Harnessing Smart Metering benefits From meter data using Data Analytics

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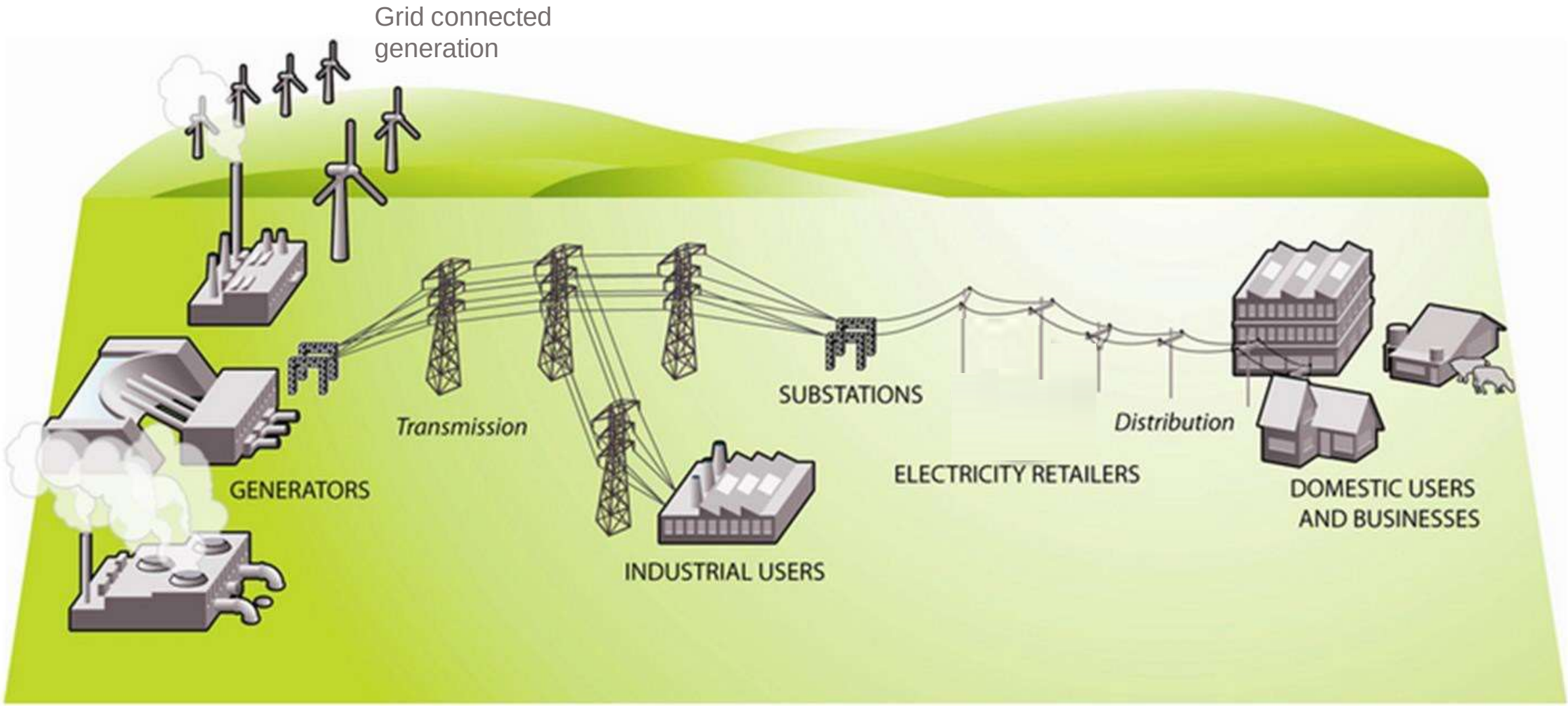
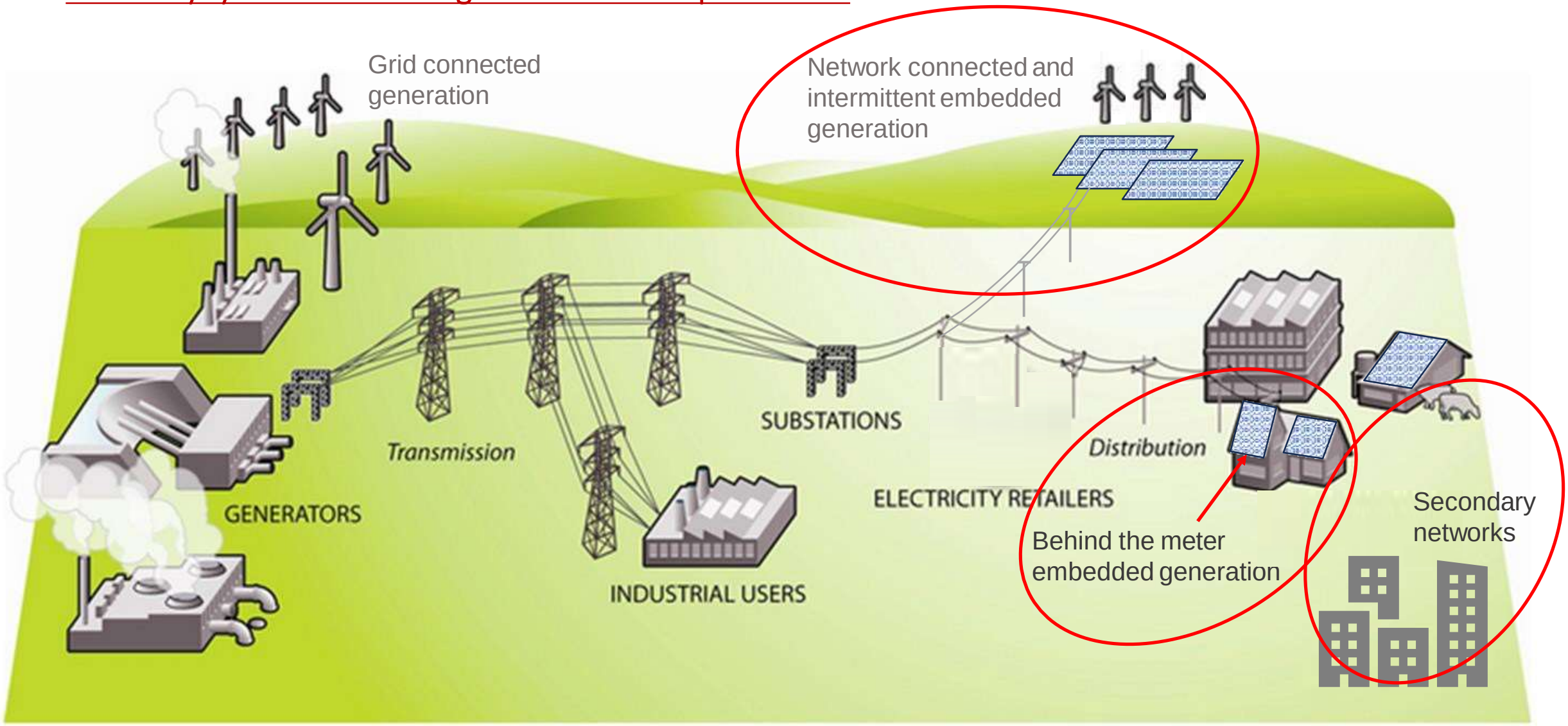
The traditional physical electricity industry structure -

centralised generation



The new world electricity industry structure

Electricity systems are no longer centralised or predictable



Power Sector Is Transforming

Emphasis on renewable energy
Higher percentage of renewable energy in mix

Electric Vehicle
High quantum of load is expected.
Mobile load

Consumer Engagement
Roof Top – Prosumer
Demand response / battery

Transformation -Affecting utilities Operations :

- **Unpredictability** : Both generation and demand are becoming unpredictable.
- **Non uniformity in demand curve :** Large variation In a day – sudden change.
- **Weather unpredictability**

Distribution Efficiency & Reliability

Changing Issue / Concerns/ Expectations

- **Power crisis --** Outage, cost of power.
- Network utilization: non optimise usage, higher capex.
- Safety – of user, gadget and network asset.
- Power quality – Harmonics, stress on network, fluctuating voltage.
- Asset failure – Demand variation, harmonics,

DISTRIBUTED GENERATION / ROOF TOP SOLAR ..% SHARE INCREASING

Transformation through Smart Metering

Improving Operational Efficiency

- **Network optimization** for Better system Availability
- **Better Asset utilization** leading to optimized CAPEX.
- **Reduce Technical loss** resulting in Lower power purchase cost
- **Asset health monitoring** to transition from Reactive to Preventive/Predictive maintenance
- **Lower Asset Failure** leading to Lower OPEX

Enriching Consumer Experience

- **Better Power Quality** improving gadget efficiency
- Identifying & Notifying potential **safety hazards** like house wiring defect etc.
- Notifications about **Pre-payment/ billing / due date**, **Reliability & Outage management**
- Consumer engagement through **TOU/ DR**
- Timely intimation about **Subsidy**

Gearing up for Energy Transformation

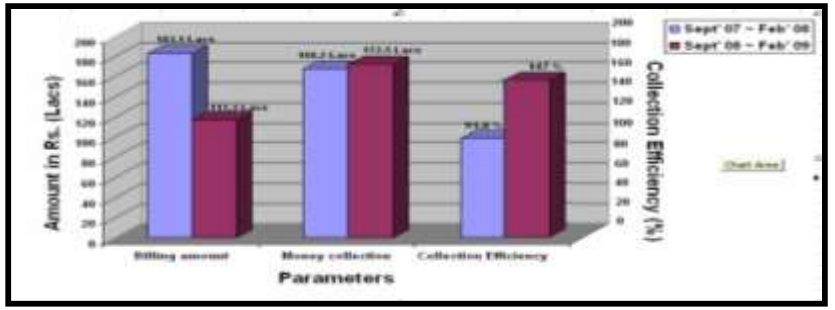
- **Managing uncertainty** through monitoring the transition into:
  - Green Energy
  - EV Charging
  - Battery/ Storage management
- To facilitate **DSM/ DER/ DR, Load curve management**

Smart metering is must for present and future challenges –

Need to have efficient, safe, quality reliable power in spite of unpredictability/ uncertainty

Smart Data Analytics –

Network management & technical loss reduction



Understanding Smart Apps – Future trend

Addressing Electrical Abnormalities ……..

"Electrical Abnormality"

Loading Pattern, network capabilities, defects in workmanship, faulty devises in network, abnormal Consumer behavior etc CAN AFFECT ELECTRICAL PARAMETER & PERFROMANCE OF NETWORK. Any event which can affect the electrical parameter to a level, or can affect the efficiency of network/ appliances/ asset performance or which can cause accident/ damage/ affect life to network assets or results in higher cost and thus **NOT ACCEPTABLE** *is called "Electrical Abnormality".*

Technical loss/ Network optimization :

Voltage drop - Low Voltage	Phase Voltage unbalance	Voltage fluctuations
Unbalance loading	Phase Load balance	Reactive energy flow
Asset failure – higher outage	High loss during peak	Under utilization of Asset – high CAPEX

Technical loss Reduction :

Minimise voltage drop	All DT/ feeder/ phase has balance load	Reduce reactive energy flow

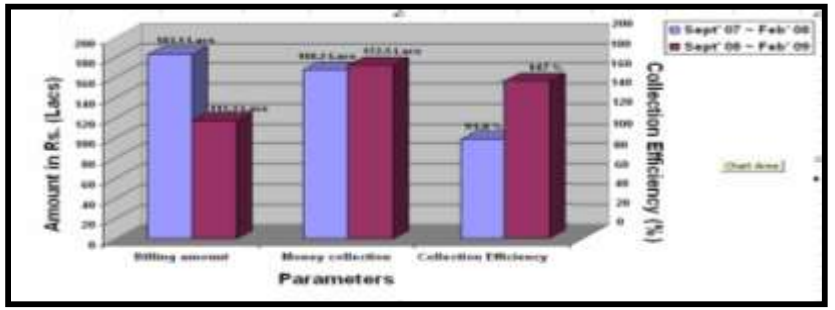
Technical loss Reduction Impact :

- Lower loss spl during peak – Reduced power purchase cost
- Even distribution of load -- Less asset failure-- less opex.
- Optimum network configuration No idle assets – lower capex.
- Better voltage quality – improve gadget life/ performance

Leveraging benefits – **Network management & technical loss reduction**

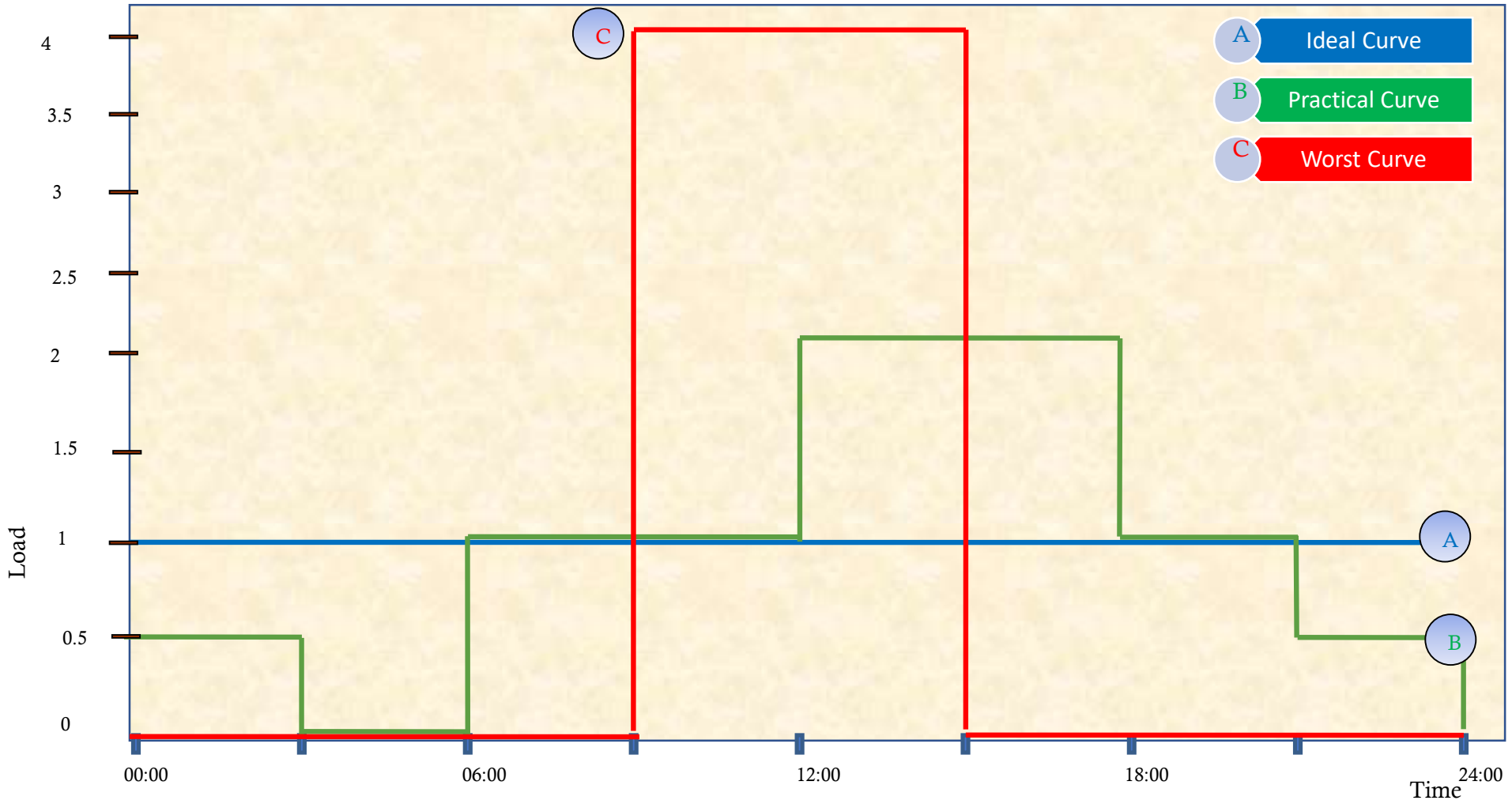
Typical abnormalities in network

- ***Overloading /abnormal loading of assets***
- ***Reactive energy flow***
- ***Unbalance phase loading / current***
- ***Technical loss***
- ***Unbalance phase voltage***
- ***Low/ fluctuating voltage***
- ***Power outage***
- ***Non uniform demand curve***



By smart meter data all above abnormalities can be addressed to have optimum network performance

DT / Feeder Over Loading – Advance report



More the non-uniformity of load curve, higher the losses

Three consumer:
Consuming same amount of energy

Three consumer:
Different load curve

Three consumer:
Different Technical loss

Understand Technical Copper Loss-LLF

$$\text{Loss in kW} = \frac{3 \times I^{\wedge}2 \times R \times L}{1000}$$

Where, I = Peak current of the feeder
R = Resistance (ohm/kM)
L = Length of feeder

$$\text{Loss in MU} = \frac{\text{Loss in kW} \times 24 \times 365 \times \text{LLF}}{10^{\wedge}6}$$

$$\text{LLF} = \frac{\sum I_1^2 + I_2^2 + I_3^2 + \cdots I_n^2}{N \times I^2}$$

N = No. of intervals in a day
I = peak current
$I_1, I_2 \ldots I_n$ = Current at 15min interval

Data collection:
I - Normalized Peak current from SCADA
R - Resistance from standards / manufacturers catalogue
L - Length from GIS system / Detailed drawings

LLF – depends upon loading pattern and has a big role.

