

TNB's approach on PQ Mitigation

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UNDERSTANDING POWER QUALITY



For normal utility power, sometimes voltage is not normal as what is generated from power generator/source

normal condition

POWER STATION

TRANSMISSION LINE

33kV & 11kV : $\pm 5\%$
400V : +10%, -6%

normal condition voltage regulation

PMU
132 kV / 33 kV

HEAVY INDUSTRY & COMMERCIAL
33kV

LIGHT INDUSTRY & COMMERCIAL
11kV

PPLU
33 kV / 11 kV

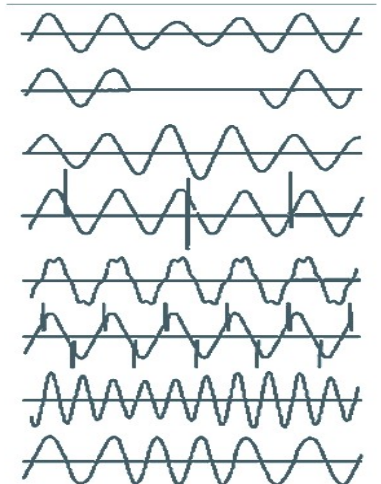
HOUSES

APARTMENTS

SMALL SHOPS

SMALL OFFICES

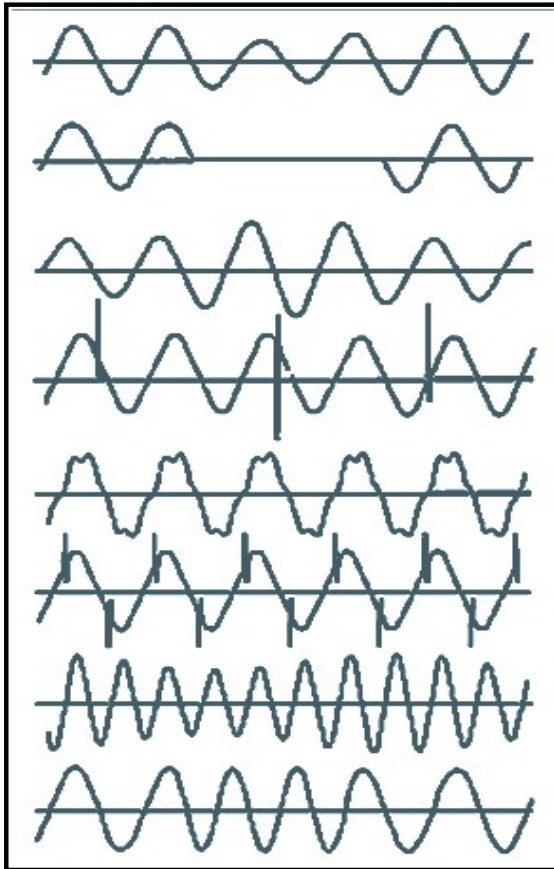
SSU / PCE
11 kV / 400 V



abnormal condition



Abnormal condition of voltage is called Power Quality phenomena



