for Work From Home



Benefits

- 24x7 Remote configuration and troubleshooting of Automation System (IED, RTU, FRTU etc.)
- Integrated Factory Acceptance Test (I-FAT) for new IED & Equipment
- Ensure business continuity in Sub Transmission & Distribution Network during COVID-19 pandemic
- Reduce Carbon footprint due to less mobilisation of Protection & Automation team on site
- Development of Work from Home Culture & flexible timing in Power Distribution
- Enhance productivity due to elimination of travel time to site location
- Safe & secure work environment for employees & their families

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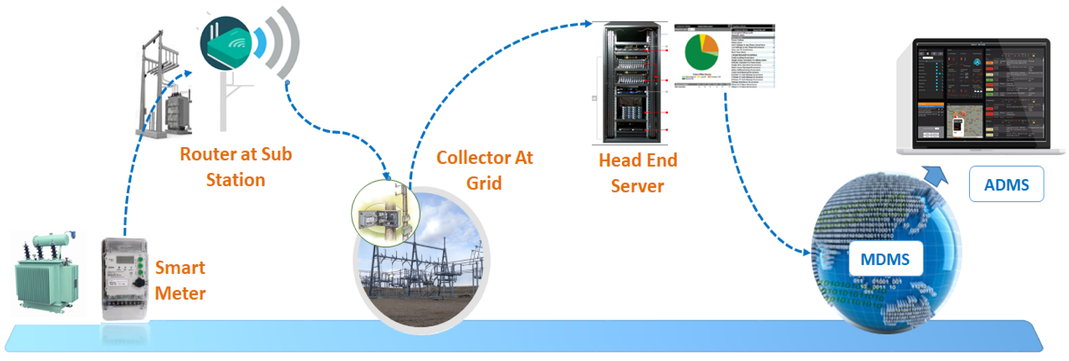
Integrated DT Management (Smart Meter DI/DO Approach)

Smart Meter with Digital Input & Digital Output (DI/DO) concept:

- DT Smart Meters have 5 Digital Inputs and 1 Digital Output.
- Integration of DT oil level signals with Smart Meter DI inputs.
- In case of low oil level, meter takes decision and sends trip command to DT control breaker after 60 seconds.
- Real-time load monitoring of DT through Smart Meter interface for any unbalancing or over load.
- Integration of RMU breaker status, SF6 Gas pressure sensors and relays for complete monitoring of DT and controlling of DT breaker.
- End-to-end integration with MDMS & ADMS.
- Real-time monitoring of alarm & event.

Scope of work: 5000 nos. of DT Meters with DI/DO

Architecture for Smart Meter DI/DO Integration Project



Benefits

- 100% automation of Distribution Transformer
- Real-time information to Power System Control of DT status (Unbalancing/Overloading)
- In case of low Oil level, Intelligent logic built to trip the DT breaker
- Enhance Asset Optimistation
- Reduction of DT theft
- Optimisation of Capex & Opex
- Attribution to Enhance SAIDI

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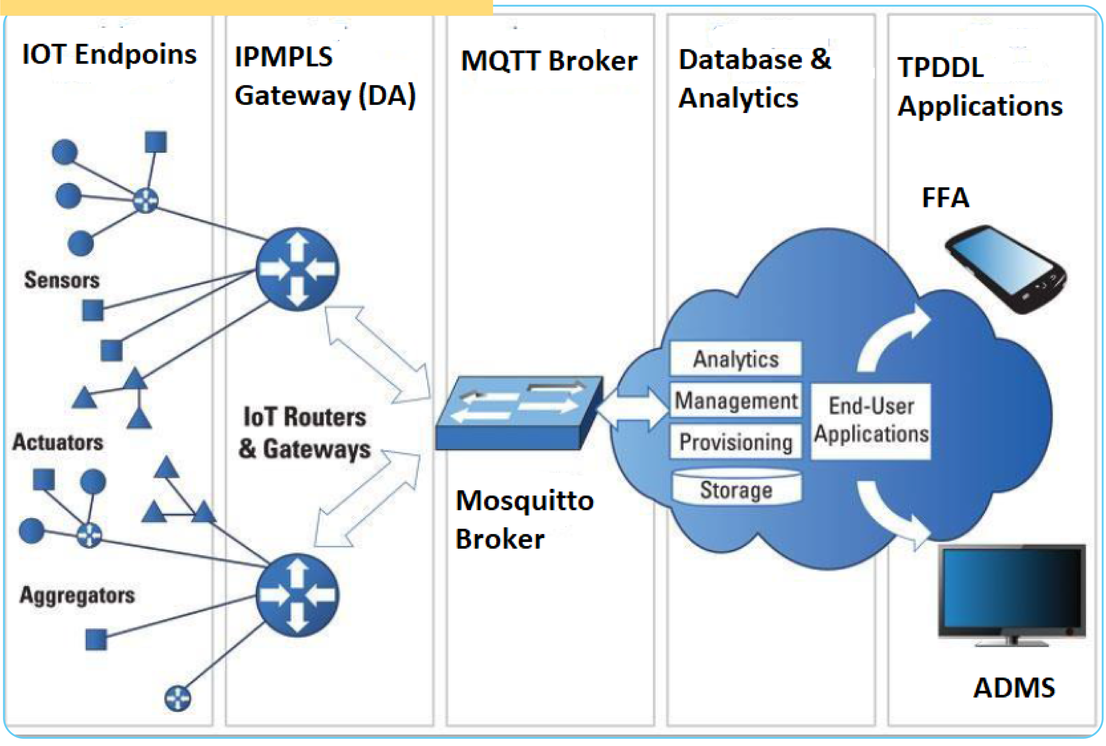
IOT-Based LV Automation for LV Network in Tata Power-DDL