Technical loss for same energy flow depend upon :
1. **Un-balance load flow**
2. **Non uniform load flow**

DT Load Management

- ✓Identify top overloaded DTs
- ✓DT Load rise trend

DT / Feeder Over Loading – Advance report

Ways to define Overloading

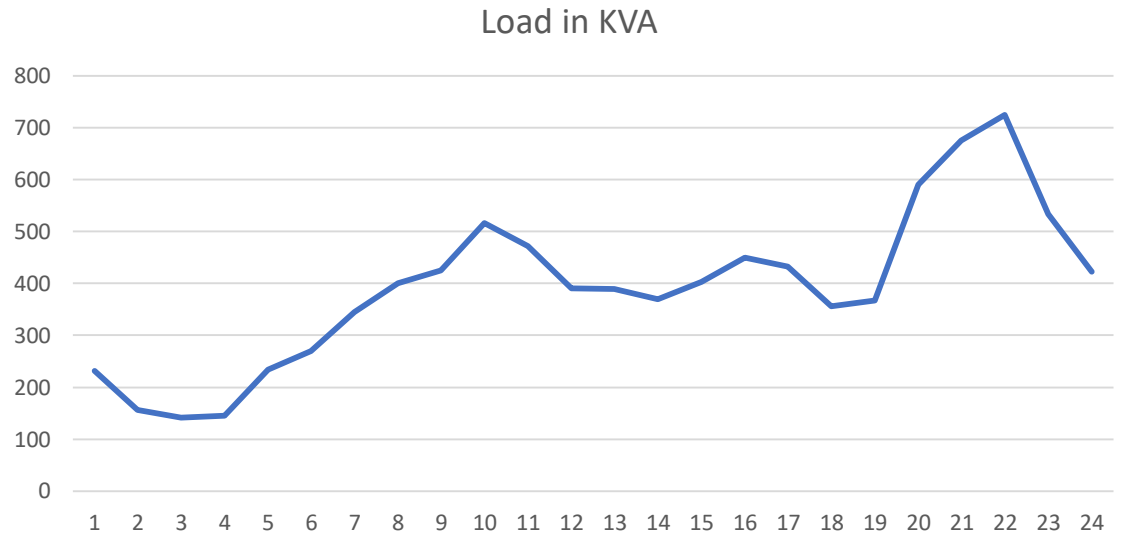
Definition Type	Brief about definition	Data required
1. Maximum demand in KVA	Basic measure: Maximum demand of the month, derived from load survey.	• Monthly MD • KVA load survey data • Asset capacity (KVA)
2. Maximum demand among all three phases in KVA	Captures unbalanced load conditions: If one phase is overloaded, the entire asset is considered stressed	Same as above, plus Phase-wise kVA Load Survey Data
3. Maximum Load Duration (Asset Loaded for XX Hours)	• Maximum demand limit (in KVA) determined from load duration curve. • Represents the threshold above which the load persists for XX hours/month (e.g., 20–30 hrs). • Helps avoid short-term overloading due to events or back-feeding.	Load Duration Curve from Survey Data
4. Forecasted Peak Demand (Next 12 Months)	Using AI/ML and forecasting tools, future peak demand can be predicted from past trends. Enables proactive corrective action.	• Past 12 months (or longer) load survey data • Forecasting Tools

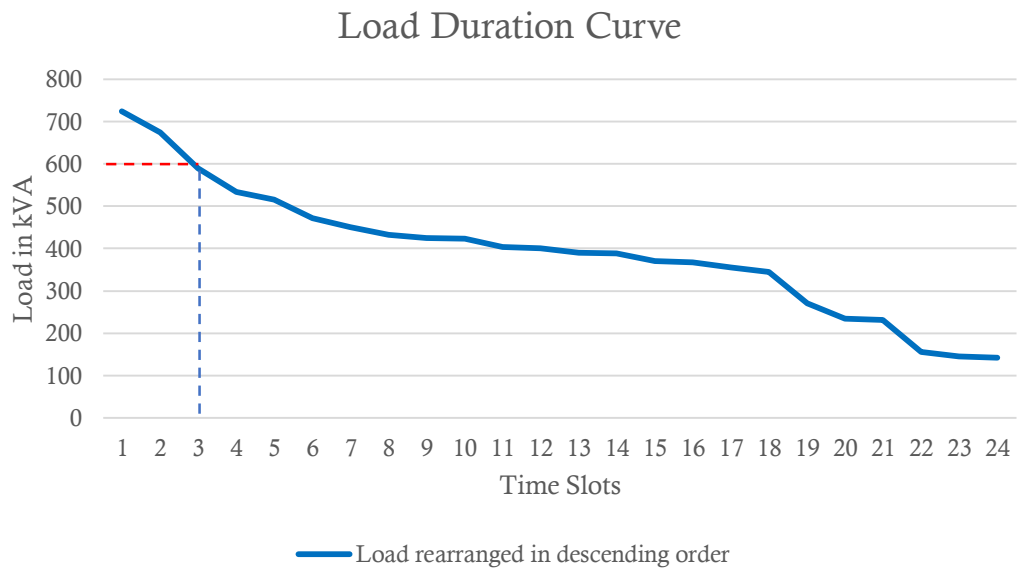
Note: *DISCOMs should choose the loading definition that best fits their needs. Direct MD in kVA is simple but may be skewed by feeder back-feed and false data peaks, leading to inaccurate overload estimations.*

Calculating Load duration curve

An example -- load duration curve		
Time slot	**Load in KVA**	**laod duration curve ***
1	232	725
2	156	675
3	142	590
4	145	534
5	234	516
6	270	472
7	345	450
8	400	432
9	425	425
10	516	423
11	472	403
12	390	400
13	389	390
14	370	389
15	403	370
16	450	367
17	432	356
18	356	345
19	367	270
20	590	234
21	675	232
22	725	156
23	534	145
24	423	142
Rearrange daat from maximum to minimum		

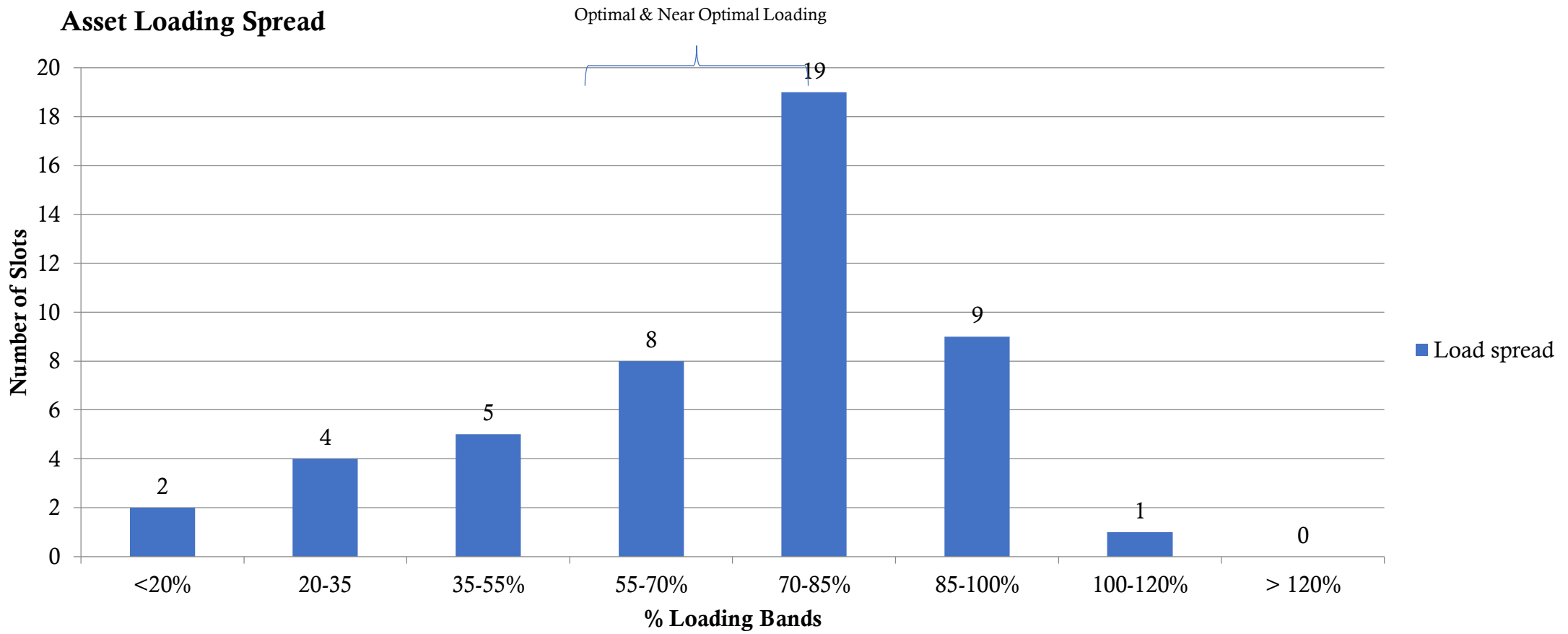
1. Draw curve by arranging data from max to lowest
2. Helps to find load for any duration or duration for any load.





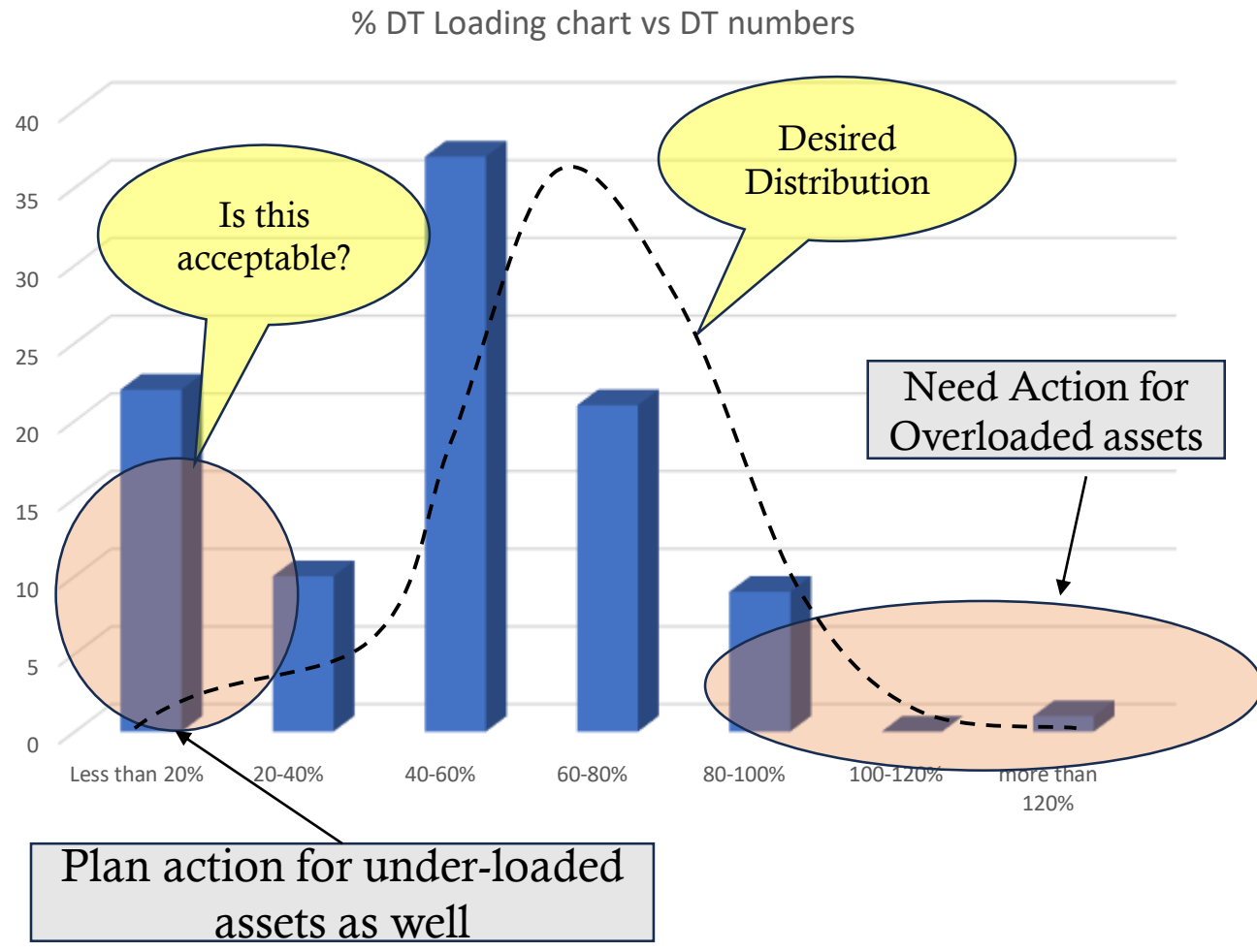
DT Load rise trend - Prepare Asset Loading Spread (2/2)

The total count of slots falling under each loading band can be plotted to determine the loading spread. This gives an idea regarding the period an asset is loaded in different loading bands.



DT Loading Report- Actionable insight

Division Name	Total DT Studied	22/06/2022						
		0% to 20%	20% to 40%	40% to 60%	60% to 80%	80% to 100%	100% to 120%	Greater than 120%
2510 - ALAKNANDA	344	36	158	116	33	1	-	-
2511 - KHAN PUR	204	19	37	64	72	12	-	-
2520 - SAKET	837	285	315	150	71	15	1	-
2521 - VASANT KUNJ	567	209	193	102	48	12	2	1
2530 - NEHRU PLACE	322	40	185	92	5	-	-	-
2540 - NIZAMUDDIN	323	63	134	96	30	-	-	-
2541 - SARITA VIHAR	108	24	35	28	19	2	-	-
2542 - NEW FRIENDS CLY	295	74	84	78	48	10	1	-
2550 - R.K.PURAM	190	50	71	55	13	1	-	-
2551 - HAUZ KHAS	216	49	89	71	7	-	-	-
2610 - JANAK PURI	91	13	45	27	6	-	-	-
2620 - NAJAF GARH	436	108	117	128	62	21	-	-
2621 - JAFFAR PUR	16	2	1	4	6	3	-	-
2630 - NAGLOI	16	2	8	5	1	-	-	-
2631 - MUNDKA	363	89	82	94	58	29	6	5
2640 - PUNJABI BAGH	221	45	67	85	24	-	-	-
2641 - TAGORE GARDEN	31	2	13	13	2	-	-	1
2650 - VIKAS PURI	9	-	4	2	2	1	-	-
2651 - UTTAM NAGAR	8	-	5	2	1	-	-	-
2652 - MOHAN GARDEN	89	11	28	40	10	-	-	-
2660 - PALAM	23	3	5	10	5	-	-	
2661 - DWARKA	618	434	114	38	26	6	-	-
Grand Total	5327	1558	1790	1300	549	113	10	7