Voltage Dips / Sags

Momentary Interruptions

Swells

Transients

Harmonic Distortion

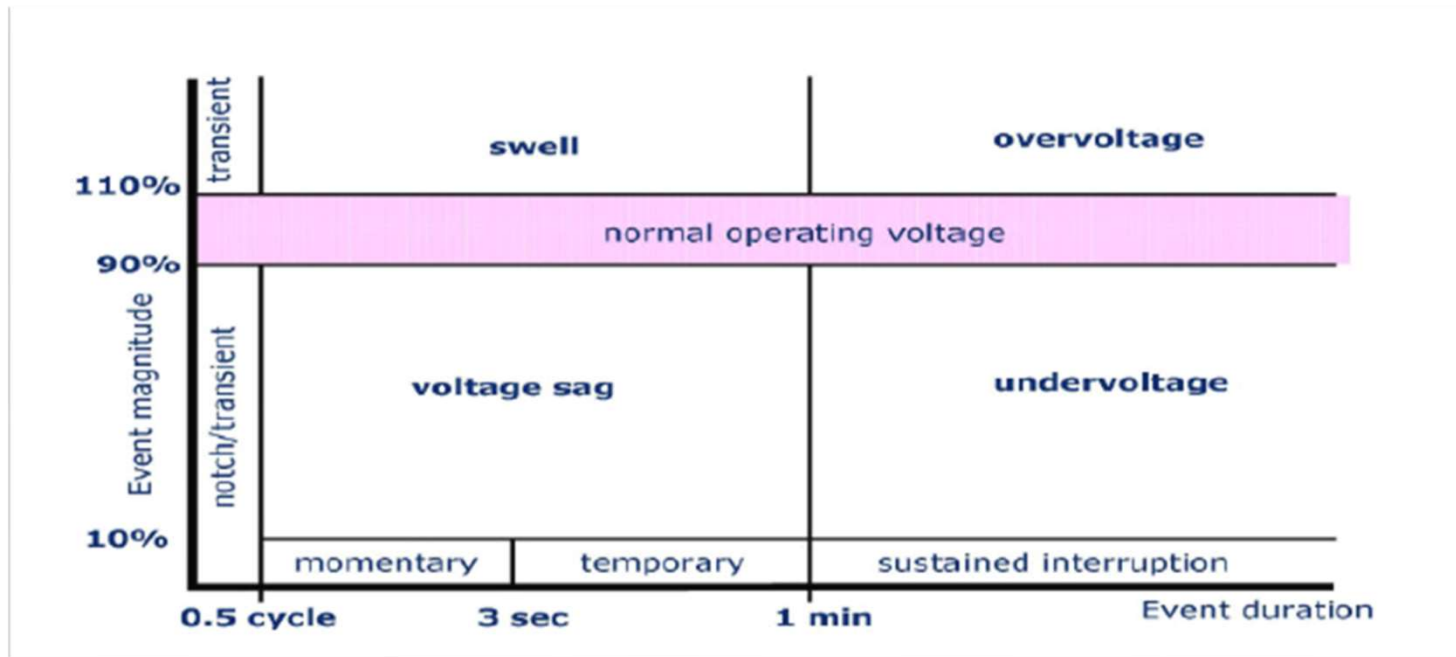
Notches

Voltage fluctuations/Flicker

Frequency Deviations

Type of
Power
Quality

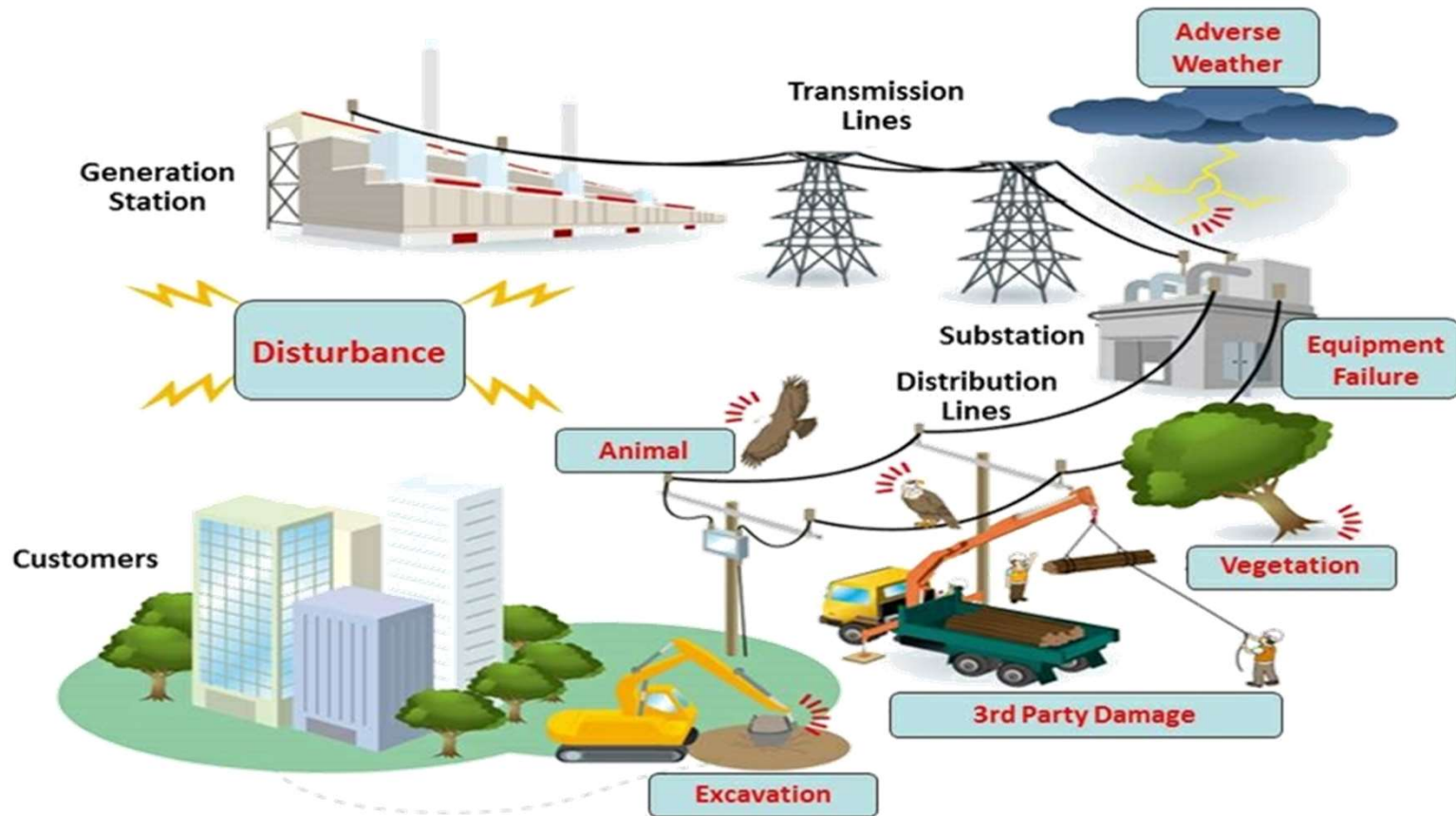
Voltage Sags - The #1 Power Quality Issues reported to TNB



Voltage sag is short duration (10ms to 1 min) voltage deviation (90% - 10%) from nominal/normal operating voltage

- ❑ Typical Symptom : Light to dim or blink for very short duration. Some sensitive equipment will stop

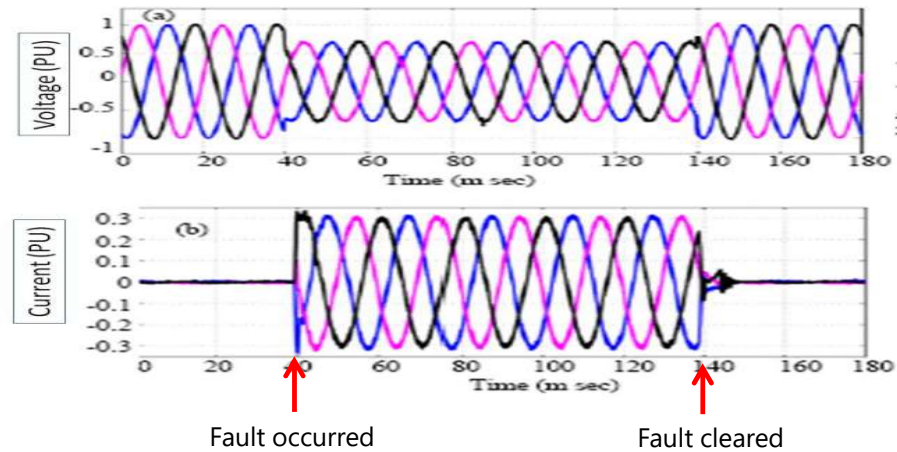
What are causes of Voltage Sags?



Mostly, voltage sags are caused by electrical faults...

