# Regional Roundtable on Infrastructure Governance
# Regulation, Governance and Transparency

## *Technology to Improve Infrastructure Governance - A Perspective of Indian Power System*

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***Power Grid Corporation of India Ltd.***

***May 23, Seoul, Republic of Korea***

# Indian Power System - Outlook

Installed Capacity ~ 356 GW

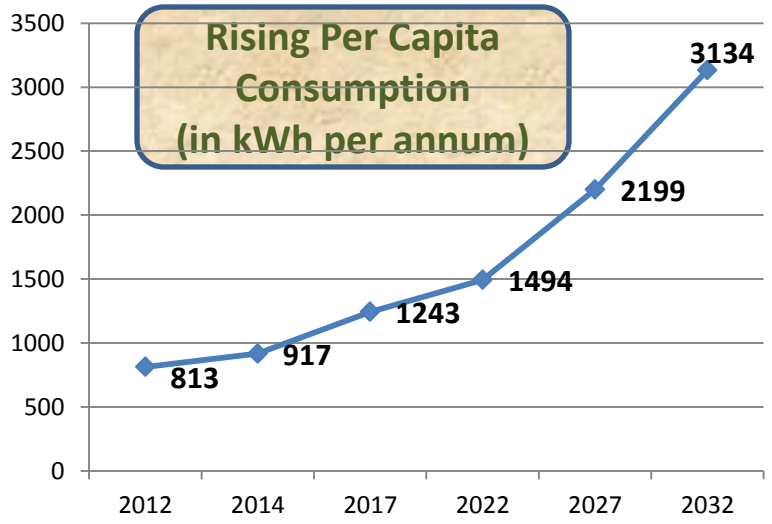
Annual Consumption - 1250 BU

Peak Demand Met: 175 GW

One Nation - One Grid - One Frequency

2nd Largest Synchronous Grid in World

| Voltage Level | Circuit Kilometers (CKM) | Transformation Capacity(MVA) |
|---|---|---|
| HVDC | 15556 | 22500 |
| 765kV | 41809 | 211500 |
| 400kV | 180746 | 324822 |
| 220kV | 175296 | 352481 |




24x7, Affordable & Quality Power for All

Seamless Cross-Country power flow

Large Scale Renewables Capacity Addition – 175 GW by 2022

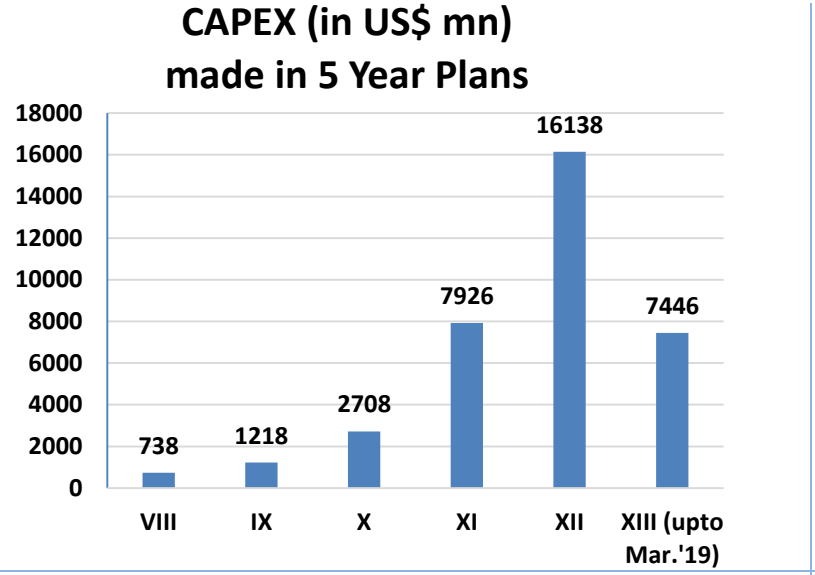
International Cooperation- Towards integrated power system