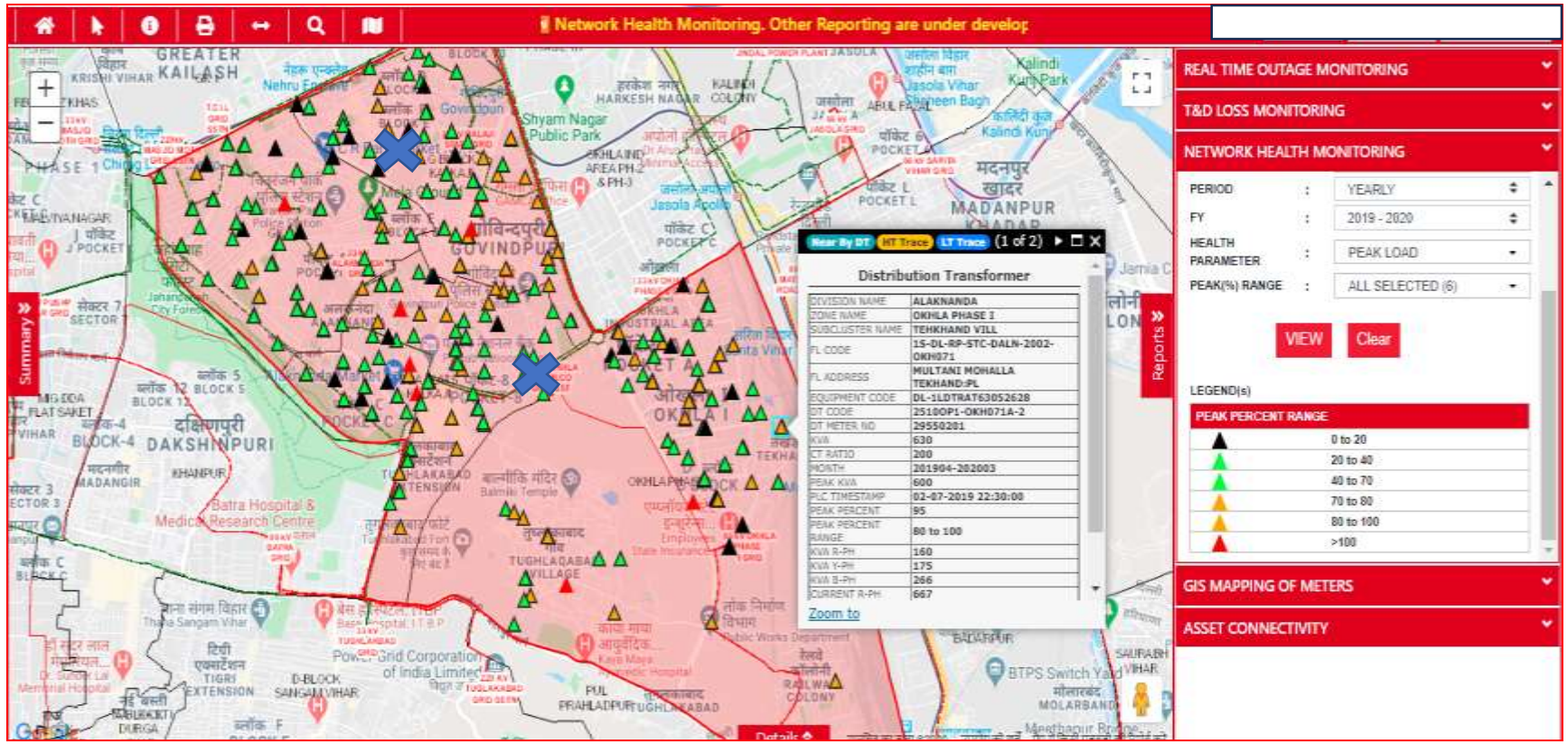


Load Management will lead to:

1. Less Failure
2. Load Balancing
3. Reduced Losses
4. Optimized Utilization

GIS Mapping for Load Balancing (1/3)

Network Health Monitoring – DT Load Balancing

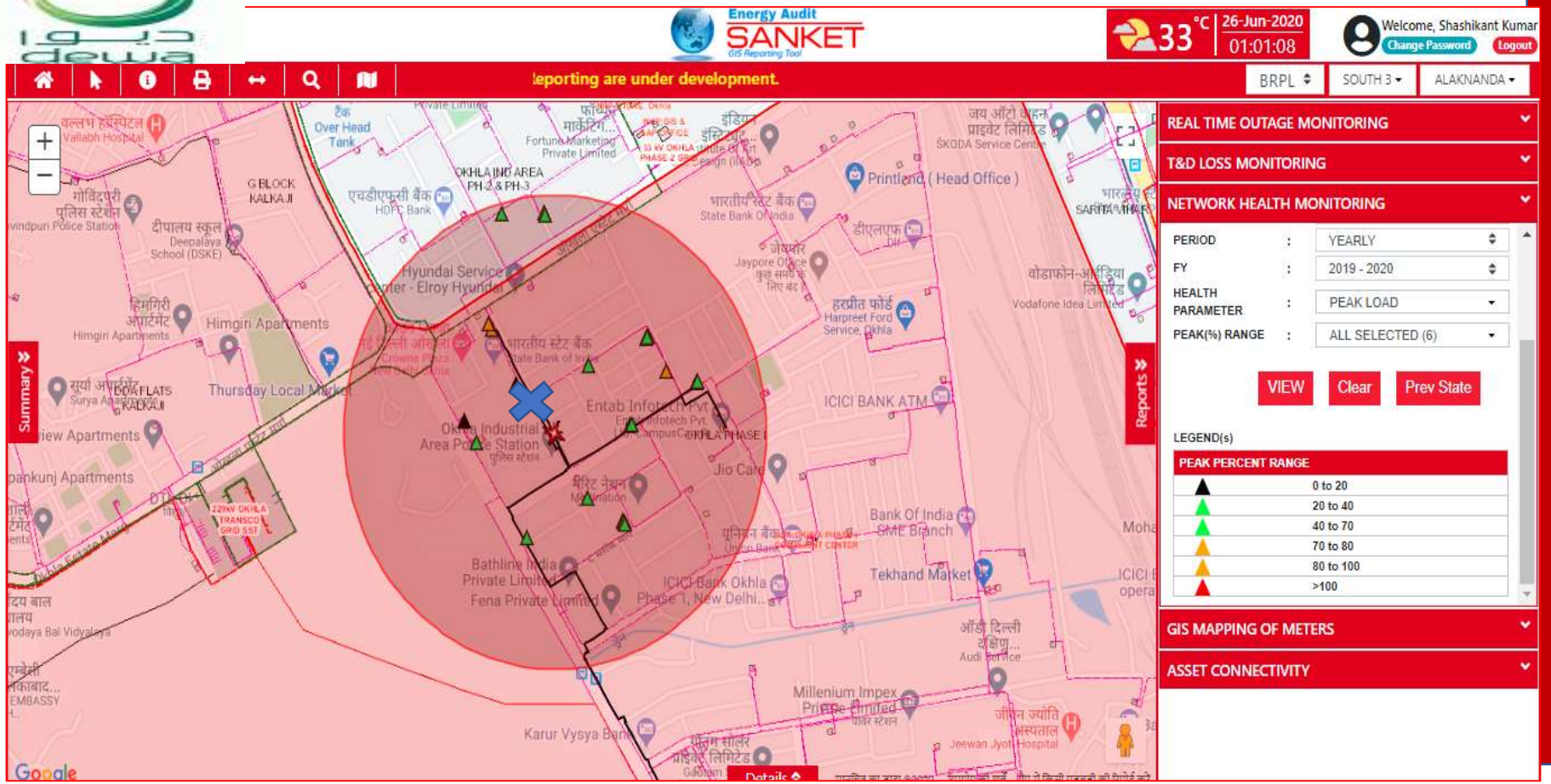


Steps for DT Load Balancing using GIS

STEP-1: Plot DT/ asset on map/GIS with colored symbol representing loading

GIS Mapping for Load Balancing (2/3)

Network Health Monitoring – DT Load Balancing

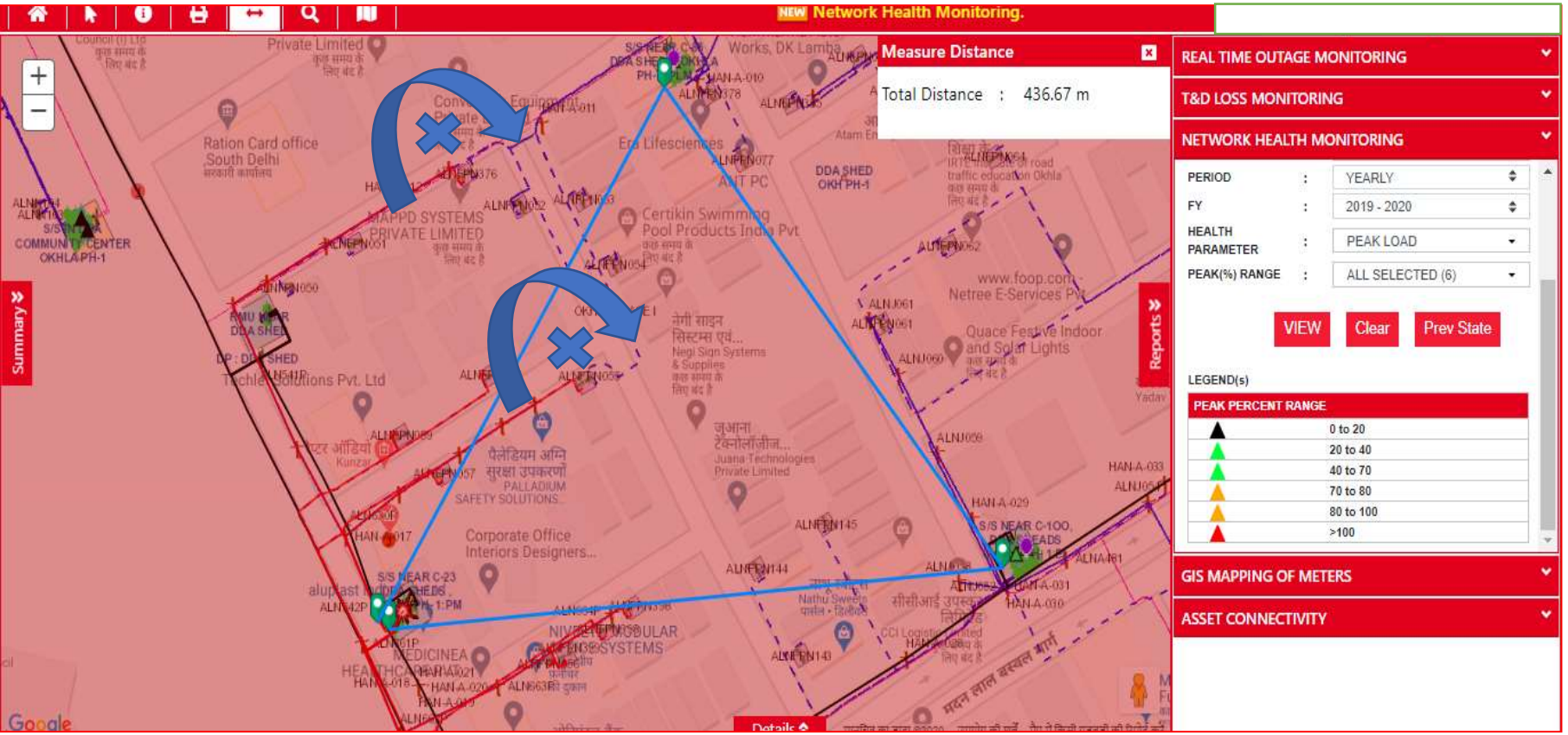


STEP-1: Plot DT/ asset on map/GIS with colored symbol representing loading

STEP-2: Visualize overloaded DTs and further underloaded DTs surrounding it.

GIS Mapping for Load Balancing (3/3)

Network Health Monitoring – DT Load Balancing



Steps for DT Load Balancing using GIS

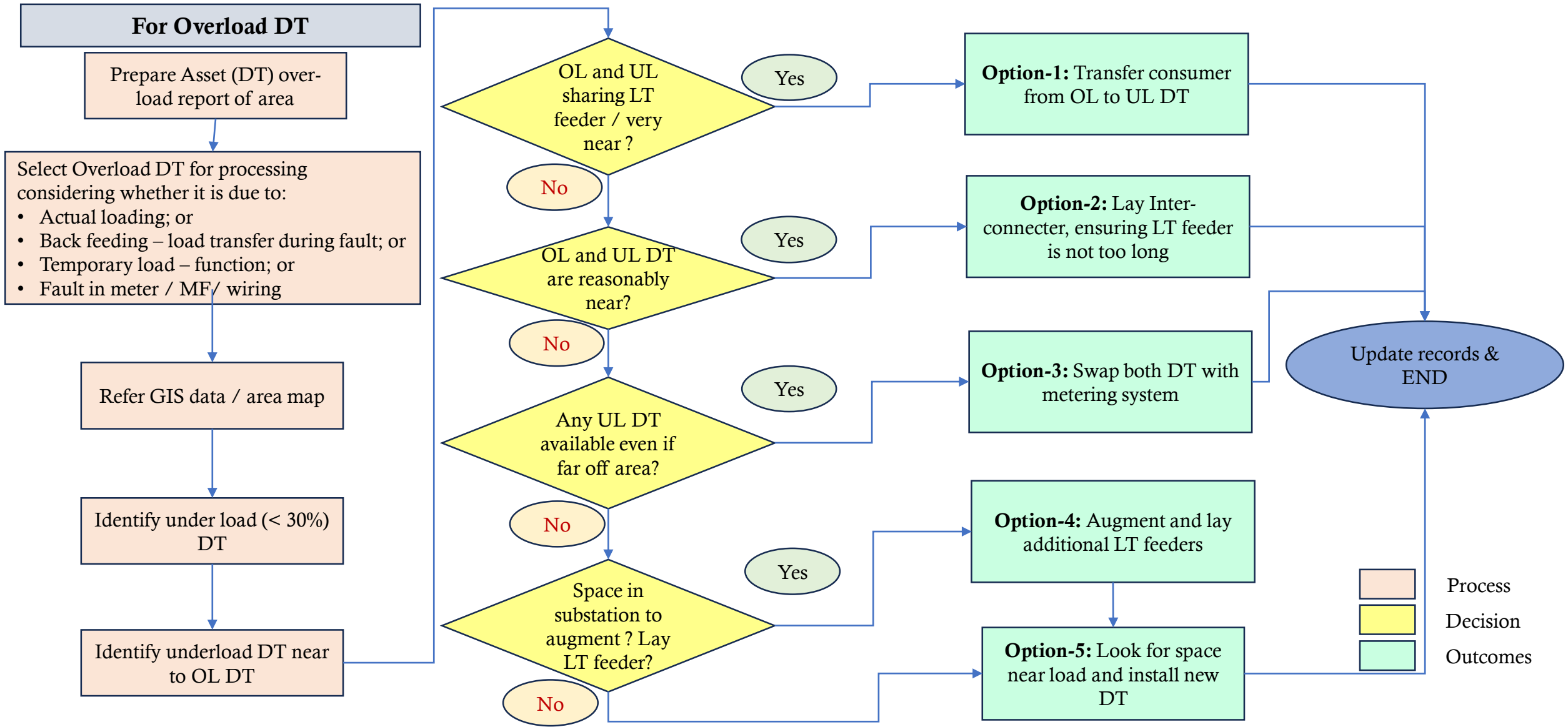
STEP-3: Select overloaded DTs for Load balancing

STEP-4: Check the underloaded DTs surrounding the overloaded DT

STEP-5: Check LT network connection and review how consumer can be shifted to under loaded DT.

STEP-6: Shift the consumers to balance the load.