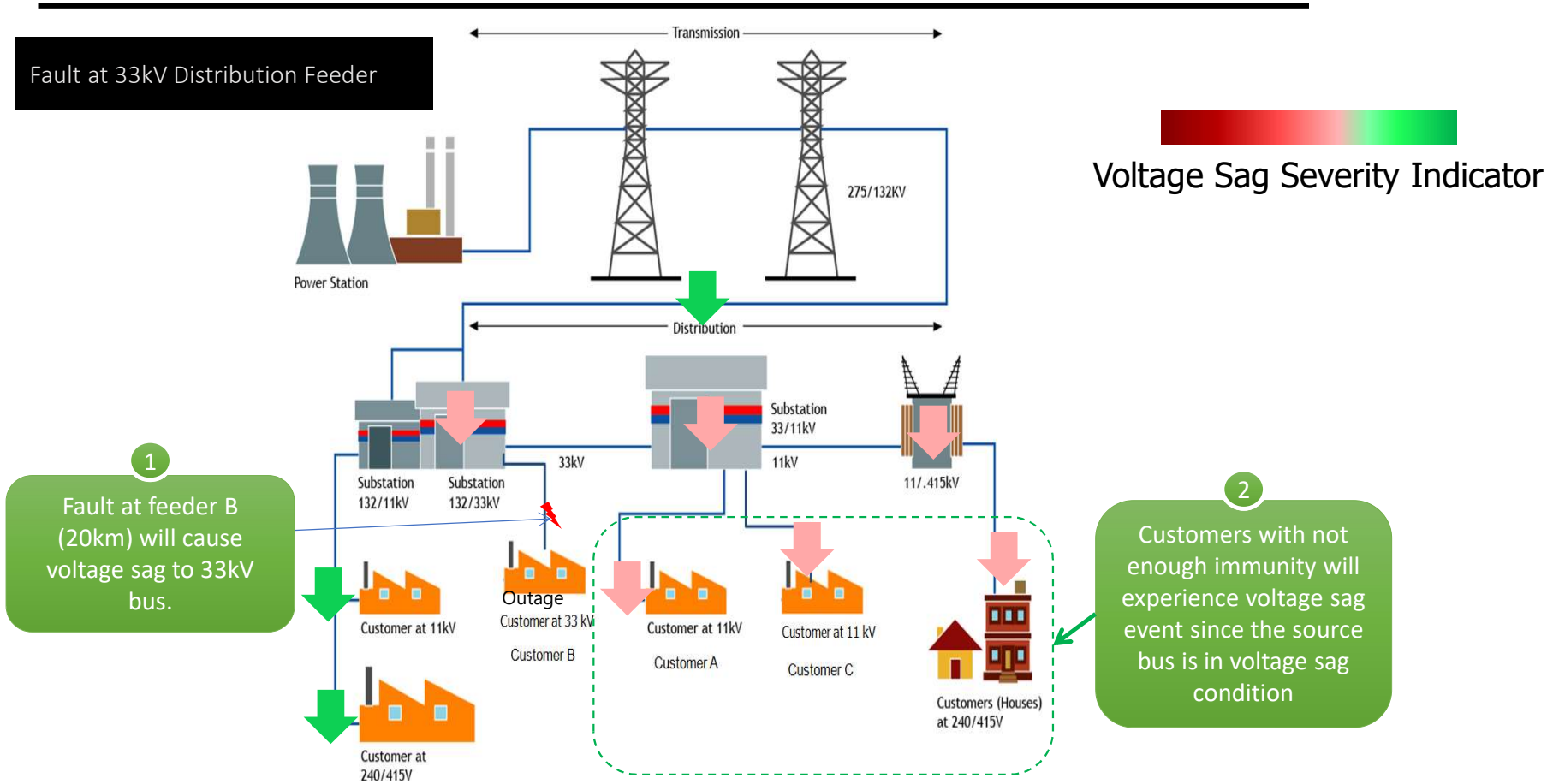


Very high fault current during fault condition will cause the voltage to dip/sag until the fault is cleared from the network.