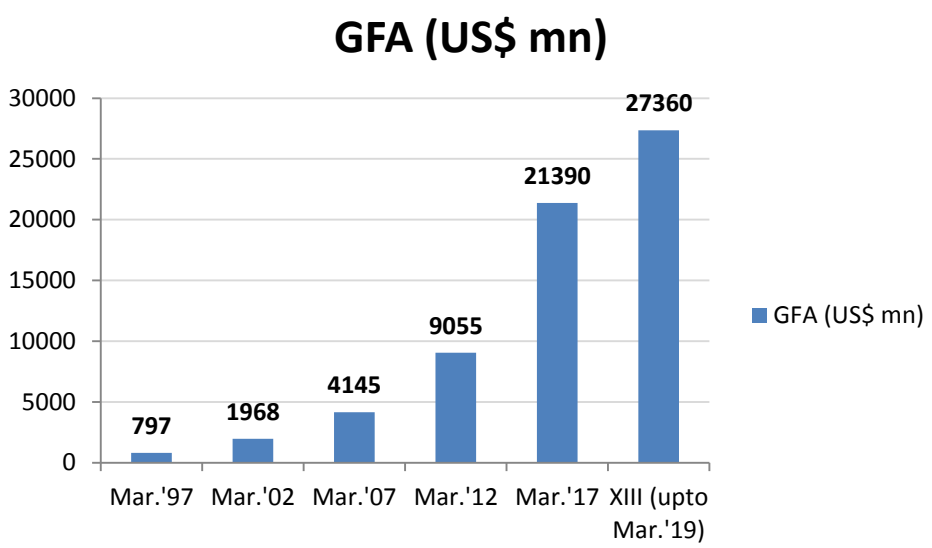
# Towards Integrated Global Power System

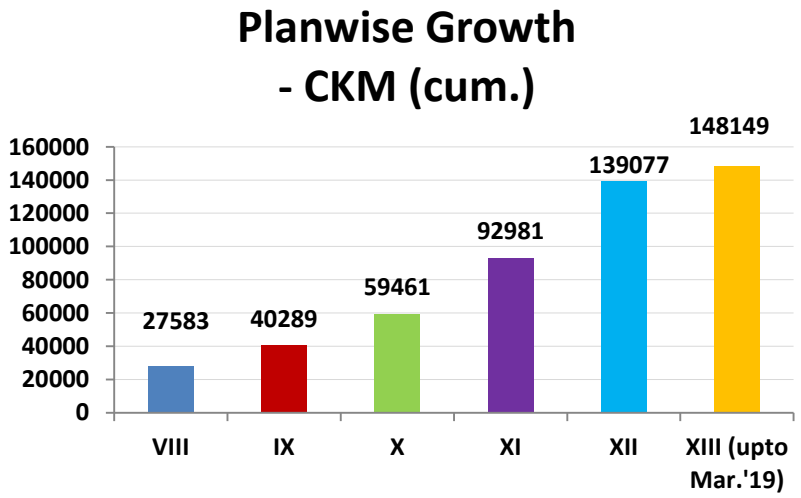

| Inter-connections | Existing | Under Construction |
|---|---|---|
| India – Bhutan | 1350 | 2900 |
| India – Bangladesh | 1200 | 1340 |
| India – Nepal | 550 | 400 |
| India – Myanmar | 3 | - |
| Sri Lanka | 1000 (under discussion) | |

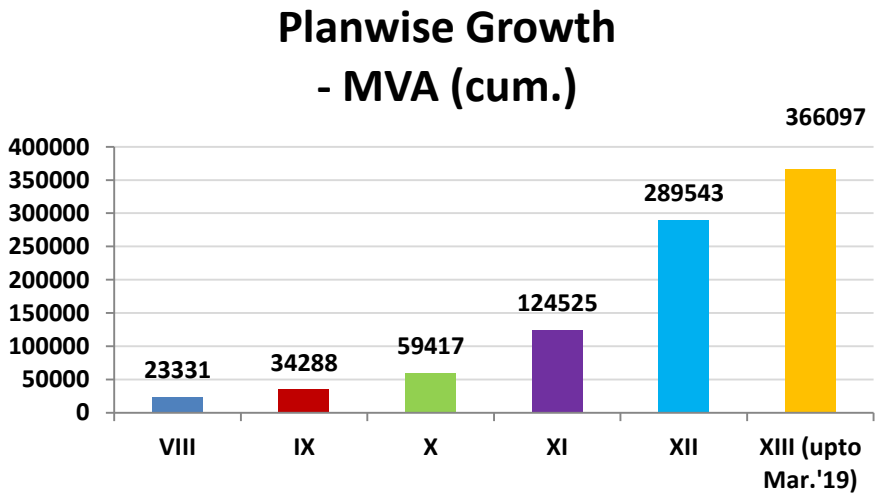
***Hon'ble Prime Minister, India Vision***
***'One World-One Sun-One Grid' for flow of solar energy across borders***