First ever large scale IOT-based Distribution Automation in India:

- Real-time information of LV network, i.e, ACB, feeder pillar & fuse box.
- Integration of RMU breaker status, FPI sensors, SF6 Gas pressure sensors and relays for complete HT and LT monitoring of the substation.
- Real-time information of pillar box fuse blown of temperature, fire sensors.
- End-to-End integration with IOT server, ADMS and mobile workforce management application (FFA).
- Advanced features of reporting outages and intimating to customers upfront through ADMS interface.

Scope of work: LT ACB covered-2400; Feeder Pillars covered-100

Architecture LV Automation Project



Benefits

Enhance customer satisfaction based on real-time information, rather than prediction

Monitoring of SAIDI, SAIFI, MTTR and MIS downloading

LV planning based on loading data

Faster restoration of supply being actual pinpointed information related to site

Universal data analytics and real time dashboard of users

Strengthen LV Maintenance based on tripping, unbalancing, overloading data

Cyber Security features with IEC standards

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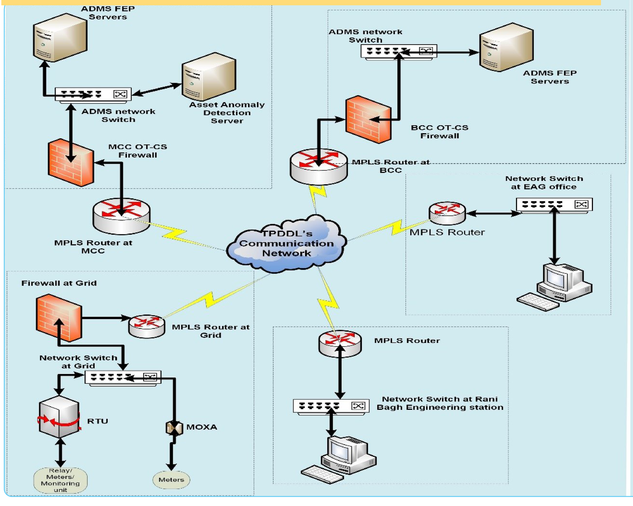
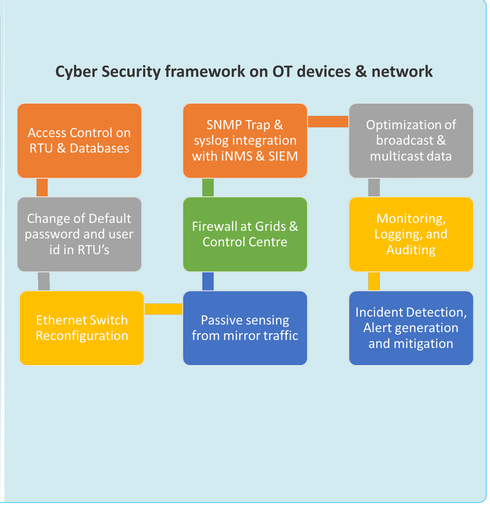
Cyber Security Implementation in Operation Technology

- Objective is to implement Cyber Security controls on the OT network & devices such as RTU, FRTU, Ethernet switches, BCPU, etc.
- Installation of Firewalls at each node and gateways to other interfaces.
- Installation of Firewall between remote nodes and control centres.
- Development of network behaviour & anomaly detection tool.
- Access control & asset register for OT devices.
- Vulnerability and penetration testing.