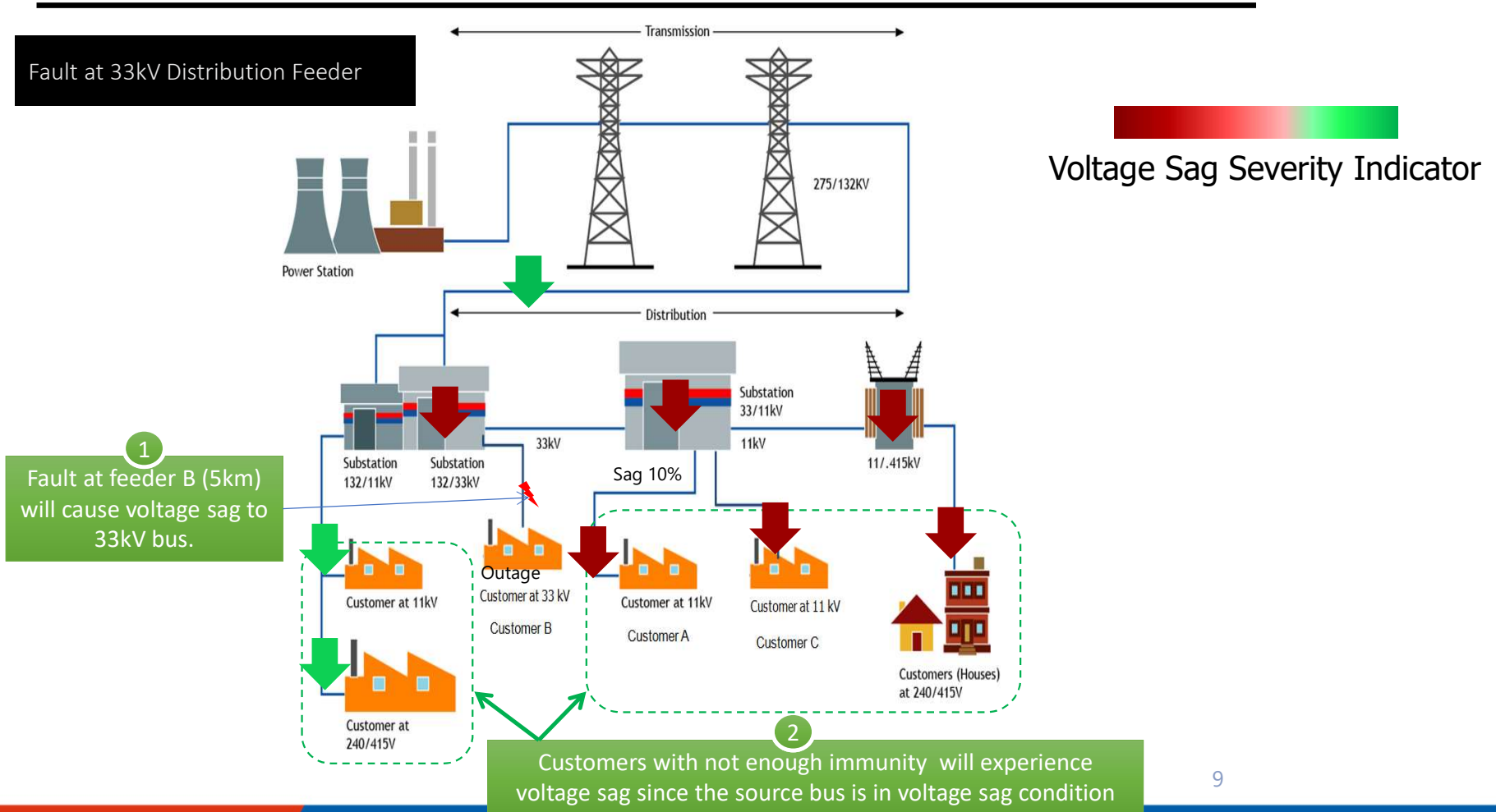
UNDERSTANDING VOLTAGE SAG

Voltage sag area of vulnerability



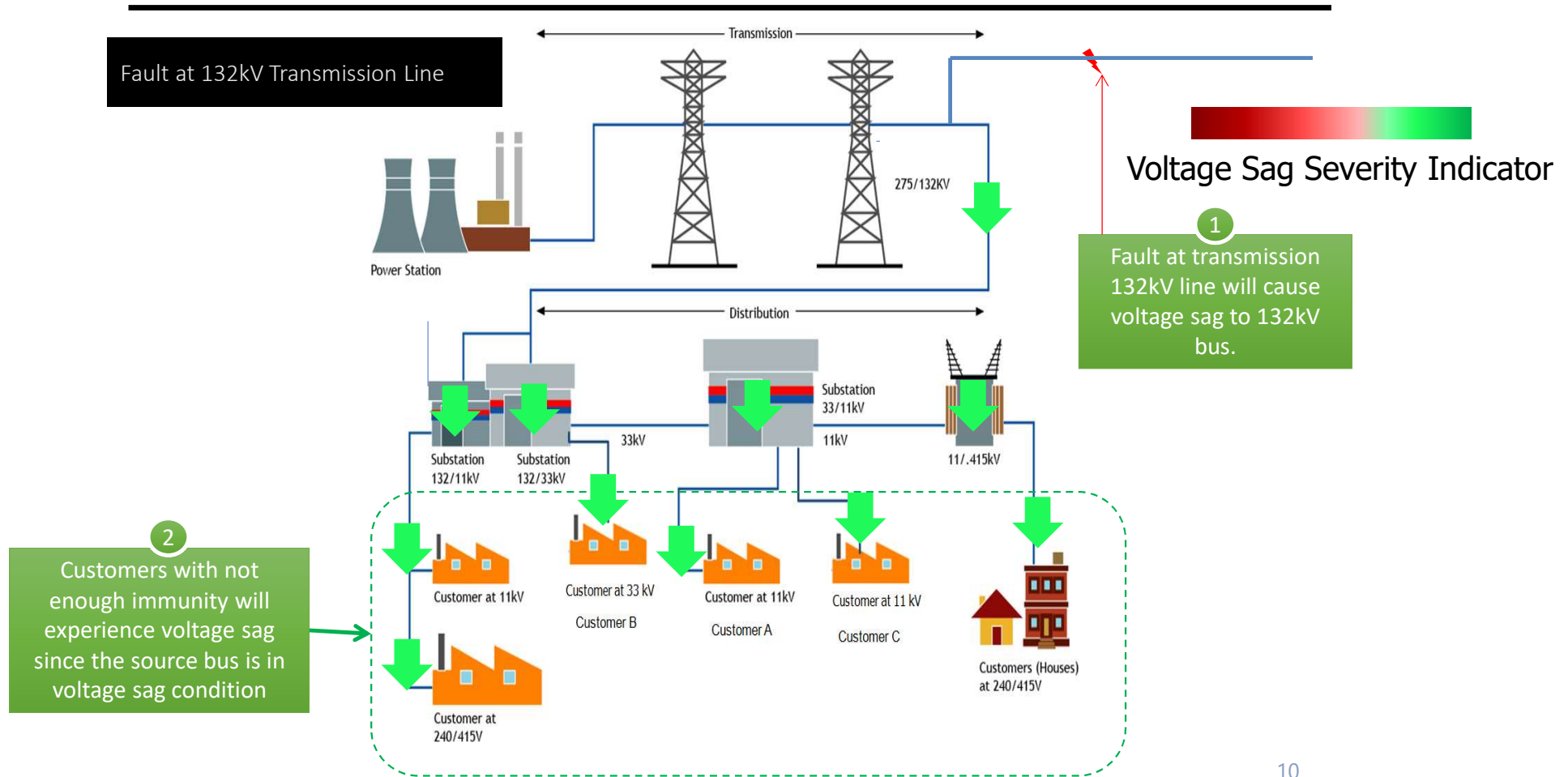
UNDERSTANDING VOLTAGE SAG

Voltage sag area of vulnerability



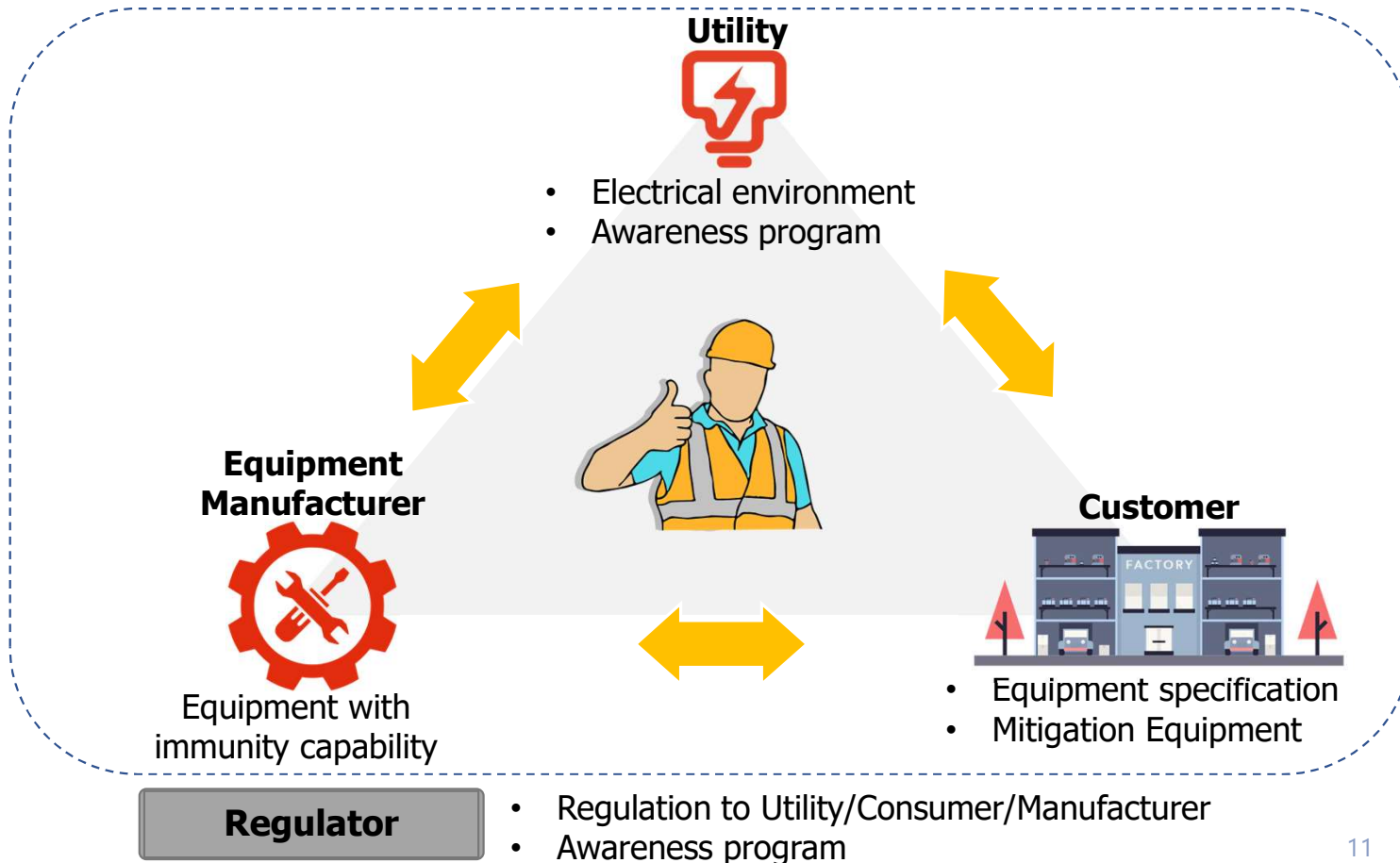
UNDERSTANDING VOLTAGE SAG

Voltage sag area of vulnerability



VOLTAGE SAG MITIGATION

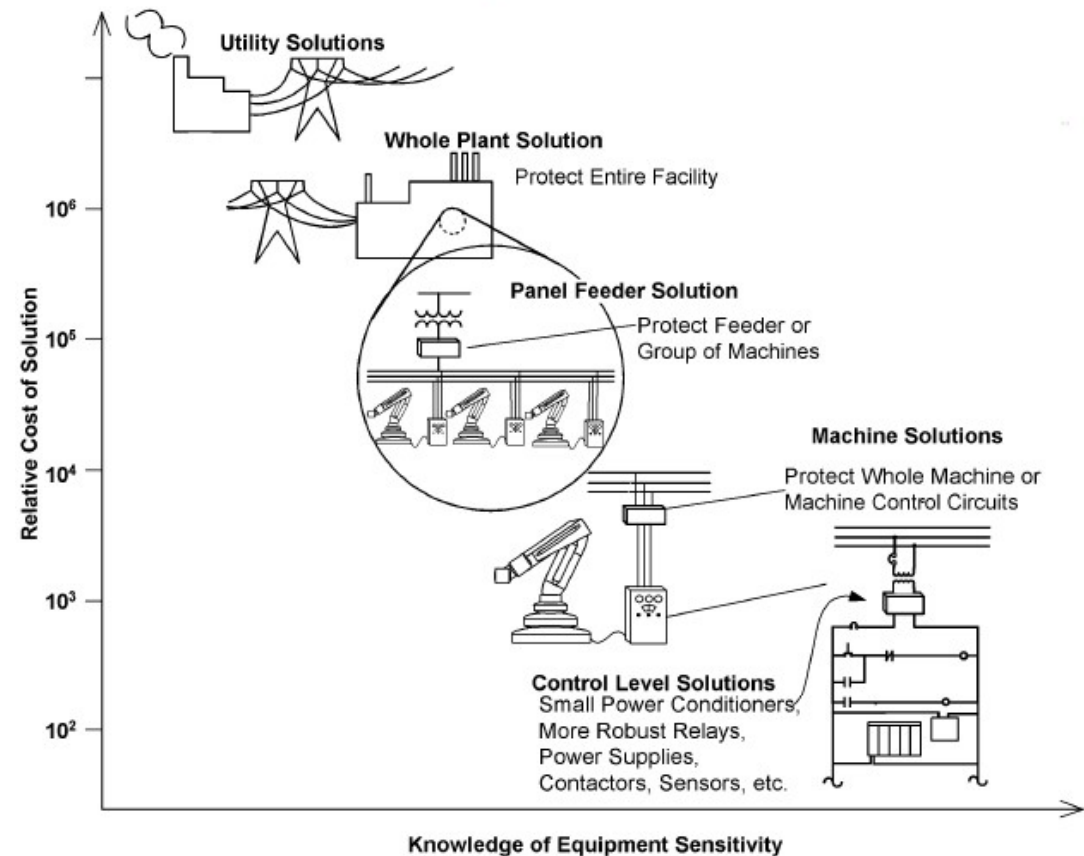
Mitigation of Voltage Sag problem will require involvement from all relevant parties



VOLTAGE SAG MITIGATION

Concept of installing PQ mitigation equipment

- Installation at control level is the most efficient due to lower cost and targeted area only
- Installation at higher level i.e. utility side or whole plant require high cost and might cover non critical load such as toilet, canteen, compound lamp etc
- However installation at control side require high level of knowledge of the equipment's immunity – which can be obtained through ride through test (in PQ Service)



PENCAPAIAN INDEKS SARFI ELEKTRIK DI SEMENANJUNG MALAYSIA (SM)

SARFI (System Average RMS Frequency Index):