# POWERGRID – Growth Story




*5 Year Plans: VIII (FY 1992-97); IX(FY 1997-02); X (FY 2002-07); XI (FY 2007-12); XII (FY 2012-17)*

# Challenges in Building Power Transmission Infrastructure

Planning

Implementation

Maintenance

❖ Generation projects issues:
- Uncertainties in time line, Power Purchase Agreements and Long Term Access

❖Renewable Energy Integration with Grid:
- RE Generation gestation ~ 1 year while it is 2-3 years for transmission system
- Issues in grid stability due to inherent intermittency, variability and uncertainty.

❖Implementing multiple large Projects within Time and Cost
- Approval of Projects
- Transparency in Procurement
- Monitoring of Progress
- Quality Control & Inspection

❖ Land Acquisition & Right-of-Way (RoW)
- Delays & Compensation issues

❖ Asset Management
- Increasing Asset Base, Complexity & Ageing Assets
- Nature's Vagaries, Changing Climate and Wind Pattern
- High Availability and Reliability

# Meeting Challenges in Transmission through Technology

## Planning based on projected demand

### ❖High Capacity Transmission Corridors

- > 60,000 MW created connecting the major generating pockets to the demand centers.

### ❖Renewable Energy Integration with Grid:

- Special green energy corridors created proactively based on assessment of potential Renewable Energy Generation.
- To manage intermittency & variability STATCOM, Fault Ride through technology, Renewable energy management centers (REMC) established.

## Integrated Project Management & Control

### ❖Transparency & Quality

- E-Procurement, E-Reverse Auction for price efficiency.
- All payments being done digitally.
- Process for inspections being carried out online, saving time and ensuring quality and effective monitoring.
- Enterprise Resource Planning (ERP).

# New Technologies – Improving Reliability & Efficiencies

❖ **Land Acquisition & Right-of-Way (RoW)**

- **High Voltage lines to save RoW.**
  - 400kV → 765kV EHVAC → 1200 UHVAC (Highest Voltage in the World)
  - ±500kV → ± 800kV HVDC
- **Multi circuit/ Pole type towers.**
- **Use of Gas Insulated Switchgear for land optimisation.**
- **Light HVDC - Voltage Source Converter (VSC)**
- **Increase in capacity of transmission corridor through -** HTLS Conductor, Series Capacitor

❖ **Making grid smarter for enhanced reliability - STATCOMs, WAMS, REMCs**

| Voltage | ROW (m) | Capacity (MW) | MW/ m-RoW |
|---|---|---|---|
| 400kV (D/c) | 46 | 1000 | 22 |
| 765kV (S/c) | 64 | 2100 | 33 |
| 765kV (D/c) | 69 | 4200 | 61 |
| ±500kV HVDC | 52 | 2500 | 48 |
| ±800kV HVDC | 70 | 6000 | 90 |
| 1200kV UHVAC | 100 | 8000 | 80 |

**Reduction in Land Requirement**

- Cost Saving; Faster Execution through GIS

**Enhanced Stability & Reliability**

- RE Integration, Grid Balancing

**Reduced Carbon Footprint**

- Forest Area reduced from 6% in 1998 to 2.26%

# Meeting Challenges in Transmission through Technology

## National Transmission Asset Management Centre (NTAMC)

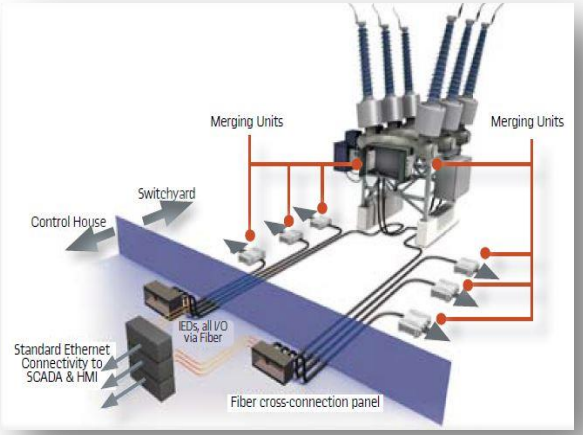
- Control Centre for Management of POWERGRID's Transmission Assets.
- Remote Operation of >200 EHV Sub-stations .
- NTAMC is equipped with latest softwares like;
  - AFAS (Automated Fault analysis software); SCADA; Visual Monitoring System (VMS); Remote Access System (RAS) and others for asset management