Scope of work: 80 Grids & Control Centre's MCC & BCC network

Architecture of Cyber Security on OT System





Best Practices Security Framework

In-Scope Areas / Domains / Activities

- Segmentation
- Access Control and Management
- System Hardening
- Monitoring and Management
- Network Security
- Security Technology
- Asset Management
- Single Point of Failure
- Non-intrusive Penetration Testing
- Documentation
- Physical Security

Benefits

Grid Cyber Security enhances vigilance against both accidental and intentional threats

Access control on Grids IED's

Provide protection of critical devices

Integrated Cyber Security platform for IT-OT

Internal process and control improvement

Ensure business continuity with change in pace with technology

Safeguard from external attack and visibility in own network

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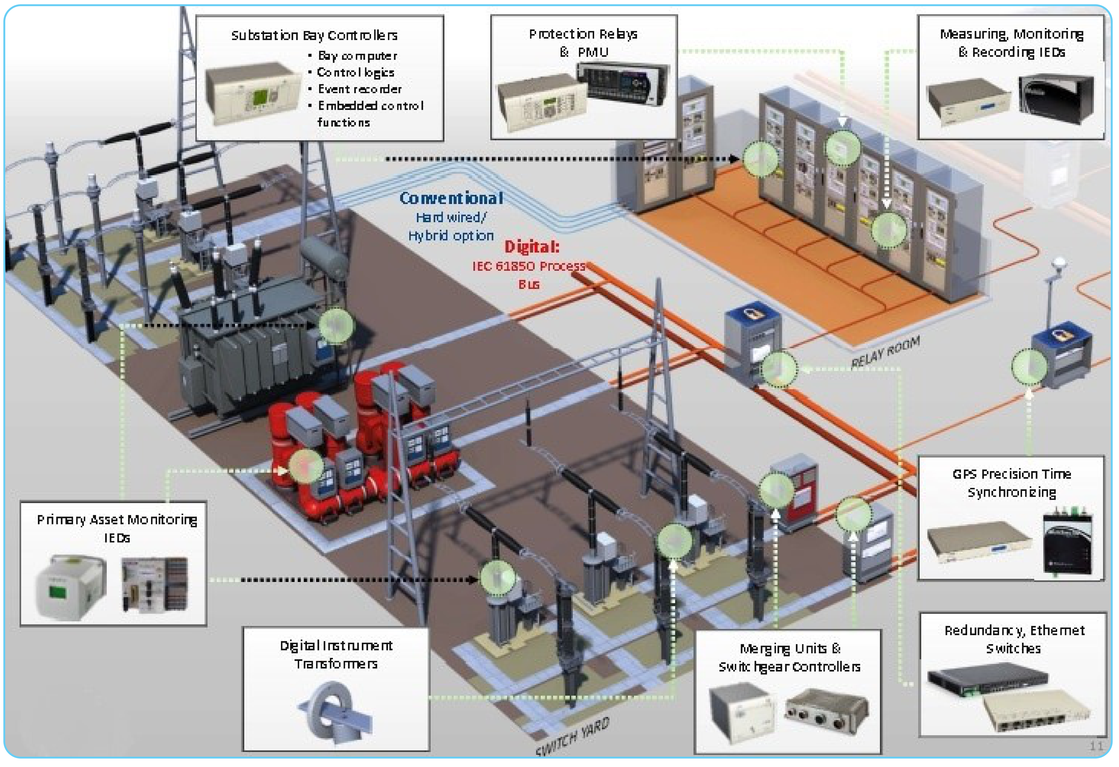
Digital Substation Implementation in Tata Power-DDL

- Land cost optimization through Digital Substation
- Optimization of control cable & wires technology helps us Land optimisation
- Optimization of control & relay panel and centralised protection system development of advanced protection system such as Bus Bar Protection
- Real-time collection of diagnostic parameter from CT and PT
- Health monitoring of entire asset in substation

Scope of work: Complete 66 KV network of 66/11KV Bawana-6 Grid

Architecture of Digital Substation

Distributed Architecture (Bay Level)



Components of Digital Substation:

Merging Unit (In Case of Conventional CT & PT)

The process level is the interface between the primary equipment in the substation and the secondary (protection & control) system through Merging Units.