SOP for DT Load Balancing



Asset Peak loading report-Leveraging more benefit

Report Purpose	Remarks
To improve asset utilization .. Asset with peak below say 20% of capacity.	Prepare exception report of DT where % peak loading less than limit.
Capex saving --- maintaining ratio of total asset capacity and company peak	Higher means redundancy, less chance of overloading but higher cost, space, no load loss.
Low cost , effective, fast SMART corrective action	To address abnormalities corrective action need to taken. There are multiple solution. Purpose of report to empower utility which is best solution,

Possible action : Reduce peak

1. Phase balancing
2. Address reactive energy / PF

Possible action : Shift load

1. From over Dt to underload DT
2. Swapping of DT -

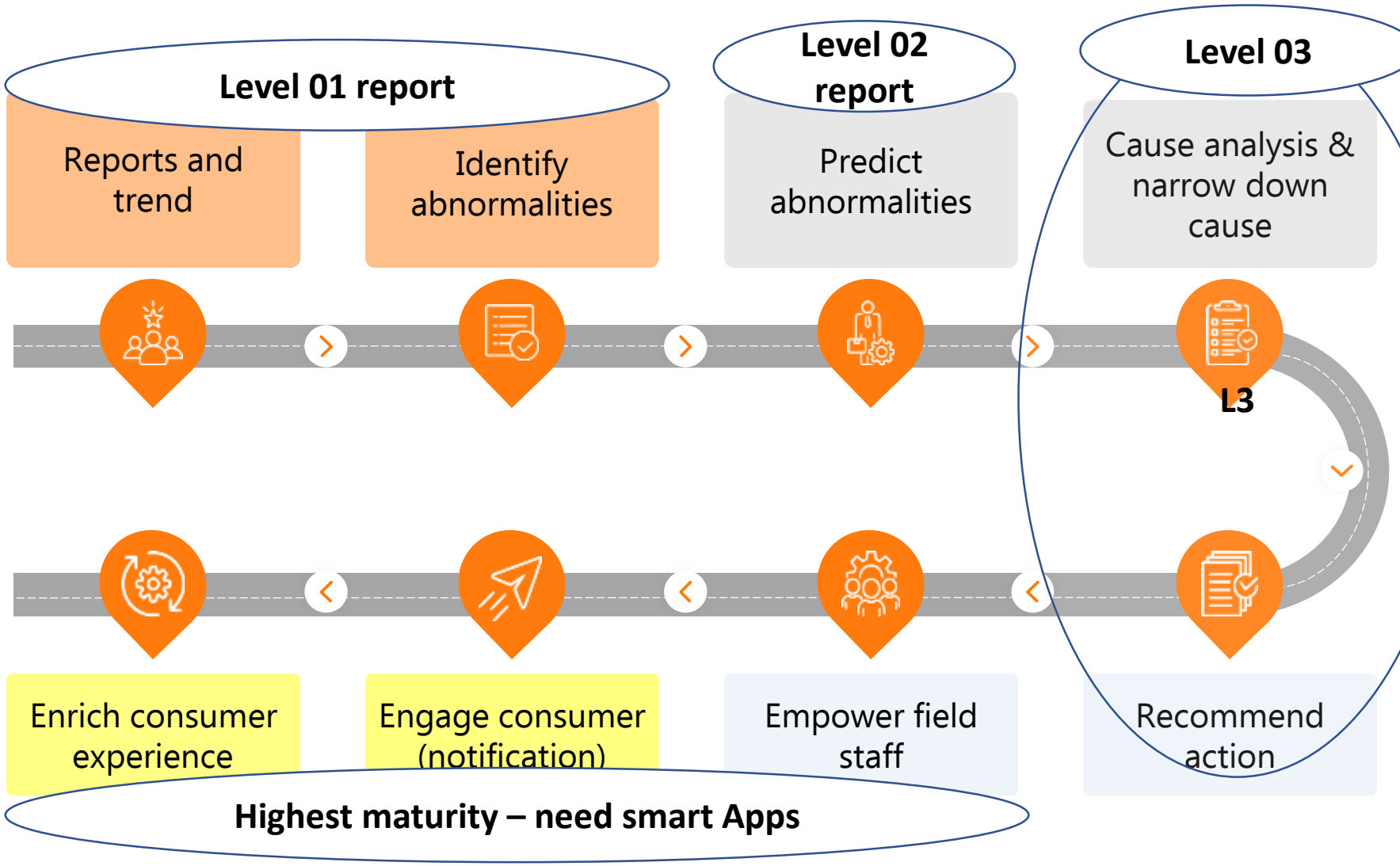
Possible action : DT level

1. DT capacity Augmentation
2. Additional DT

Expected advantages

- Simple reports – most of action by field – **No Major Team of Engineer**
- More than 2/3rd cases get resolved without adding new DT – **Lower CAPEX.**
- No overloading – **Lower Asset Failure/ Lower Capex which can go down by 75%**
- **Lower technical loss** –High % loading means higher loss/ loading near optimum level-**can reduce by 0.5-1%**
- Lower technical loss – **Better asset life**
- Power quality – **Less voltage variation & improved consumer gadget performance**
- **Better capacity utilization**

Meter data analytics …. Maturity level



Smart meter empowers with online data

Online Data means instant action

Leveraging gain – involve mass Data report beyond – CEO/ planning

Smart Apps for field force

End user is consumer – enrich his experience - sustainability

To leverage gain – need smart Apps

Smart Applications (Apps)

Loading related objective :: Avoid overload, Better asset utilization/ load balancing for technical loss reduction , lower asset failure and lower Capex.

Define abnormalities , identify parameter and define range (better configurable)..
Better go for **PREDICTION** … Understanding meter data/ alert is essential

Link abnormality range , secondary parameter with cause , where ever possible.
Domain knowledge

Suggest corrective action in priority. …..**Authorization**

Job Ageing, SLD up-dation, dash board, trend chart.

Smart Apps involving field staff suggesting most appropriate corrective action can be developed to address all abnormalities

To leverage gain – need smart Apps for that Smart meters / DI DO AO required

Power Quality- Voltage Deviation Report

Voltage Deviation Index

$$\%(VD_{phase})_n = \frac{\left|V_{rated} - (V_{phase})_n\right|}{V_{rated}} * 100$$

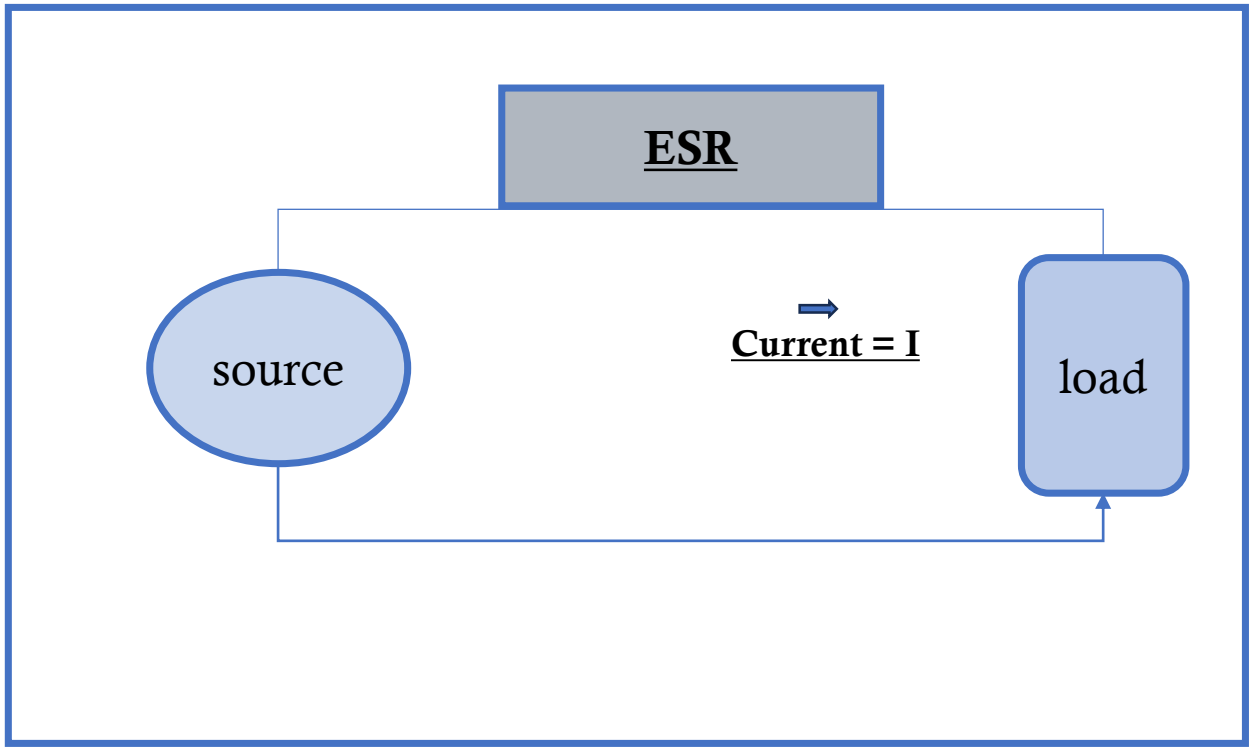
$$VDI_{phase} = \frac{Number\ of\ Slots\ with\ VD > defined\ band}{n}$$

Asset code:							V_{rated} :	Date:		
Sr No	Time Slot (n)	Voltage in slot			Voltage deviation wrt to V_{rated} in each slot			Slots with VD>Bands defined (10%Δ)		
		Vr (V)	Vy (V)	Vb (V)	VDr (E= [{|Vrated - Vr|}/ Vrated] *100)	VDy (F= [{|Vrated - Vy|}/ Vrated] *100)	VDb (G= [{|Vrated - Vb|}/ Vrated] *100)	R Phase	Y Phase	B Phase
1	00:00 - 00:15	222	228	241	3.5%	0.9%	4.8%	0	0	0
2	00:15 - 00:30	220	212	262	4.3%	7.8%	13.9%	0	0	1
.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.
96	23:45 - 24:00	201	227	238	12.6%	1.3%	3.5%	1	0	0
	Number of Slots with VD>10%Δ							19	5	12
	Phase wise VDI = {(Number of Slots with VD>10%Δ)/n}*100							19.8%	5.2%	12.5%

** Vrated has been considered as 230V for calculations in this document. The same needs to be considered as per applicable Standards/Regulatory guidelines for the state/DISCOM.*

Δ Voltage deviation band of ±10% has been considered for calculations in this document. The same needs to be considered as per applicable Standards/Regulatory guidelines for the state/DISCOM.

Why study - Voltage drop - concept



- Drop in voltage = Vs- VL
  - ΔV = Vs-VL= IR
- Multiple all by I
  - ΔV I = IVs-IVL= I^2R

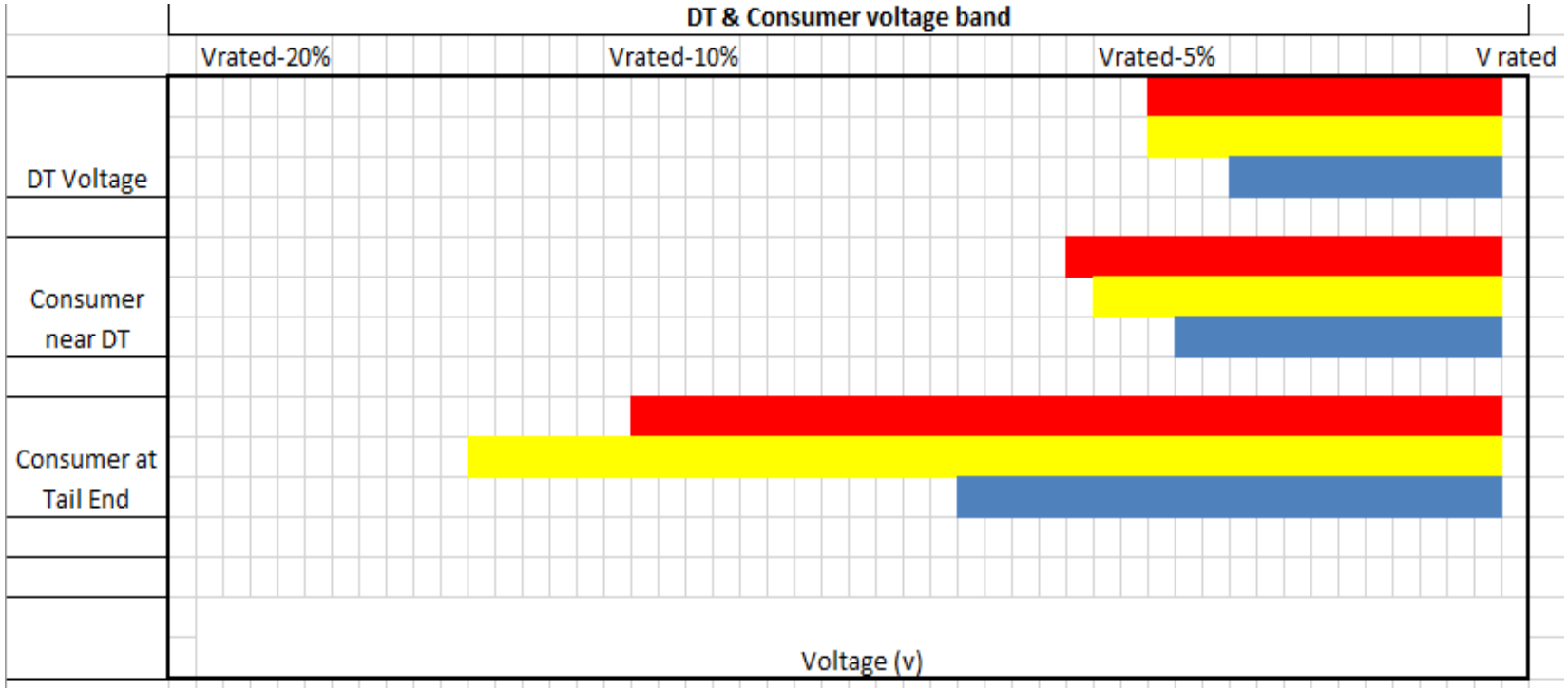
Power loss = Input power – load power

- ΔV I/Ivs = (IVs-IVL)/Ivs
- ΔV /vs = (Delta P/ Input power)

% Tech loss = % voltage drop

- Higher drop in voltage means higher technical loss
- Voltage drop depends upon wire resistivity, length & current …
- Higher drop means inadequate cable size, more length or poor joints.
- Sudden voltage drop ---- some joint / fuse issue (or else load)
- Voltage fluctuation – fault going to happen or wire becoming too hot/ may burn.. Better strengthen cable
- Ideal limit – 3% at the last consumer

DT & Consumer Voltage Bands



1. Using Tap changer, Set DT voltage around 245V in no load position
2. Check Voltage change during peak .. It should be with DT specification limit
3. Consumer near DT .. Follows DT Voltage .. If big gap means joint issue
4. Study of DT and consumer at both end of feeder is very useful

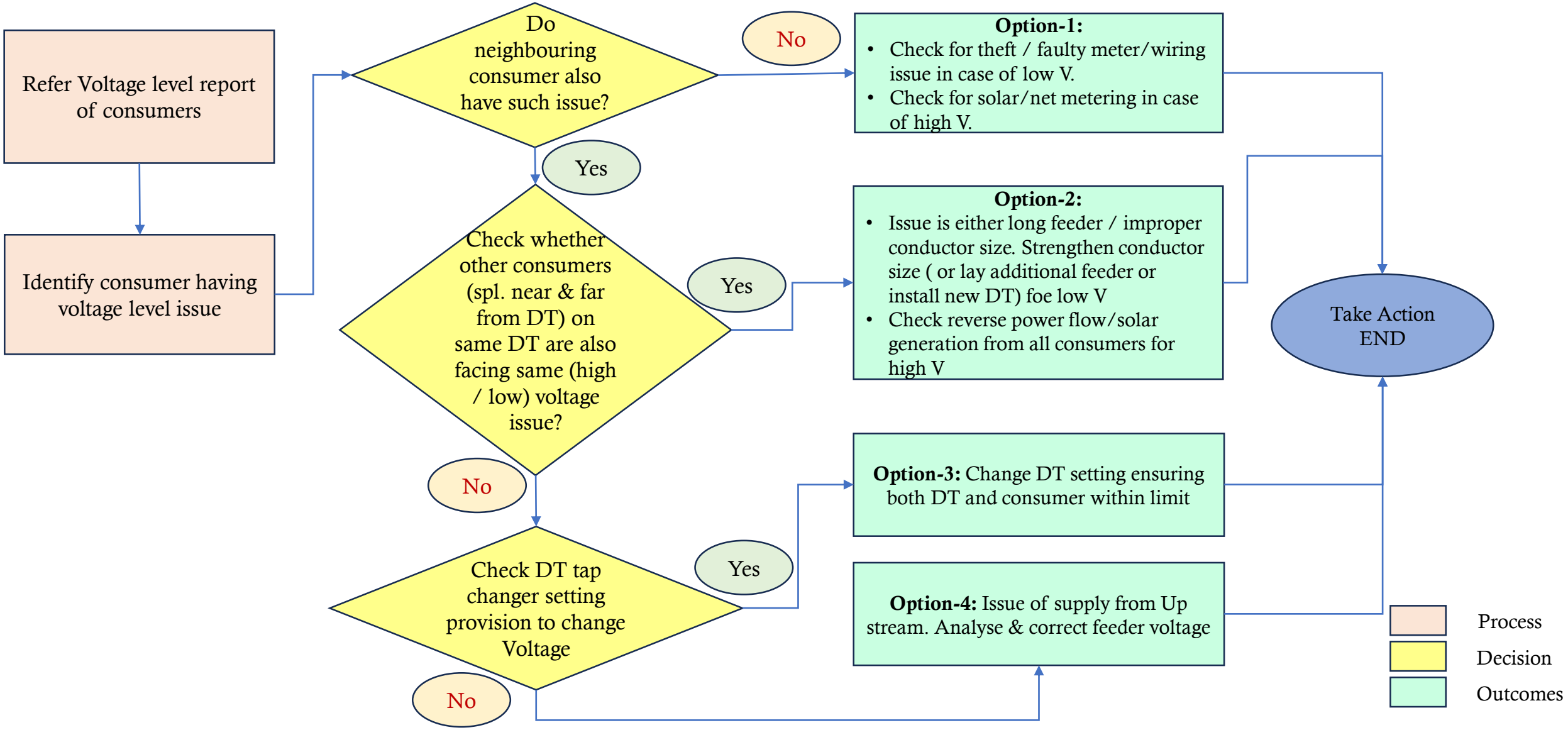
Voltage unbalance linked with load unbalance