# Meeting Challenges in Transmission through Technology


**Patrolling of Lines through Drones, Helicopters and Tablet App based**


**84 meters away in 2011** | **22 meters away in 2016**

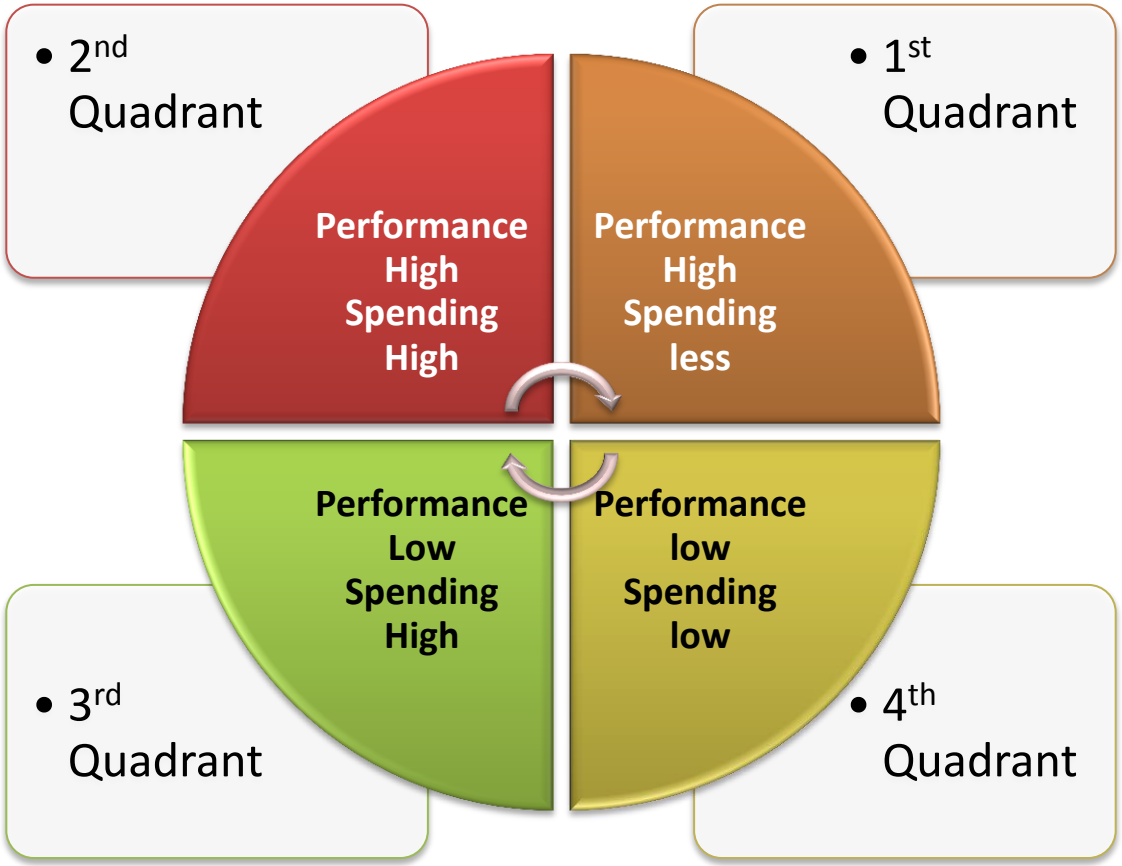
**GIS Mapping of transmission assets**



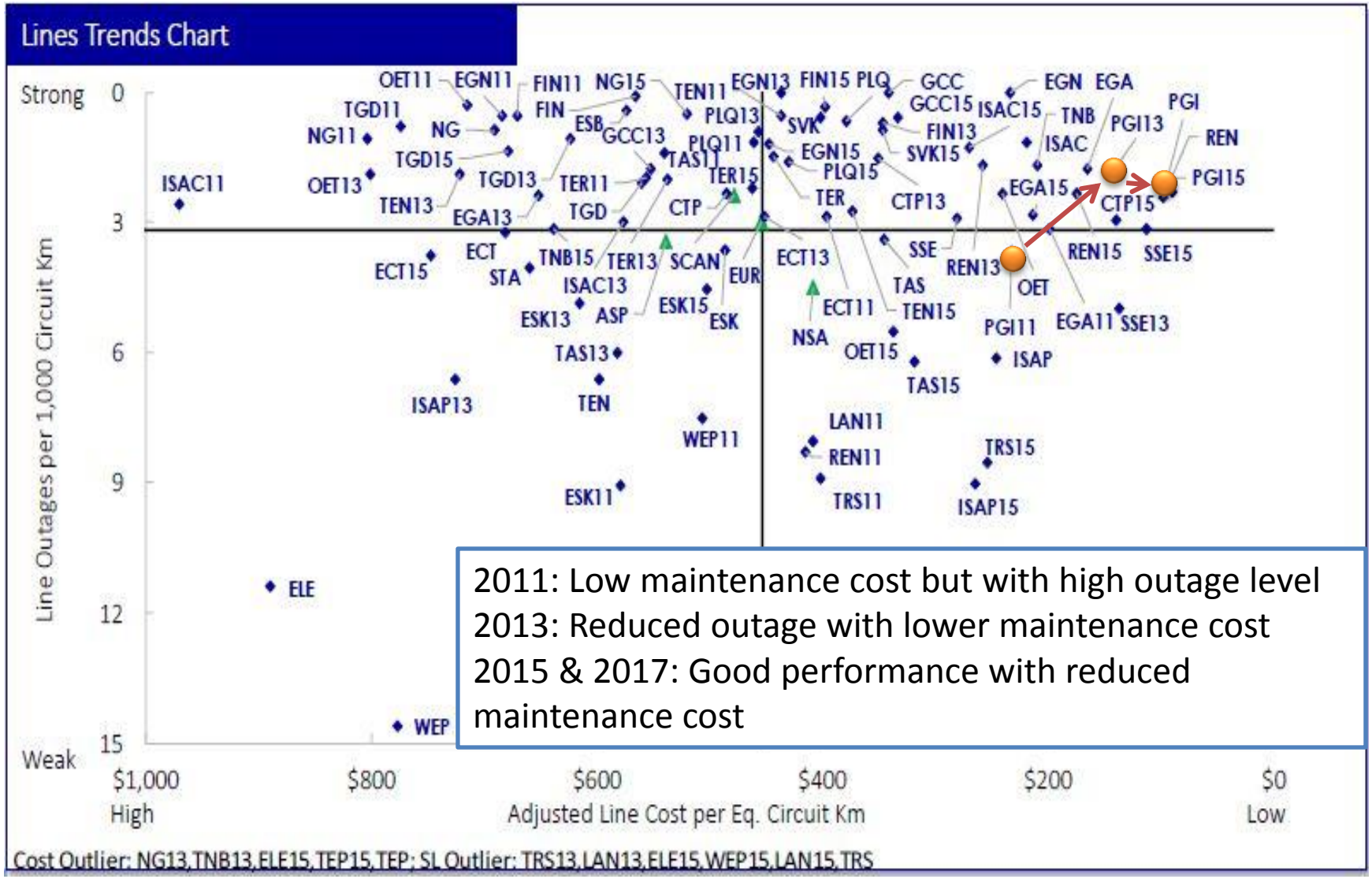

**Process Bus for Substation Automation**

# International