The interface is fully defined by the use of IEC 61850-8-1 for status and trip signals, IEC 61850-9-2LE (Sample values) for analogs and IEC 61869-13 on the way for instrument transformers and associated digital communications.

Ensuring the highest availability and dependability: The IEC 62439 standard available – Parallel Redundancy Protocol (PRP).

GPS Clock:

Time Synchronization

Time synchronization over the process bus network is generally preferred, using the IEEE 1588 protocol use for critical application such as Differential Protection.

SNTP (Simple Network Time Protocol): Could not guarantee micro second accuracy required for synchronized IEC 61850-9-2 Sampled Values, which may lead to Phase shift of the data processed at the Relay end resulting into unwanted Tripping.

Benefits of Digital Substation

- Approx. 30% land optimization
- Elimination of laying control cable & wiring
- Real-time data of CT & PT for analysis
- Diagnostic information over entire protection value chain at substation level
- Safe and maintenance free approach

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Technical Loss Estimation & Reduction

Transmission & Distribution Loss is one of the prime yardsticks to measure the performance & efficiency of any Distribution utility. Technical loss is a major component of Transmission & Distribution Loss and significantly impacts the bottom line. Technical losses occur as a direct result of the physical characteristics of the electrical equipment used in distribution networks.

They depend on the design of the power grid, the voltage and transformation levels and the length of the power lines. Technical losses relate to investment in equipment (lines, transformers) and long term signals (compromise between investment costs and operational expenditure). They also relate to efficient planning and the design of distribution networks.

As such, accurate estimation of technical losses and optimum planning to manage them plays a major role in the short, medium or long term goals of a Distribution Utility.

Tata Power-DDL has extensive experience and technical know-how in the area through the use of cutting-edge load flow softwares.

Development of customized load flow algorithms for solutions or studies based on unique requirements.

Our approach & methodology is validated through collaborations with leading centers of academia.

We have extended consultancy services to multiple utilities, both in India and abroad.

We provide consultancy services in:

- Technical Loss Estimation
- Loss Trajectory Preparation
- Evaluation of ways and means to reduce technical losses along with cost-benefit analysis. These include:
  - Line Re-conductoring
  - Optimal Capacitor placement
  - Feeder bifurcation
  - Network reconfiguration (Optial NOP identification)
  - Customized load flow studies to meet unique requirements

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Solutions for Space Constraints Related to Distribution Substation

Urbanization has led to difficulty in getting space for installation of new substations, especially in metro cities and areas of high load growth, which necessitates design of substation and its equipment with highly reduced footprint having excellence in operational safety, power reliability, and rapid fault restoration to maintain the quality of power with minimum fluctuations. Following are the designs of substations which have been adopted by Tata Power-DDL in the last 4-5 years.

11kV Substation on Drain: Drain Top Substation

Salient features:

1. Creating platform on boundary walls of drain using channels & chequered plates
2. Complete substation will be installed on drain with 400kVA, 630kVA or 1000kVA DTs including RMU & ACBs
3. Practically NO space requirement as compared to conventional substation of 8mX4m, i.e., 100% reduction of space, however as per width of the drain, this design can be customized
4. Augmentation from 400kVA to 630kVA to 1000kVA is possible

11kV Substation on Elevated Platform: Vertical Substation

Salient Points:

1. Platform has been designed using channels & chequered plates on top supported by corner steel columns & beams
2. DT (400kVA, 630kVA or 1000kVA) will be installed on platform and RMU & ACBs at ground floor level
3. This substation required space of 3.5mX3.0m as compared to 8mX4m for conventional substation, i.e., 65% reduction of space
4. Augmentation from 400kVA to 630kVA to 1000kVA is possible

11kV Substation on Elevated Platform: I-Type Substation

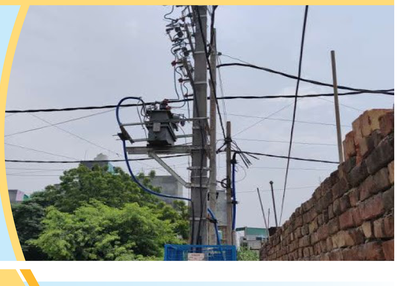
Salient Points:

1. Creating RCC I-shaped Platform to have elevated DT and to create space below
2. DT (400kVA or 500kVA) will be installed on top platform and RMU & ACBs at ground level
3. This substation required space of 2.0X2.0m as compared to 3.0X2.5m for conventional substation, i.e., 45% reduction of space
4. Augmentation from 400kVA to 500kVA is possible