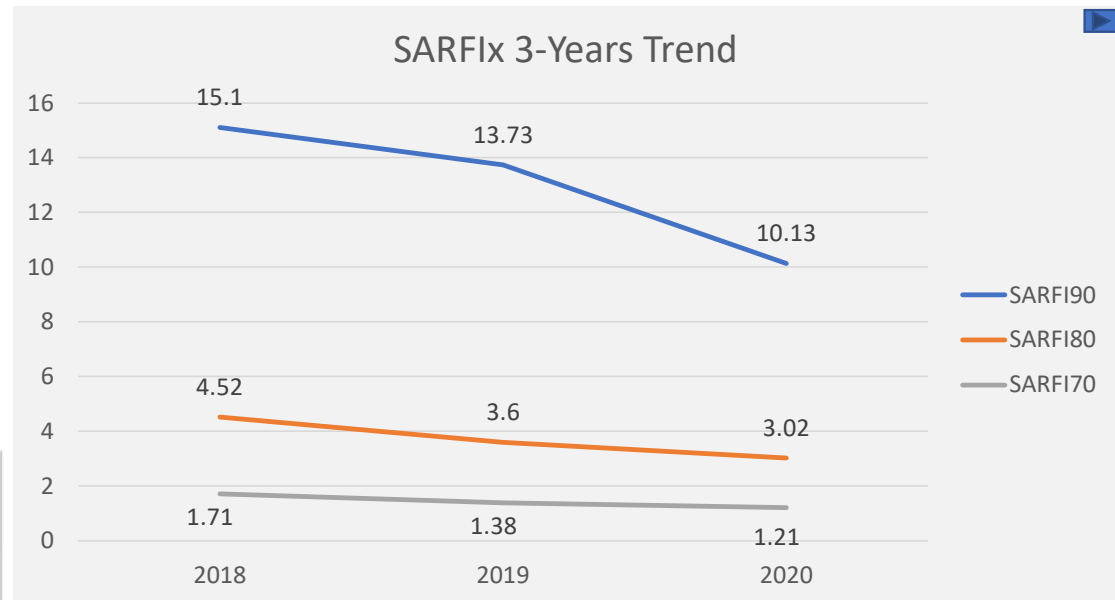
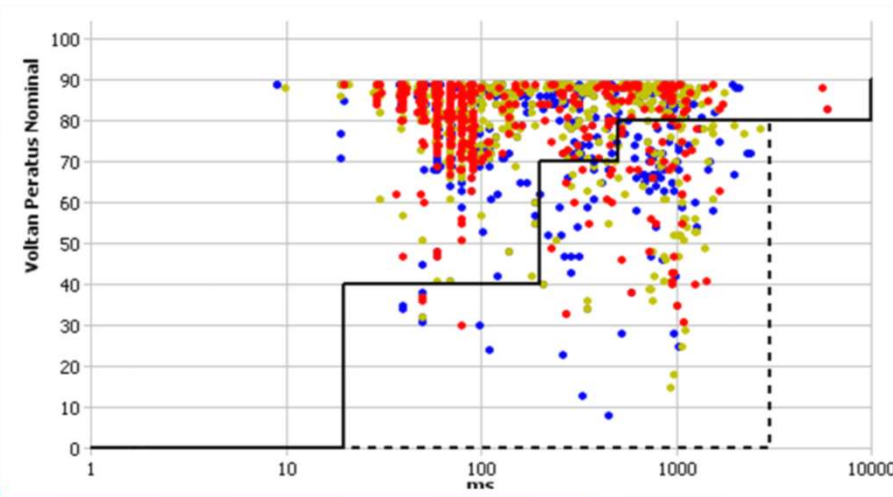
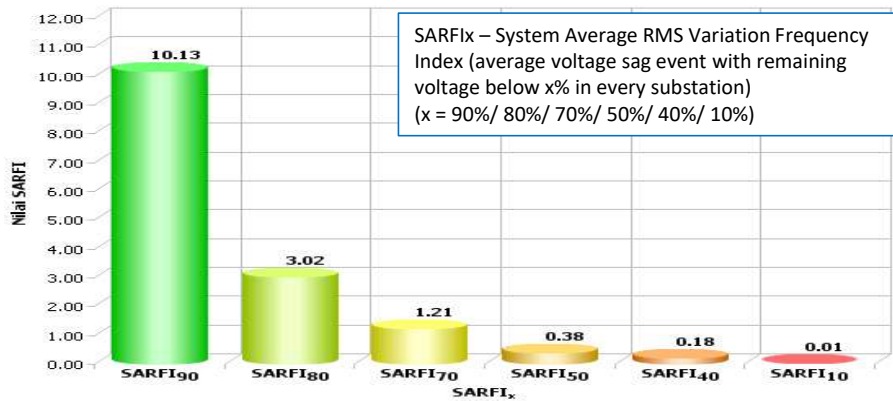
SARFI_x (TNB) : Bilangan kejadian voltage sag di bawah paras X% dalam TNB
Bilangan alat perakam bagi seluruh TNB

SARFI_x (setiap negeri) : Bilangan kejadian voltage sag di bawah paras 90% dalam negeri
Bilangan alat perakam bagi negeri tersebut

Nota: Bilangan kejadian voltage sag bawah X% adalah termasuk semua kejadian antara voltan RMS X% sehingga voltan 0%