Benchmarking: Comparison with Peers

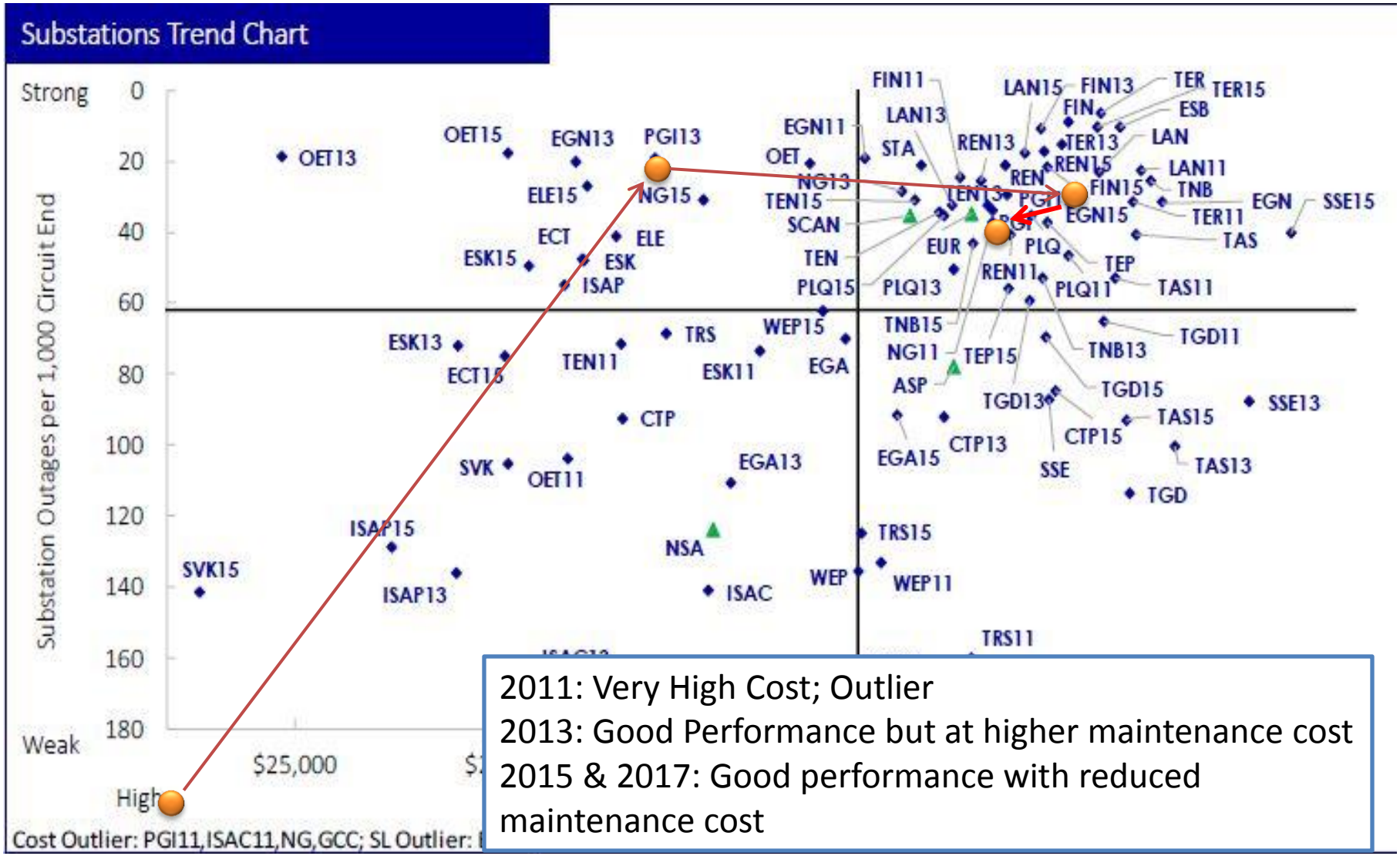
## Philosophy of benchmarking



# International Benchmarking for Transmission Lines



# International Benchmarking for Substations




2011: Very High Cost; Outlier
2013: Good Performance but at higher maintenance cost
2015 & 2017: Good performance with reduced maintenance cost

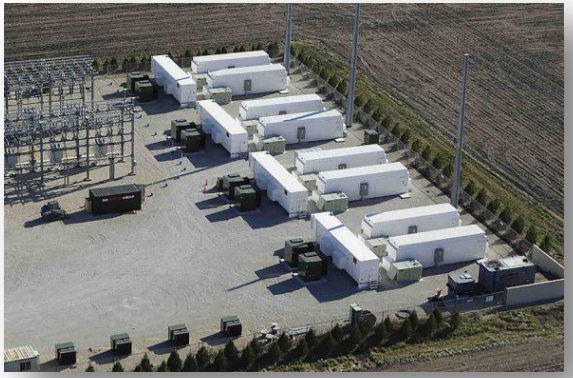
# Way Forward: Planning for future

## Technology Integration for Infrastructure Management


**Asset Health Indexing of Transformers**

**Use of Hybrid GIS**

**Substation Inspection Robots**



**Battery Energy Storage Systems**

**Superconducting Fault Current Limiter**

**Gas Insulated Lines**

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