1. Consumer at far End will see drop and fluctuation in voltage
2. If loading is unbalance , especially during high loading, consumer meter may observe unbalance voltage.
3. Each feeder far off consumer can observe different drop and voltage unbalance – it depends upon
   - Loading of that LT feeder
   - Unbalance in loading of that LT feeder
   - Length of feeder

Voltage Tolerance Bands

Allowed Tolerance	-10%	-7.50%	-5%	-2.50%	2.50%	5%	7.50%	10%
At DT No load V								
At DT Full Load								
At DT Avg Load								
Drop in LT feeder								
Consumer Voltage								
11kV fluctuation								

SOP for Voltage quality issue at consumer end



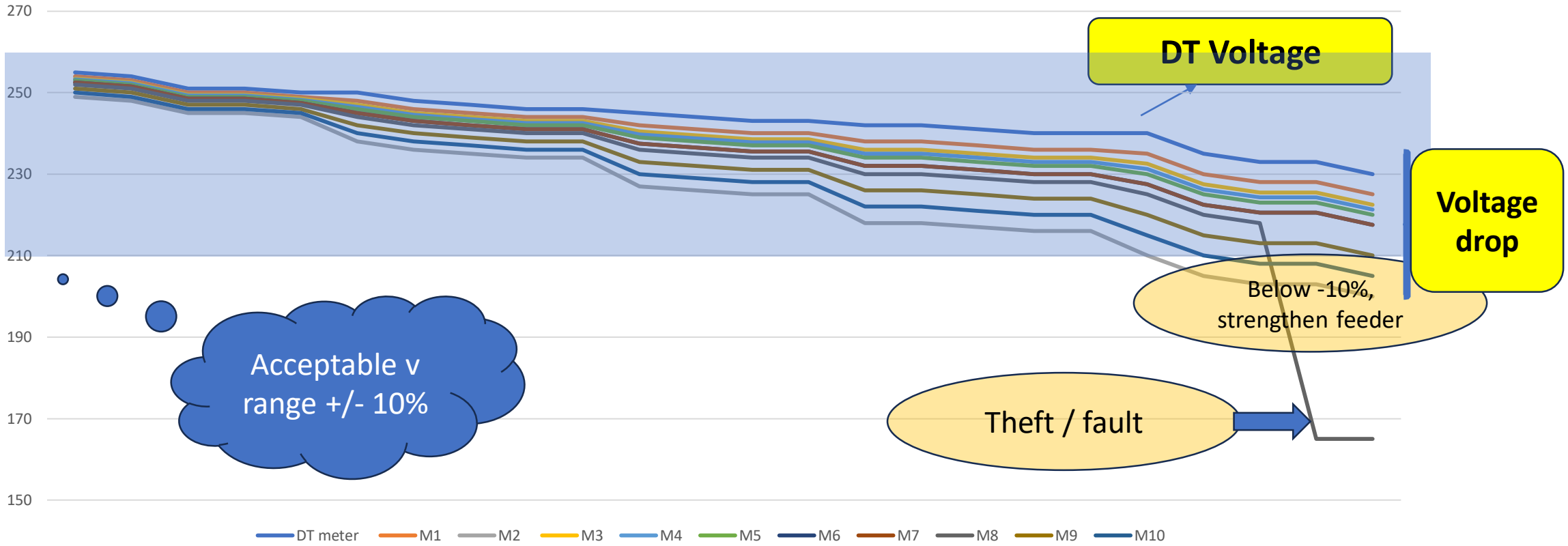
GIS Voltage plotting to review Network health

Voltage drop :

- **Sudden drop** – Potential fault
- **Large but gradual drop** – Stressed/overloaded feeder
- **Discrete consumer drop** – Probable Theft

Just by ensuring voltage in V +/- 10%, utility can reduce tech loss, failures and thus expenses.

Study of Voltage/ power OFF – Advance analytics



High Voltage drop – high technical loss

High Voltage drop – Chances of asset failure

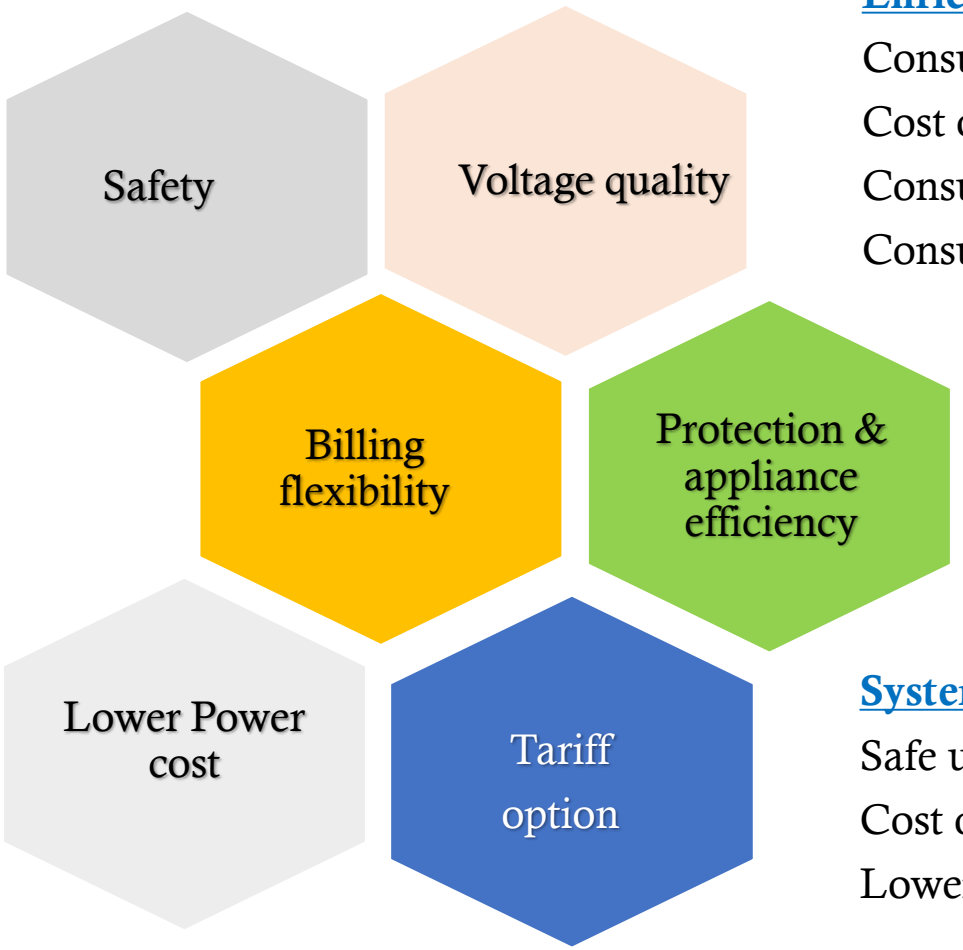
Too much drop – loose joint/ fault OR THEFT

Wide voltage range – Need network replanning

Concept of Smart Apps and Smart Consumer Apps

Enriching consumer Experience .....

UNDEFINED EXPECTATIONS



General

Lower electricity Bill

Reliable power – lower outage

Better services

Timely information

Enrich consumer experience

Consumer apps -- Efficient / safe appliances

Cost of Power

Consumer participation - Bill management

Consumer participation– roof top/ DSM

System efficiency

Safe usage / zero accident - protection

Cost of Power

Lower technical loss – better power quality

Consumer Alerts & Notifications - Safety

Why accident happens at consumer premises
Faulty wiring or fault in appliances -Smart meter detection and notification system

Advance alert

Your DG set/ Battery inverter / Roof top generation is not isolated and observed feeding power at XX:XX hrs to grid. This can cause serious accident.

Get your wiring repaired through license electrician in TT days and report.

Advance alert

At 18:15 hrs, you switched ON equipment. It has leakage of current through its body and thus a potentials safety risk.

Kindly get it checked by trained electrician.

Advance alert

Your house wiring is mixed with meter# xxxdd,
It is a potential safety hazard and can cause error in meter working.

Get your wiring repaired through license electrician in TT days and report.

Nothing valuable than human life. Damage due to electrical fire is painful

Consumer Alerts & Notifications – Consumer Empowerment

Notification : Base load

Your base load is around … KW which can result into XXXX Rs additional billing .. For more information, visit the DISCOM App

Enrich Experience

Notification : **Subsidy**

In first 11 days you have consumed 75 units. Your Billing consumption is expected around 223 units.
To Avail Free electricity, ensure consumption within 200 Units.

Refer your expected daily pattern and day wise target to ensure you do not miss subsidy

Empathy- Taking care
Build trust

Notification : Flexible Billing

Consumption is going high due to intense heat.

You can opt your billing period to 25 days in summer and 35 days in winter to have uniform monthly billing.
For more details, visit DISCOM apps

Empower consumer – offer flexibility

Safety Notification sent:

1. House Wiring Defect

Earth current leakage alarm was detected on your meter (No. AL2812024) on 2024-11-15 11:17:38, indicating a wiring fault in your premises. For your safety, we advise you to have it inspected by a certified electrician.

To avoid earth leakage in the future, we advise you to install an ELCB with the correct rating or have your existing ELCB checked by a certified electrician.

2. House Wiring Intermixing

An alarm was detected on your meter (No. AL2812024) on 2024-11-15 10:55:56, indicating an intermixing of wiring with your neighbor`s connections of meter no. AW8000499. To avoid high bill and ensure proper safety, we advise you to have it inspected by a certified electrician immediately.

3. MCB Trip

Please check your main MCB regarding the power supply complaint raised on 15-Nov-2024 16:26:59.

4. Appliance Body Shock

You have turned ON an appliance on 2024-11-15 10:57:37 (Meter No.AL2912024) which has current leakage in its body, indicating a potential risk of electric shock from the electrical appliances. Please ensure that all appliances are properly grounded and inspected for safety.

5. Reverse energy Flow

Meter no. AL2912024 has detected Back feed of energy supply after power cut on 2024-11-15 10:59:44. You are warned to immediately isolate your Solar battery system/DG/Inverter from main grid and get it checked by a certified electrician to avoid accident.

Licensee Responsibility to notify improper house wiring related matter to consumer

CEA Regulation on safety

CENTRAL ELECTRICITY AUTHORITY

NOTIFICATION

New Delhi, the 8th June, 2023

No. CEA-PS-16/1/2021-CEI Division.—Whereas the draft of the Central Electricity Authority (Measures relating to Safety and Electric Supply) Regulations, 2022 was published in six newspaper dailies, as required by sub-section (3) of section 177 of the Electricity Act, 2003 (36 of 2003) read with sub-rule (2) of rule 3 of the Electricity (Procedure for Previous Publication) Rules, 2005 for inviting objections and suggestions from all persons likely to be affected thereby, before the expiry of the period of forty-five days, from the date on which the copies of the newspaper containing the said draft regulations were made available to the public;

And whereas copies of the said newspapers containing the public notices and the said draft regulations on the website of the Central Electricity Authority were made available to the public on 14th June, 2022;

And whereas the objections and suggestions received from the public on the said draft regulations were considered by the Central Electricity Authority;

Now, therefore, in exercise of the powers conferred by clause (b) of sub-section (2) of section 177 and read with section 53 of the Electricity Act, 2003, and in suppression of the Central Electricity Authority (Measures relating to Safety and Electric Supply) Regulations, 2010, except as respects things done or omitted to be done before such suppressions, the Central Electricity Authority hereby makes the following regulations, namely: –

Chapter I

Preliminary

1. **Short title and Commencement.** – (1) These regulations may be called the Central Electricity Authority

CEA Regulation on metering

भारत का राजपत्र
The Gazette of India

असाधारण
EXTRAORDINARY
भाग III—खण्ड 4
PART III—Section 4
प्राधिकार से प्रकाशित
PUBLISHED BY AUTHORITY

सं. 488] नई दिल्ली, सोमवार, दिसम्बर 23, 2019/पौष 02, 1941
No. 488] NEW DELHI, MONDAY, DECEMBER 23, 2019/PAUSHA 02, 1941

केन्द्रीय विद्युत प्राधिकरण

अधिसूचना

नई दिल्ली, 23 दिसम्बर, 2019

सं. सीईए-जीओ-13-15/3/2019-डीपीआर प्रभाग.—विद्युत (पूर्व प्रकाशन की प्रक्रिया) नियम, 2005 के नियम (3) के उप नियम (2) के साथ पठित विद्युत अधिनियम, 2003 (2003 का 36) की धारा 177 की उपधारा (3) द्वारा यथापेक्षित केन्द्रीय विद्युत प्राधिकरण (मीटरों का अधिष्ठापन और प्रचालन) विनियम, 2006 का संशोधन करने के लिए प्रारूप विनियम का प्रस्ताव छह दैनिक समाचार-पत्रों में प्रकाशित किया गया था, जिसमें उन सभी व्यक्तियों से जिनकी इनसे प्रभावित होने की संभावना है, उस तारीख से जिसको उक्त प्रकाशनों को अंतर्विष्ट करने वाले समाचार-पत्रों की प्रतियां जनता को उपलब्ध करा दी जाती है, पैंतालिस दिनों की अवधि की समाप्ति से पूर्व, सुझाव और आक्षेप आमंत्रित किये गये थे;

और उक्त विनियमों को अंतर्विष्ट करने वाले उक्त समाचार पत्रों की प्रतियां 21 फरवरी, 2019 को जनता को उपलब्ध करा दी गई थीं;

Transforming Distribution Network asset metering using DI Port

Why Innovative Smart DT meter

Smart DT metering helps study load and energy flow, to assess network health and for network operations.

DI/ AI port

1. To measure various sensor digital and analog output
2. To capture status of breakers
3. To capture status of various indicators eg Fault path indicator (FPI).
4. Even in surrounding sensor like smoke, fire, intruders can be sensed.
5. Can integrate with other electronic devices.

Advance Firmware and application software

1. Meter firmware which can raise alerts/ events after analyzing data captured at DI/AI port
2. Smarts apps to improve network performance using smart analytical apps.

Blue tooth(*optional*)

1. Help to communicate with neighbouring devices, meters, breakers etc.
2. Line man ,on site can also communicate with meter.