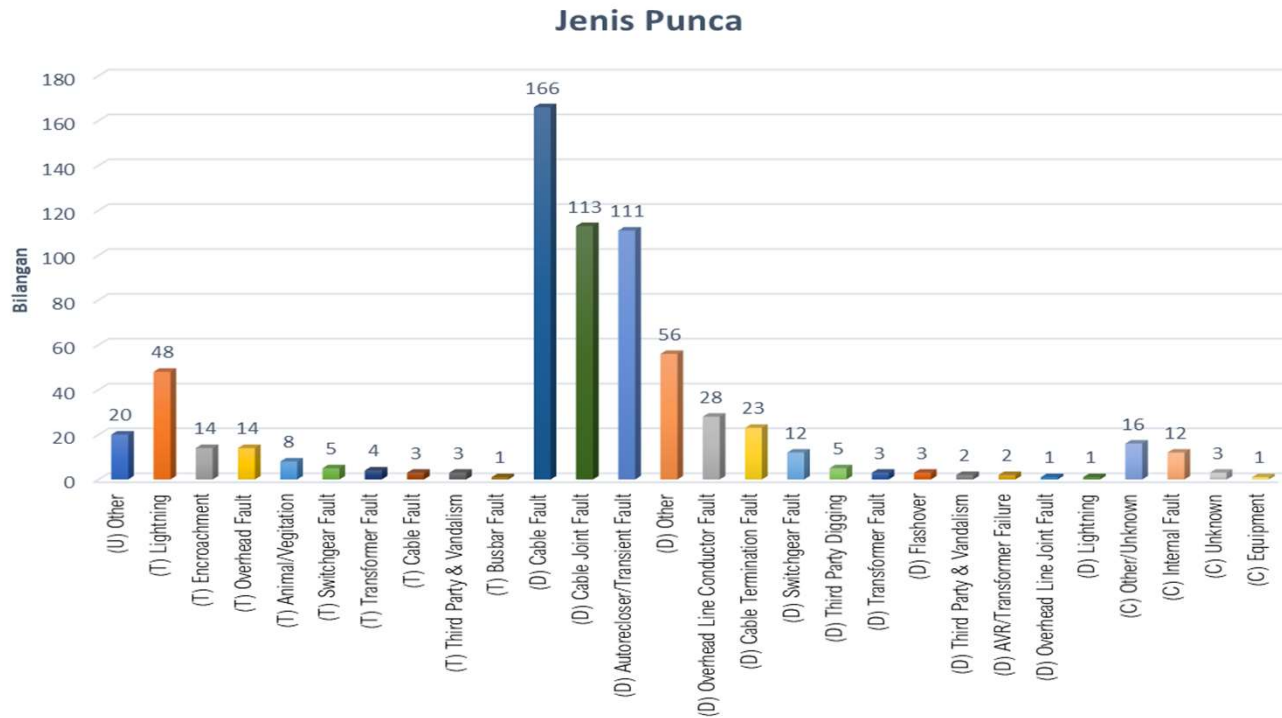


TNB Power Quality Performance



✓ Above trending shows that overall number of voltage sag and number of fault condition in power system is reduced

Cause of Power Quality (Voltage Sag)



Top contributor

Cable & Joint Fault

- Cable network is dominant in distribution network
- 90% MVBD in DN is related to cable

Transient Fault

- Non permanent fault at 33kV bare overhead lines
- Normally cause by lightning and animal/vegetation encroachment
- Auto recloser will restore the supply automatically

Power Quality Complaint Mitigation Action

Work hand in hand with customers to mitigate power quality problem (to manage compatibility issue)

PQ Task Force

- Collaboration based on best practice from TWGGE benchmarking visit
- Platform for both parties to discuss & share mitigation action for voltage sag issue

Annual PQ Briefing & Awareness

- Educate customers on power quality problem in general and action should be taken by customers
- 133 sessions conducted in 2020

PQ Service Program

- Consultancy/advisory service
- Complete investigation, testing and mitigation recommendation.

Leasing Package for PQ Mitigation Equipment

- TNBES offer new leasing package on top of existing outright purchase – ease customer's financial burden
- To improve take up rate on 13%

Task 1 : Walkthrough Investigation Identify the sensitive equipment and to have an overview of the equipment & circuitry and to plan for the ride through test.	Task 2 : Ride Through Test (RTT) Testing to measure the immunity level of your production and facility equipment toward voltage sag event.	Task 3 : Full PQ Study Report Presentation & report on PQ exposure analysis, proposal of optimum mitigation plan, current PQ conditioner's market price & ROI evaluation.
		

Worth RM50k

OUTRIGHT PURCHASE		LEASING	
OPTION A	OPTION B	PQ Lease PLUS	PQ Lease HYBRID
Supports 0% remaining voltage up to 200ms only	Support 0% remaining voltage up to 1000ms	Supports 0% remaining voltage up to 1000ms	Support 0% remaining voltage up to 50/200/1000ms
COST	COST	COST	COST
RM 15.5 mil	RM 17.8 mil	RM 480k monthly for 5 years	RM 335k monthly for 5 years
Service Level Agreement (SLA) for Performance Guarantee			

Action Plan to Reduce Voltage Sag Event

Continue to carry out all maintenance activities to prevent equipment failure through normal program and special program such as SAIDI 50 and ZTAP initiatives



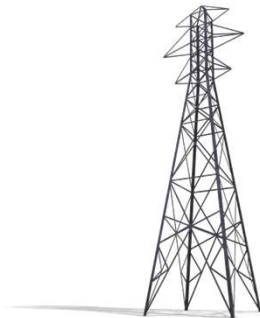
Condition Based Maintenance

Preventive Maintenance

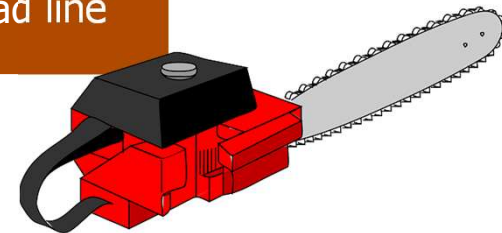


Tower Footing Resistance for lightning mitigation

Vegetation Management for overhead line



Cable Route Patrolling & Third Party Digging Management (CBYD)