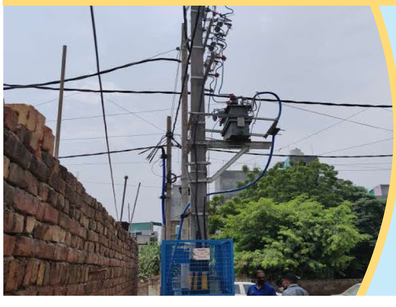
63kVA Three Phase DT on Single Pole

Salient Points:

1. Generally up to 50kVA single phase DTs are installed on single pole
2. This design was developed to install 63kVA three phase DT on single pole
3. HT GO Switch will be on the same pole & ACB will be installed below the DT, fencing size is 1X1M
4. This will reduce the space requirement by 80%.



Underground (Open Trench) Substation with 630kVA DT



Salient Points Underground Design:

1. This will be installed first time in India
2. An underground vault will be created with top open
3. Submersible duty 630kVA Oil Type DT will be put inside the vault
4. RMU & ACBs will be kept on the ground level
5. Top of this vault will be covered with gratings
6. Virtually no space is required for Transformer, however, vault size will be 3.5X3.0m

TEPCO Power Grid

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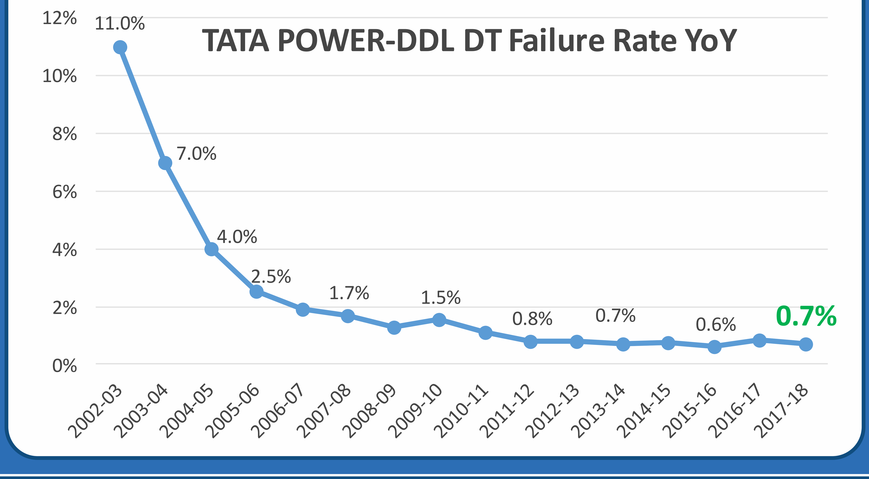
REDUCTION OF DISTRIBUTION TRANSFORMER FAILURE

❖ Total No. of DTs: **29,742**

❖ Total MVA:**5312**



Established Well Equipped DT Workshop

Extensive Quality Control of Repair Process at Workshop

Extensive Sample Testing of New DTs

Preventive & Condition Based Maintenance

BEST IN CLASS INTERNATIONAL EXPERIENCE

Tata Power-DDL collaborated with TEPCO POWER GRID to setup a state-of-the-art Distribution Equipment & Engineering Centre

TEPCO Power Grid's Key Initiatives for Reduction of DT Failure Rate

Distribution Engineering Centre : Established in Tokyo, 1998

Step 1 Failure analysis
Investigation of failure factors and accumulation of data

Step 2 Counter measure establishment
Countermeasure establishment with cost efficiency and possibility

Step 3 Feedback
Feedback for improving failure by data analysis

- **Step 3.1** Construction work improvement
- **Step 3.2** Maintenance methodology improvement
- **Step 3.3** Specification revision
- **Step 3.4** Manufacturing process improvement

Step 4 Rollout

DT Failure Rate
0.006%

Distribution Lines:
360,000km
More Than 2.5 M DTs

SAIFI 0.07 times/y
SAIDI 4 minutes/y

Value Proposition

Reviving Existing Workshop

Creation of World-Class Infrastructure

Effectively managing the DT Workshop

Analysis of existing processes and restructuring

Managing DT Workshop

Establishment of well equipped DT Workshop

Designing of processes involved in life cycle of DT

Training to DISCOMs employees for better maintenance practices

Technical Advisory & Consultancy

Root Cause Analysis

Performance Evaluation

Study of existing processes

Solution matrix for corresponding root cause