Such smart meter not only provide electrical parameters but status of breakers/ RMU/ FPI and output of sensors like oil level, temperature, smoke, fire, MOG,

Asset meter and breaker control

Asset smart meter with DI/ DO

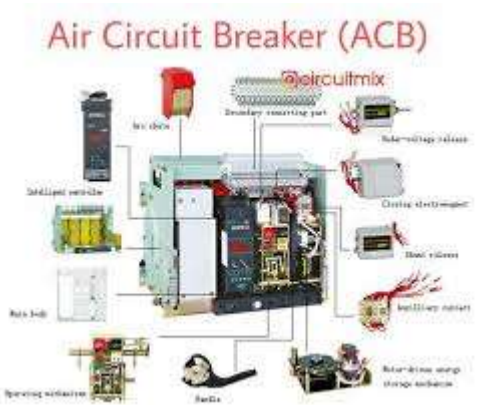
11 KV feeder Smart meter

DT Smart meter

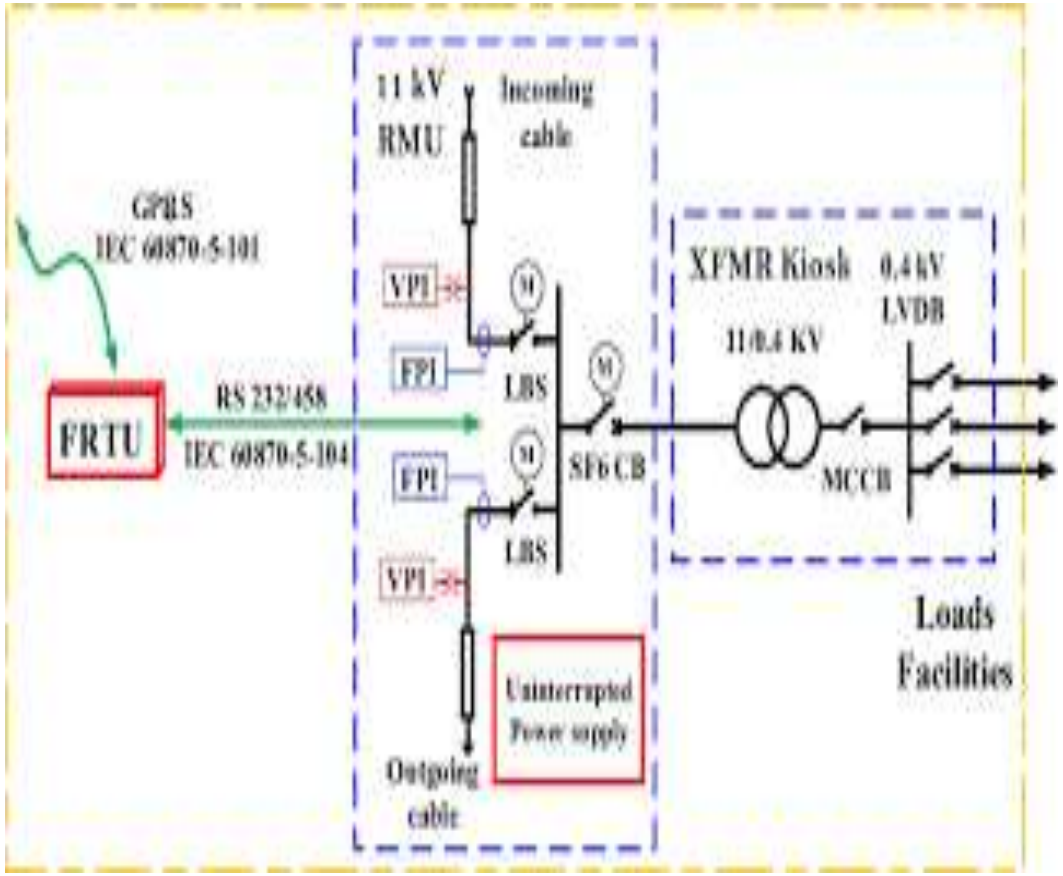
11kv feeder breaker

RMU

MCCB



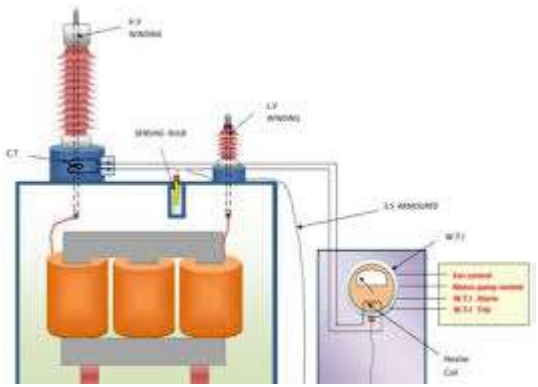
Need of smartness at RMU



1. To capture FPI data –
   - Present practise – site visit
   - Smartness – By communication.
2. To capture isolator status–
   - Present practise – site visit
   - Smartness – By communication.
3. To capture Breaker trip event
   - Present practise – No information through RMU
   - Smartness – By communication.
4. To Switch off load supply
   - If any emergency - fire
   - Any planned outage – agriculture/ high theft.

These information helps in faster outage management

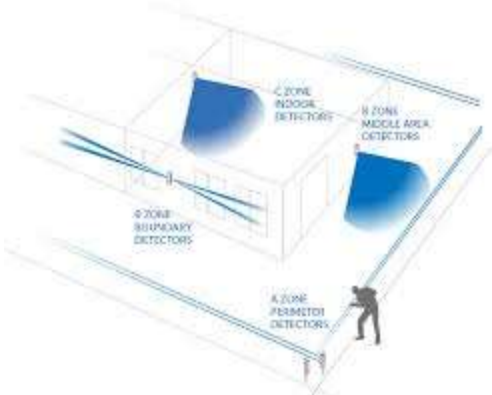
Various Sensors / Indicators in Distribution Network



Winding and terminal temperature

Oil Level sensor

Magnetic oil gauge MOG



Intruder detection

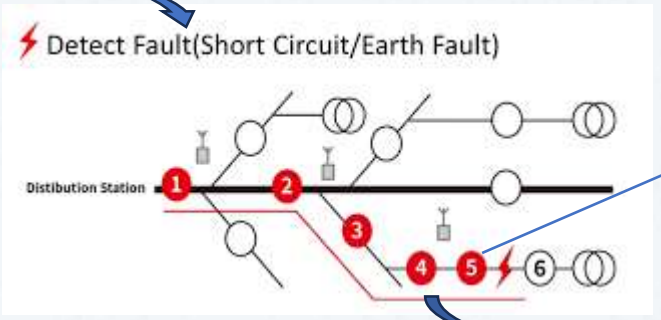
Smoke/fire detector

Fault path indicators

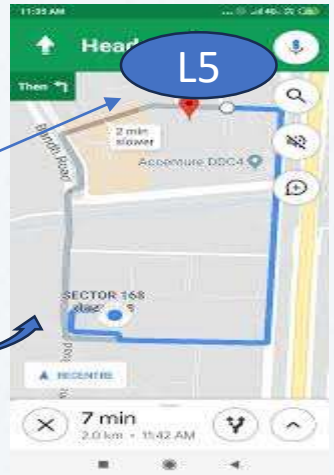
Reliability-Outage Management

Field smart Apps for supply restoration …….

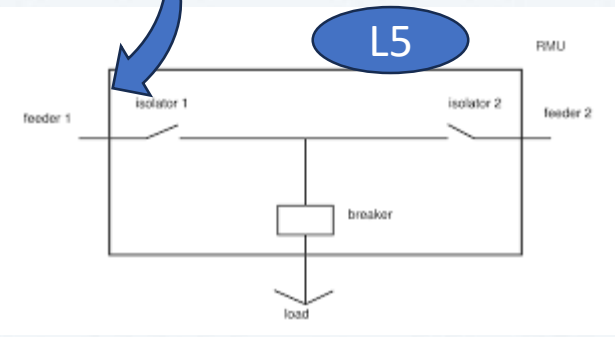
Alert for outage



FPI showing feeder and location



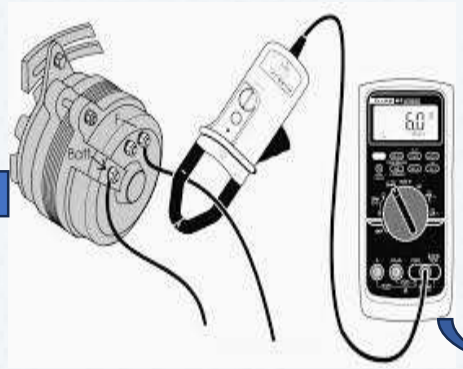
Google map - Location and direction to RMU – to isolate supply to faulty network



Isolated the supply to faulty network – RMU isolator – L5

SCADA restored supply upto RMU isolator – L5

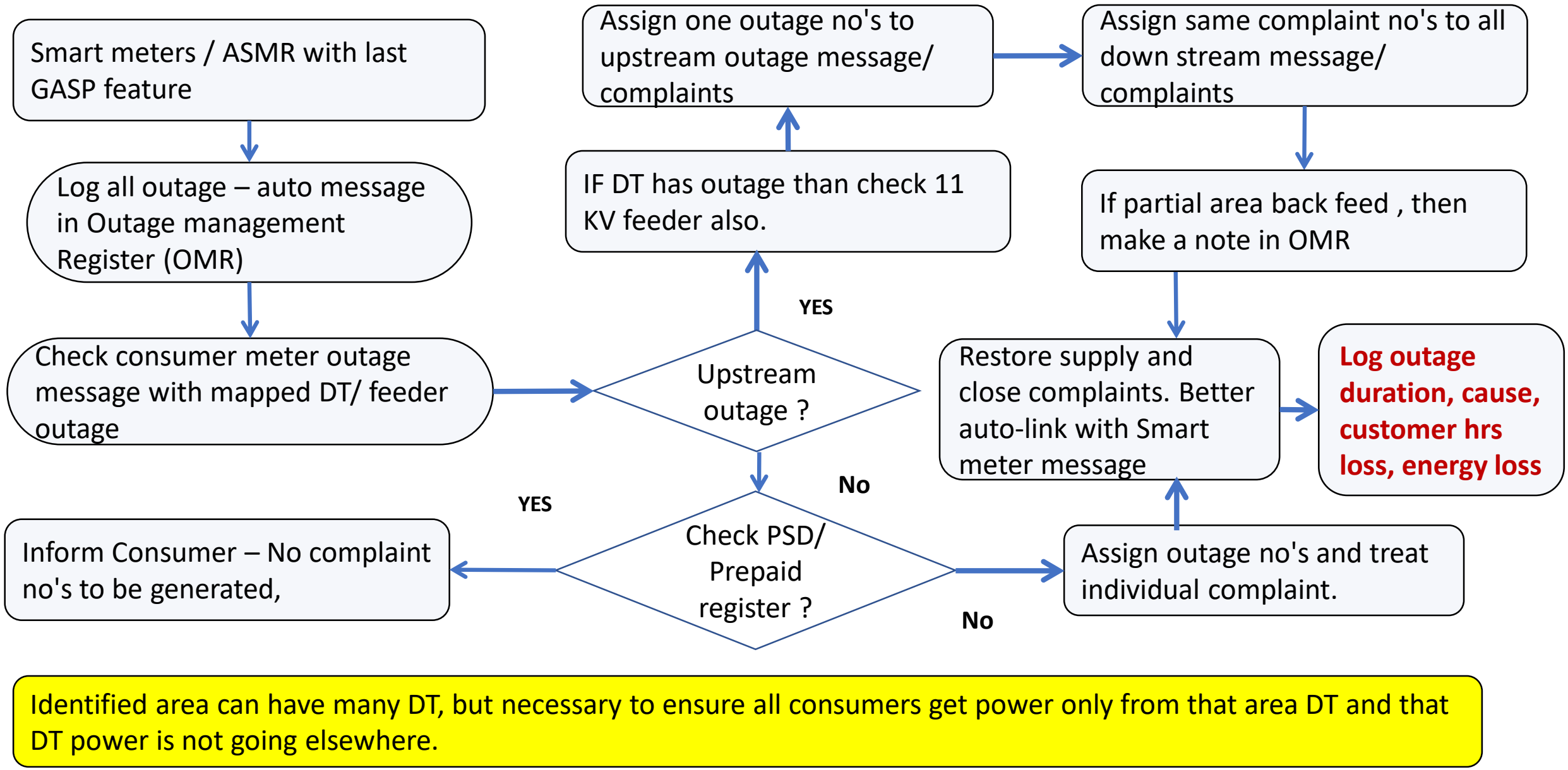
Field inspection L5 to L6, to understand fault;
If no fault – energise L5 else isolate L6



Check load of feeder on which load of L6 onward can be transferred -

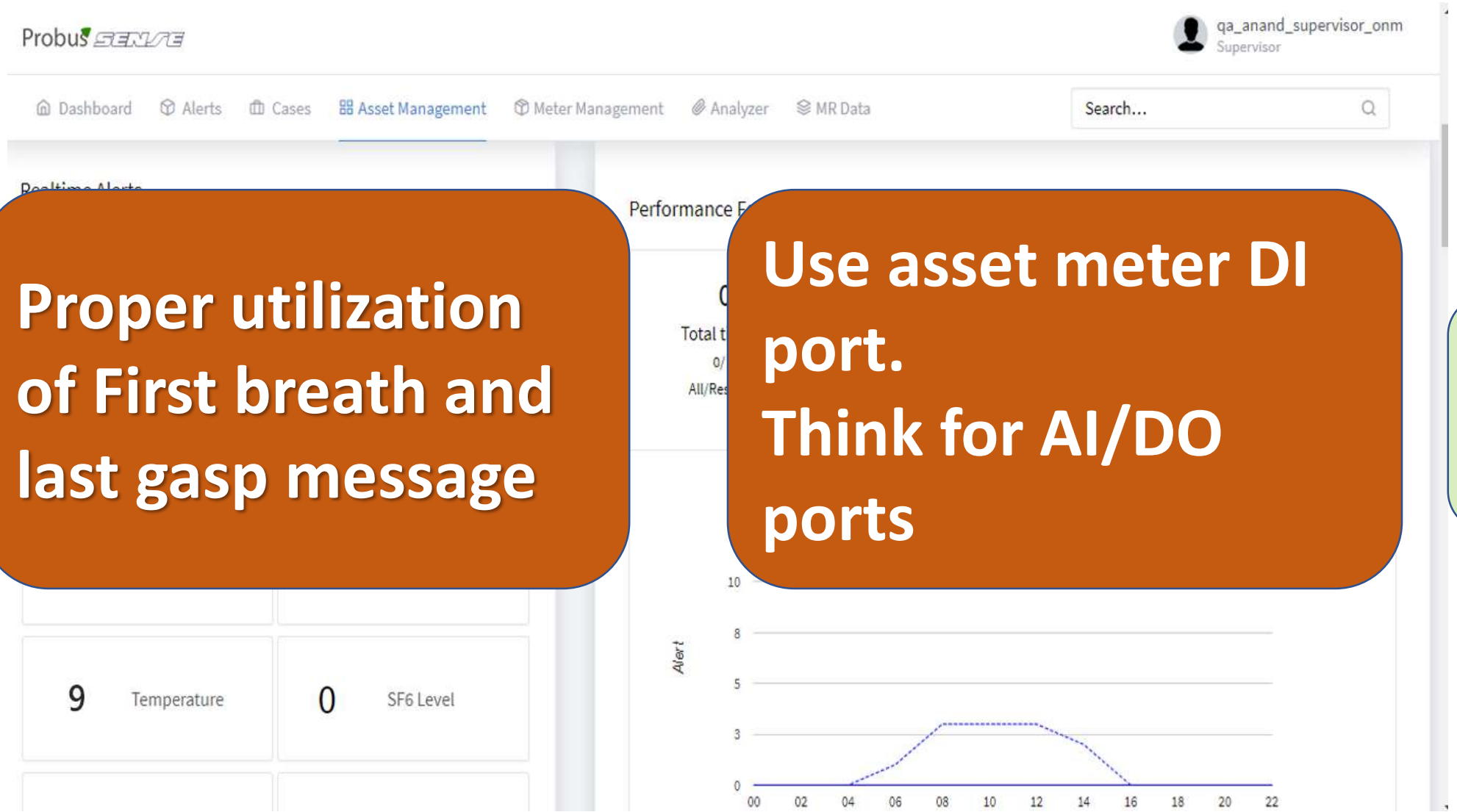
Load transfer
Supply restored
SLD updated

8.M1 Master Outage management Record – Process Flow



Identified area can have many DT, but necessary to ensure all consumers get power only from that area DT and that DT power is not going elsewhere.