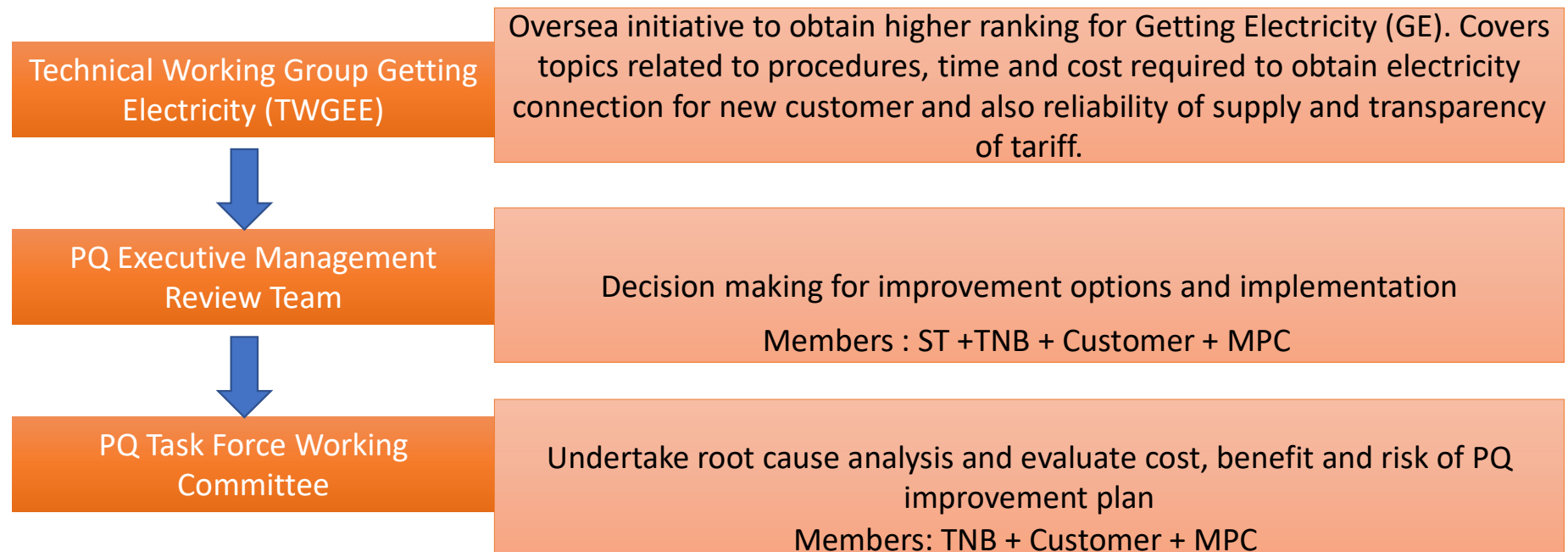


PQ Taskforce



Implementation of industry best practices

In order to engage customer in managing power quality issues, TWGGE performed benchmarking and subsequently adopt the best practices by forming the PQ Task Force Working Committee & PQ Executive Management Review



PQ Task Force Working Committee is bi-monthly collaboration with intention to discuss cause of voltage sag events and relevant action plan by both parties

9 meetings conducted from December 2019 until Nov 2021.



MEETING AGENDA



Overall Performance



Cause and action plan update by TNB



Action plan update by customer

PQ Task Force has identified action plans to mitigate the voltage sag issue



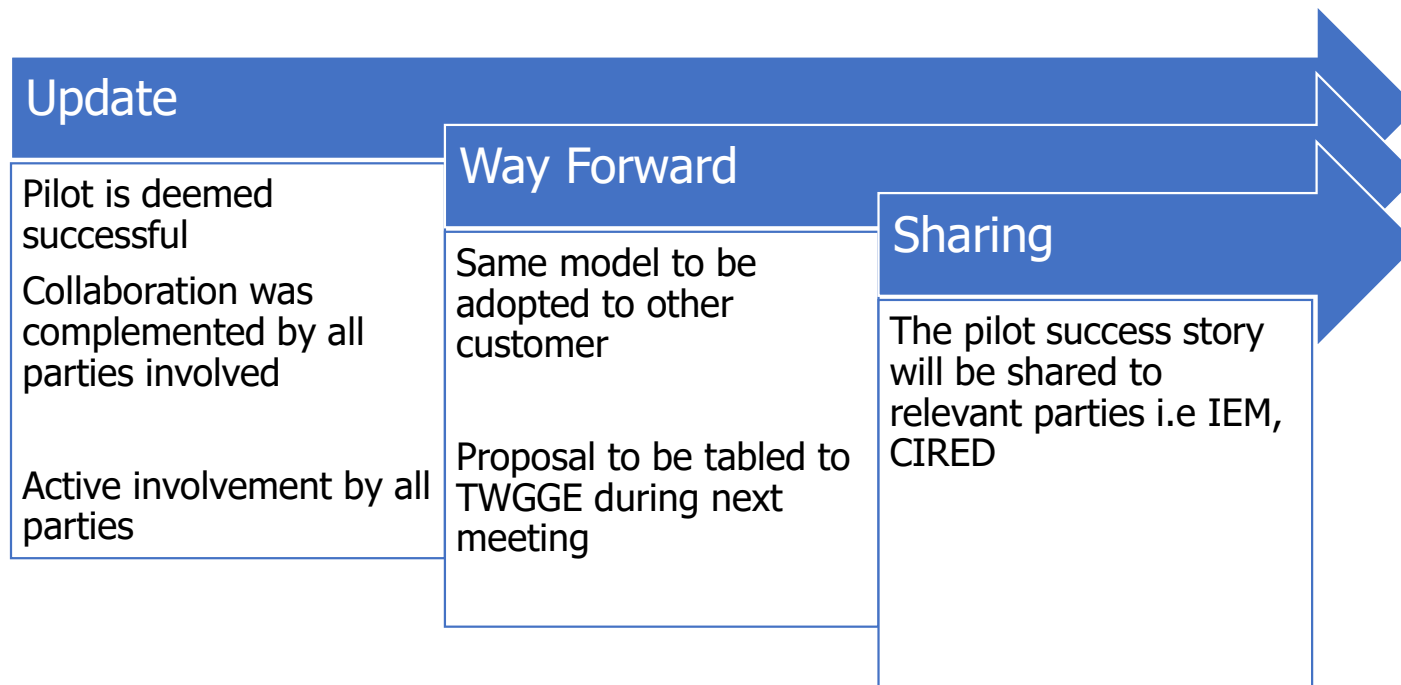
Action plans for TNB network are based on high impact networks and area of vulnerability



Action plan by customer is to comply with voltage sag standard (SEMI F47)

Action Plan	Action by
TOWER GROUNDING SYSTEM IMPROVEMENT – Remeasure & improve Tower Footing Resistance (TFR)	TNB
Overhead Line Lightning Performance Study	TNB
Ageing Underground Cable Replacement	TNB
Switchgear (Gas Insulated) Refurbishment	TNB
Oil Impregnated Paper (OIP) Bushing to Resin Impregnated (RIP) Bushing Replacement	TNB
Equipment Hardening to comply SEMI F47	Customer

PQ Task Force Working Committee update and way forward presented to TWGGE in November 2021



TWGGE congratulated the PQ Taskforce Working Committee on the successful collaboration and appreciated the transparency promoted in every meeting

Conclusion

- A good collaboration will benefit both parties because more idea and more knowledge can be obtained and discussed
- By having enough information on the Voltage Sag event, both parties (utility & customer) can take the necessary action.
- To protect both party, a Non-Disclosure Agreement (NDA) required to ensure confidential is contained.
- The working model between TNB and Customer is successful and the same model to be adopted in future collaboration involving other parties.

Thank You



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