Real-time alerts



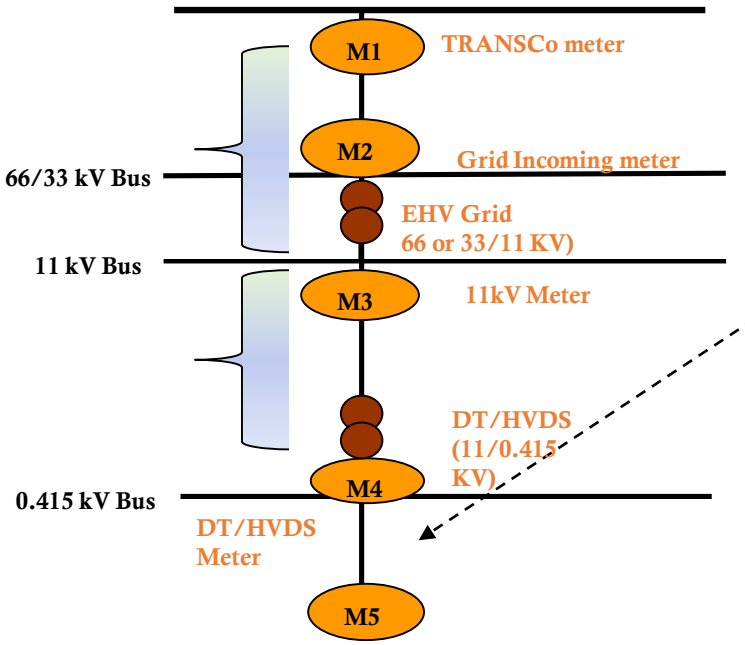
Proper utilization of First breath and last gasp message

Use asset meter DI port.
Think for AI/DO ports

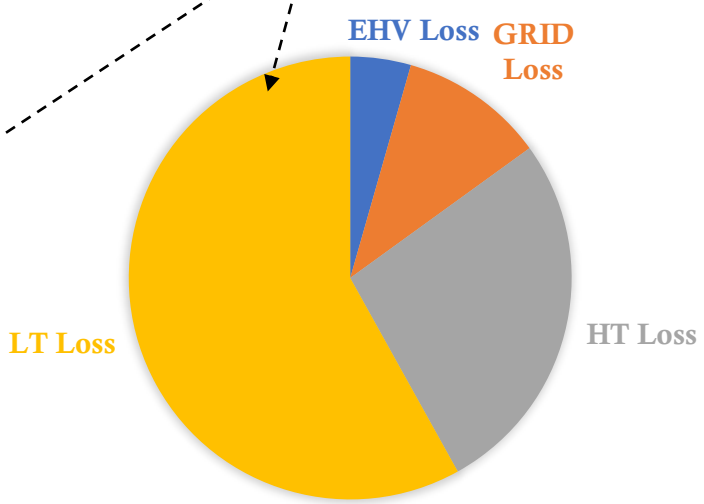
Real-time alerts and performance parameters

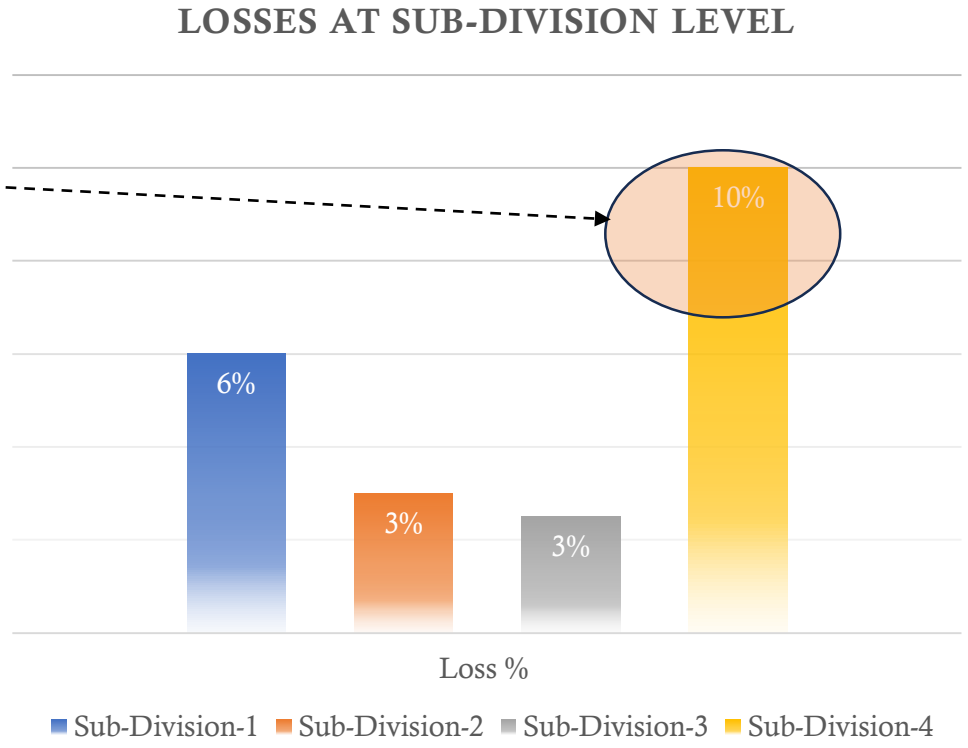
Revenue Protection

Energy Audit Dashboard – Targeting high loss areas



Need Action on these voltage levels/ sub-divisions**(Prioritization)**





1. Based on monthly Energy audit reports identify subdivisions with highest % losses (threshold values may be configured as per DISCOM)
2. Further, a deep-dive analysis on the selected sub-divisions may be done to identify suspected cases.

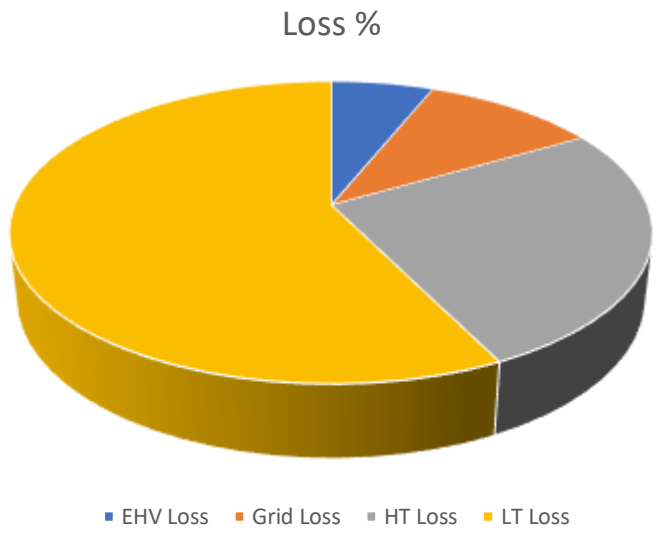
KPI: Reduction in AT&C losses

Loss Breakup – a Typical report

Parameters	Values
TRANSCo Input Energy (13.8KV & 33 KV)	**10000**
EHV Loss 33 KV transmission + grid loss %	1.00%
EHV Loss MU	23
loss in capacitor	47
Loss in 33/13.8 KV	30
Total EHV loss	100
Grid 13.8KV feeder panel Energy	9900
HT Sales to consumer	3000
Net Metering net input to Grid	**4**
DT LT Level Energy	6650
HT Loss%	**2.57%**
HT Loss MU	254
DT LT Level Energy	6650
LT Level Sales	6313
LT Loss%	5.07%
LT Loss MU	337
Total Sales	9313
over all loss	6.91%

Voltage level loss wrt total input

Category	Loss %
EHV Loss	
Grid Loss	1.0 %
HT Loss	2.57%
LT Loss	5.07%
Total	6.91%



Make this report at company level, circle level, distt level, feeder level and DT level.

Method-01: Illustrative Event/Alert related Analysis Logics & Scoring (1/3)

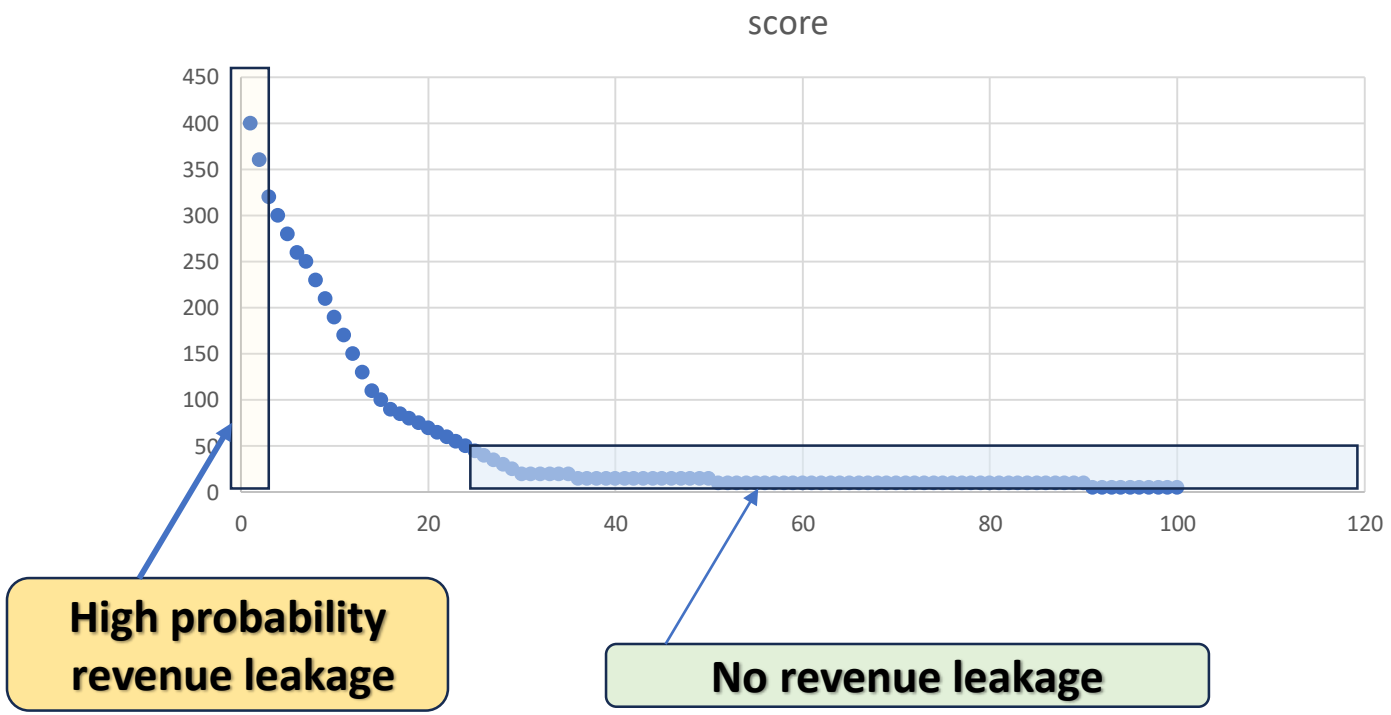
S.No.	Logics	Condition*	Marks*
1	Pf around 0.5 and reasonable high load	Month average	100
2	Cover Open	Instant	100
3	Current Without Voltage	12 hours & above	50
4	Power Fail	50 hours & above	30
5	Voltage Missing	100 hours & above	20
6	Voltage Unbalance	100 hours & above	10
7	Low Voltage in any Phase	100 hours & above	10
8	Over Voltage in any phase	100 hours & above	10
9	Single Wire Operation(neutral missing)	12 hours & above	20
10	Neutral Distubance	12 hours & above	40
11	CT Open in any phase	12 hours & above	50
12	Current Bypass	12 hours & above	50

Method-01: Illustrative Event/Alert related Analysis Logics & Scoring (2/3)

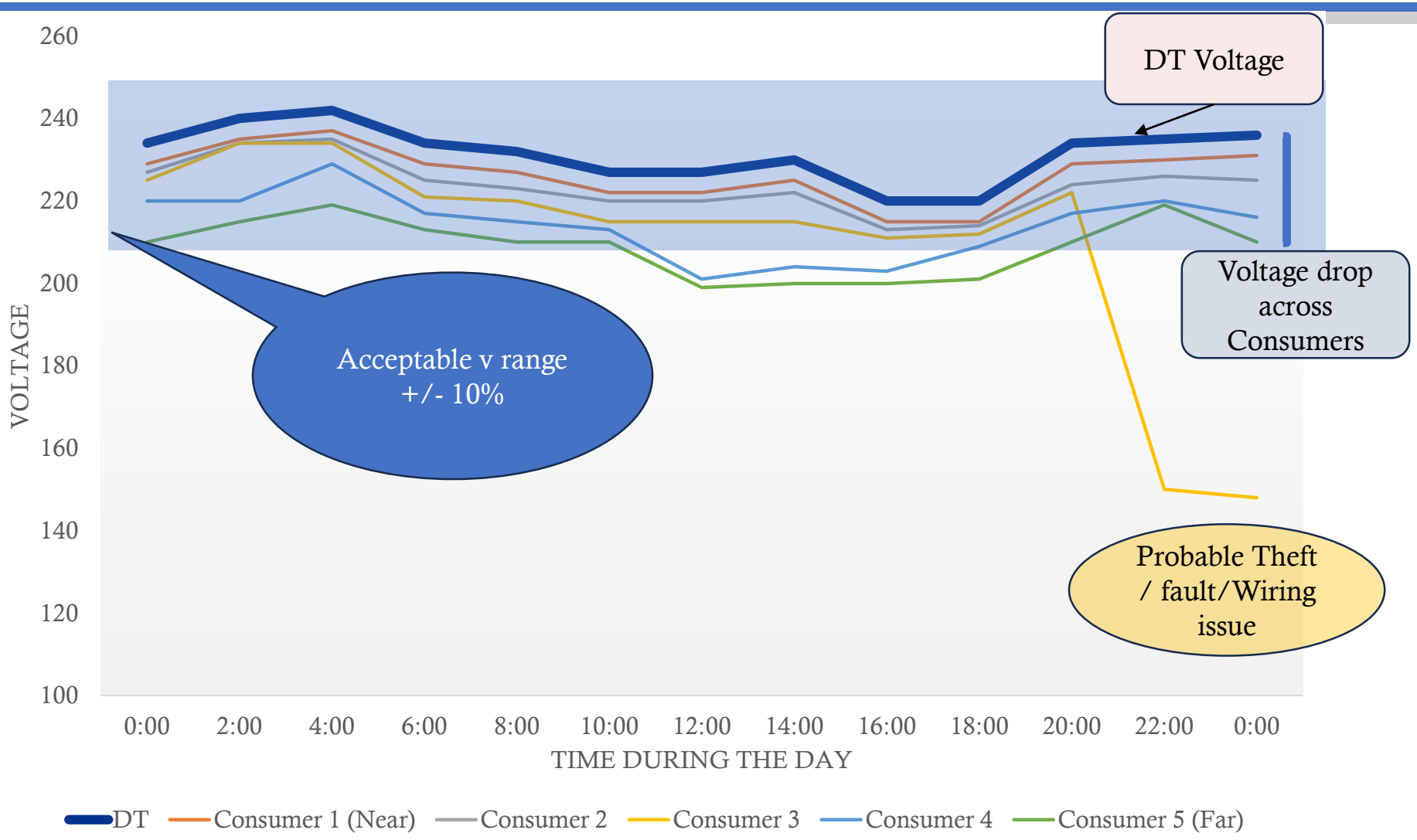
S.No.	Logics	Condition*	Marks*
13	Current Unbalance	12 hours & above	10
14	Earth Loading	12 hours & above	20
15	Low Power Factor	12 hours & above	10
16	Ip≠In (Phase current is not equal to neutral current)	Event count ≥ 80% of IP count	50
17	Ip=0 & In≠0 (Phase current is equal to zero & Neutral current is not equal to zero)	Event count ≥ 80% of IP count	50
18	Ip≠0 & In=0 (Phase current is not equal to zero & Neutral current is equal to zero)	Event count ≥ 80% of IP count	50
19	Consolidated Events-Sum of total Event Count	100 Nos & Above	30
And there are many more …… say upto 50 -60 logics			

Final step .....

- Run all logic as applicable for each consumers.
- Some consumer has 100% confirmed theft case/ faulty meter .. Segregate that
- Find consumer with top 1% score .. Make a list
- Share with field team or keep a watch on them,.. If repeat take action.



Method 02: Study of Voltage - Plot Voltage of all meter of a DT including DT meter for full day



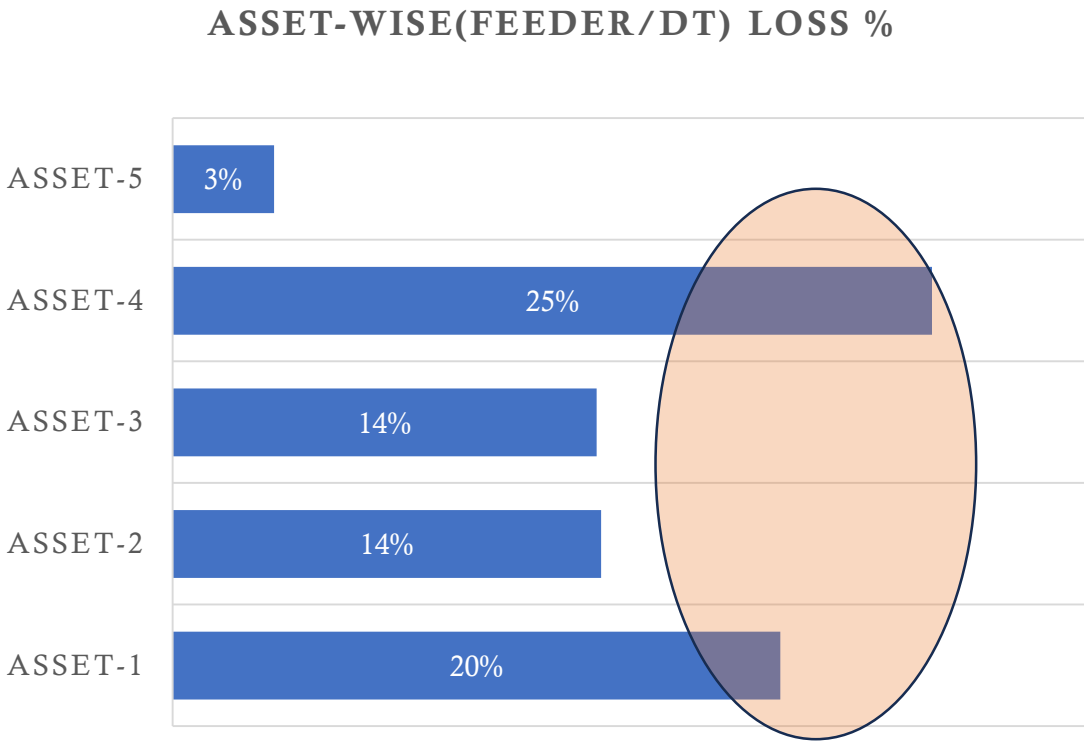
Higher drop in Voltage leads to
1. High technical loss
2. Chances of asset failure

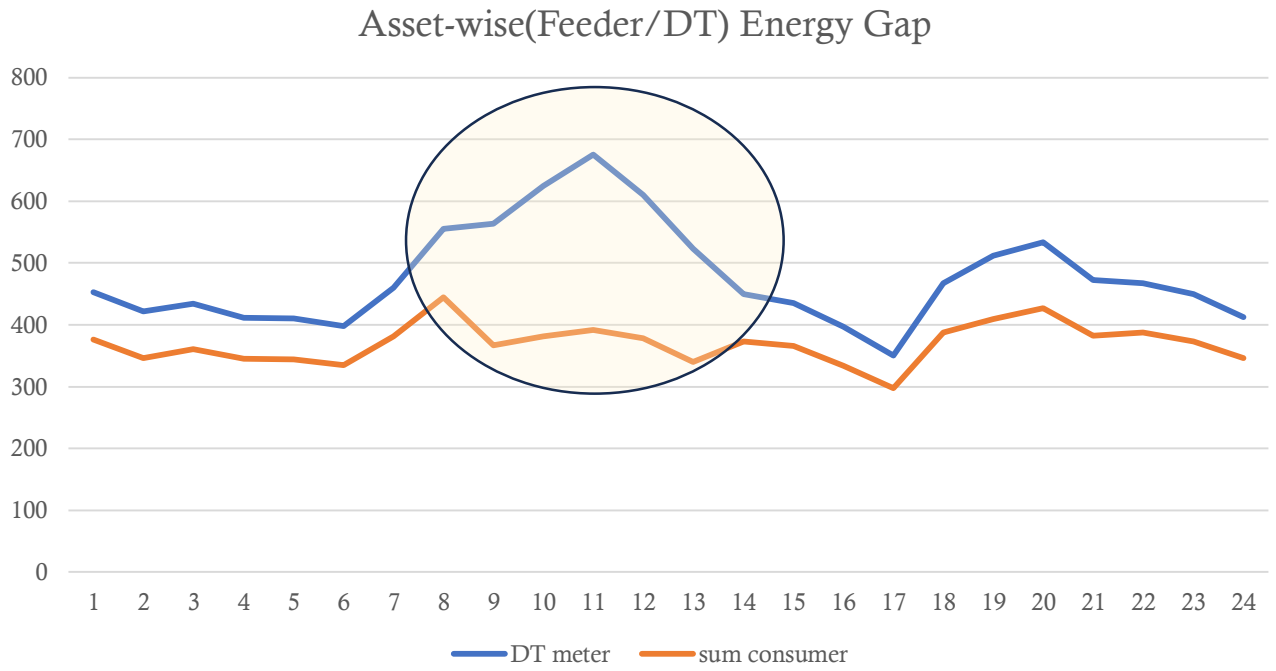
Higher drop in Voltage may be because of:
1. Loose joint
2. Fault
3. Theft

For consumers with Voltage drop below -10%, there is a need to strengthen LT feeder

Note: This comparison can be done for each phase of DT and corresponding consumers on each phase.

Method-03: Asset Load wrt Cumulative consumer Load





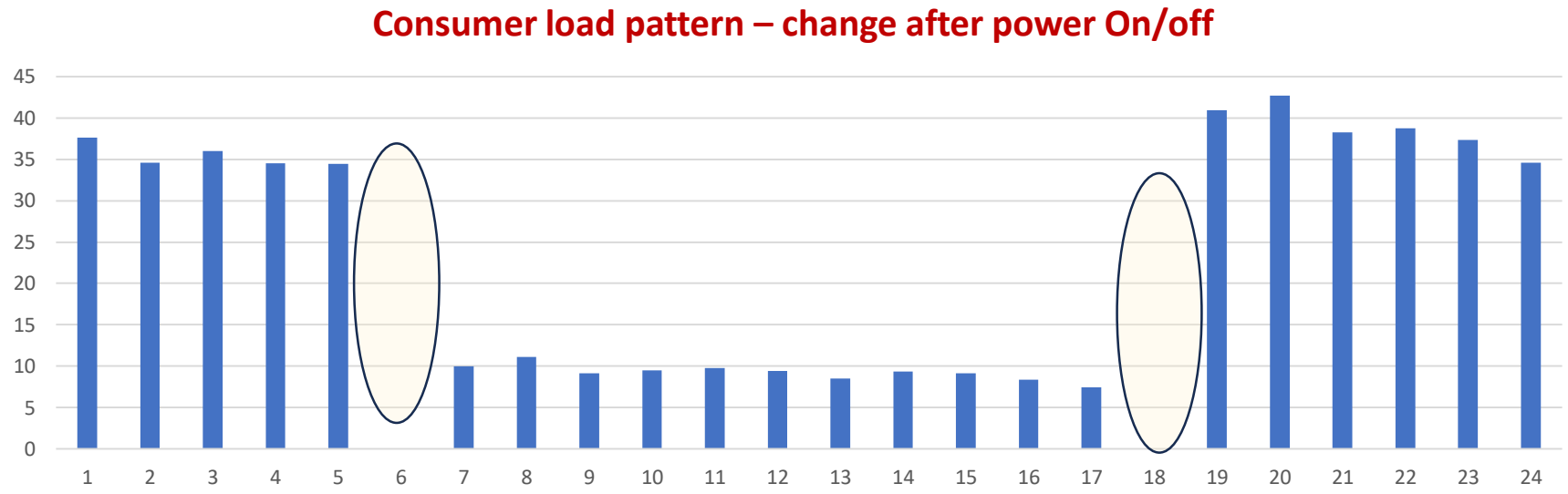
Step -01
In the identified sub-division(s), select the top worst performing assets for focused corrective actions

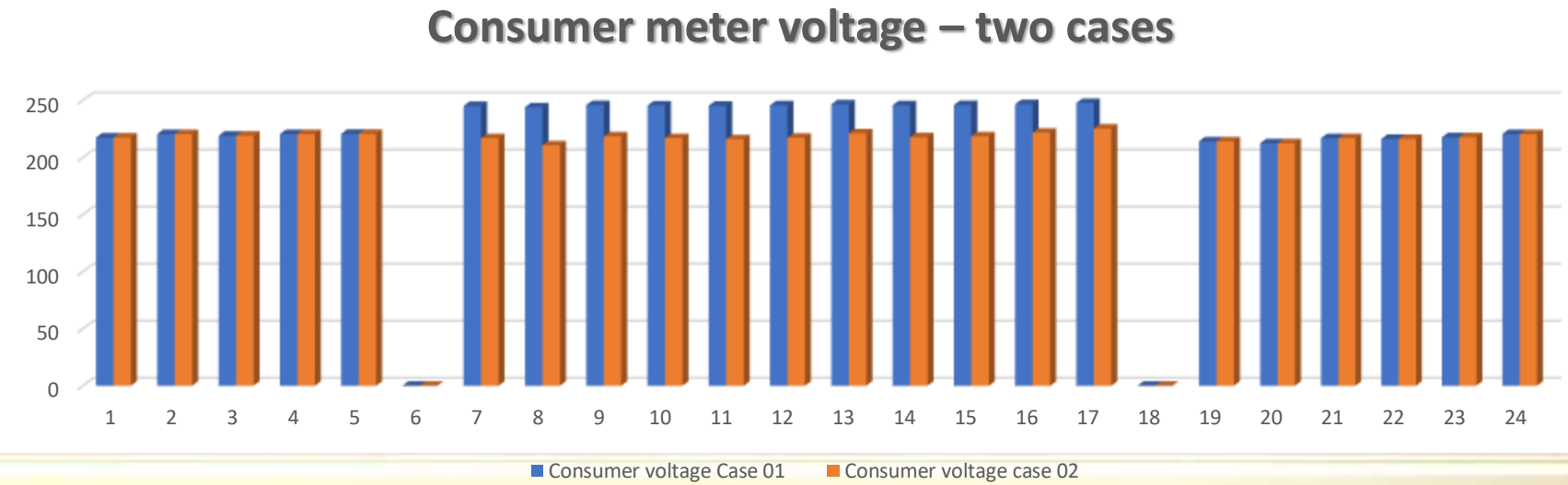
Step -02
Analyse daily energy patterns specially in doubtful assets/area wrt cumulative consumer consumption

Step -03
Find time slot when energy gap is higher than acceptable limit

Step -04
Identify suspicious consumer meters in the identified time period with unacceptable energy gap based on alerts and multiple logics/scoring.

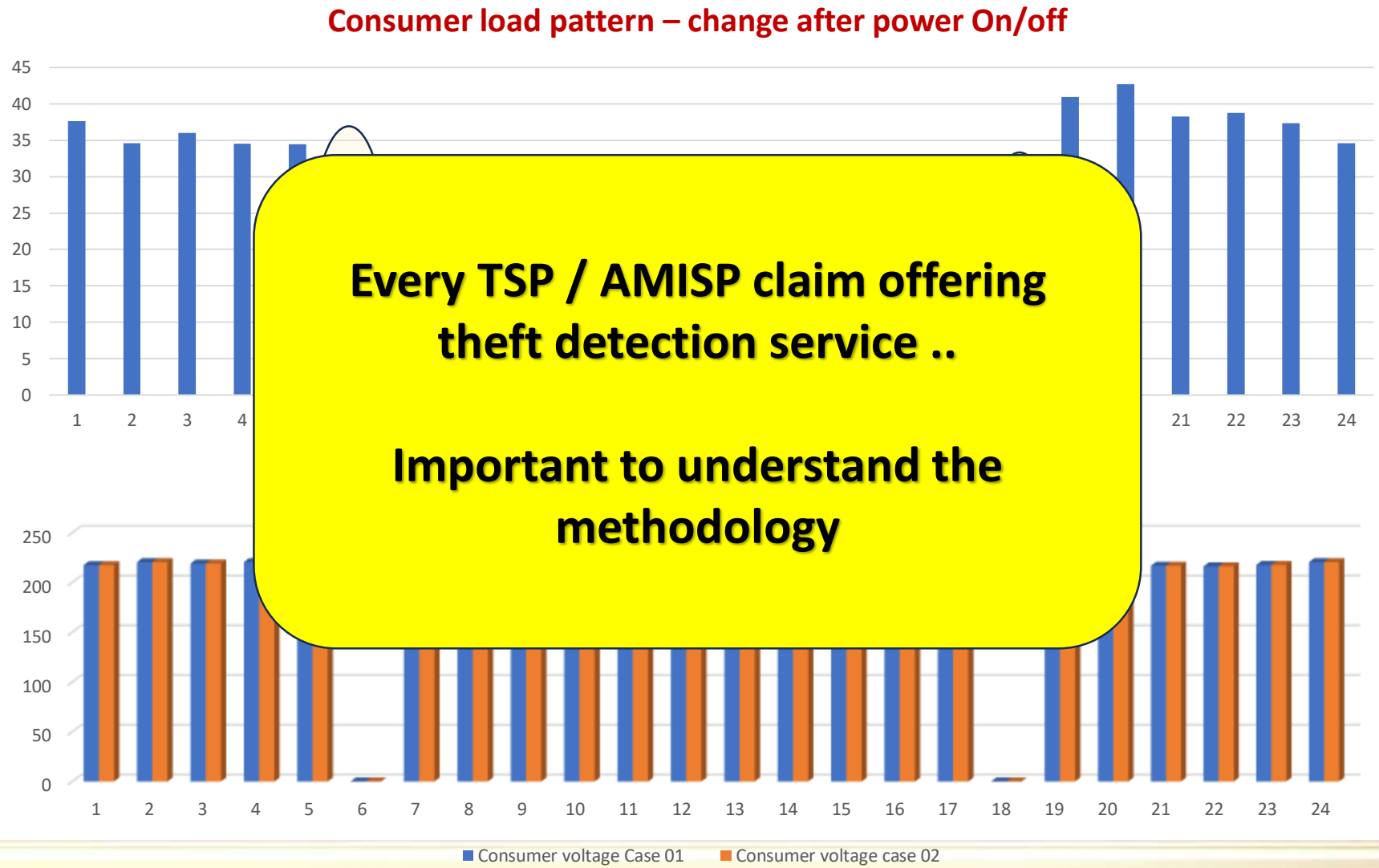
Method 03 Consumer load pattern – impact on voltage





Load and voltage relation

Method 03 Consumer load pattern – impact on voltage



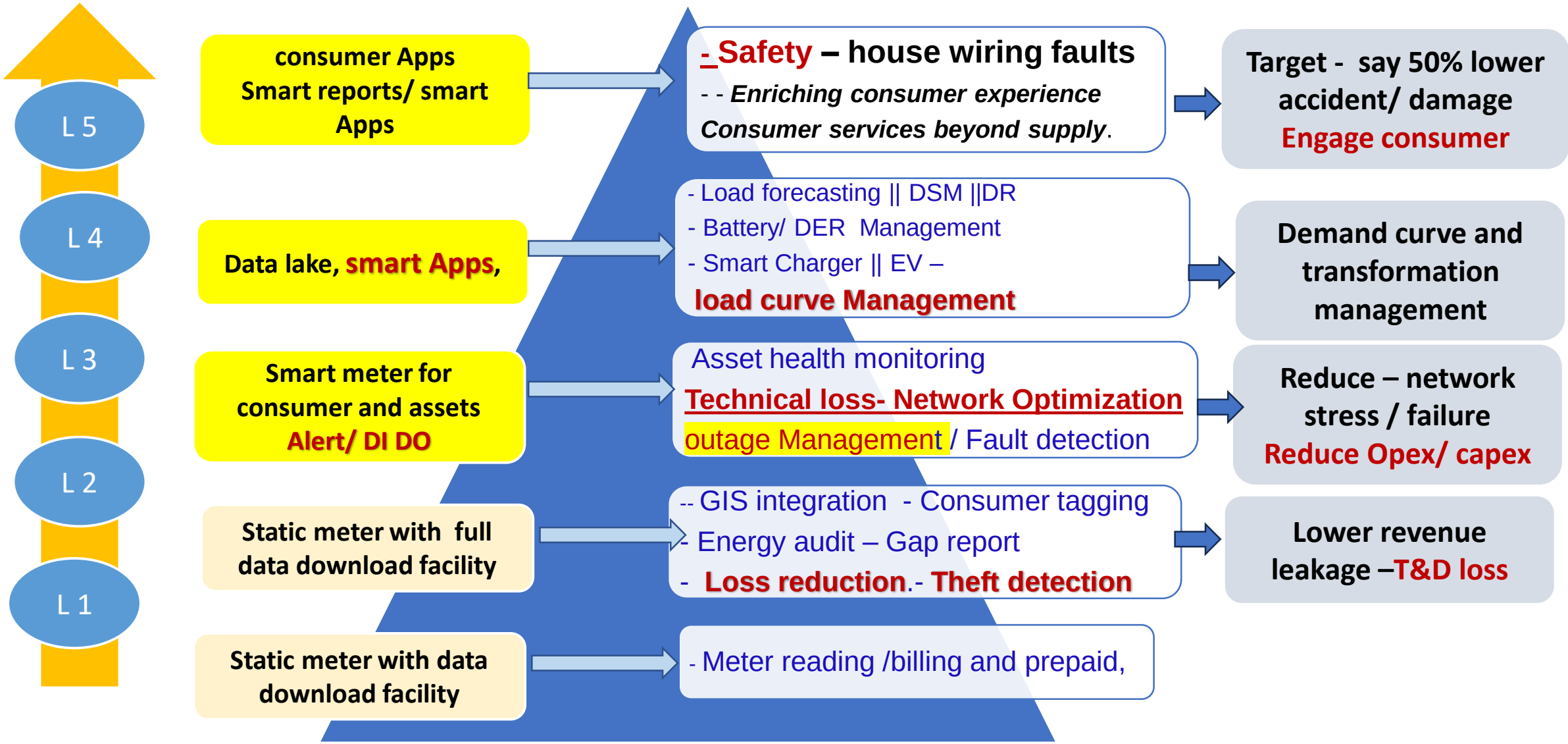
Every TSP / AMISP claim offering theft detection service ..

Important to understand the methodology

Load and voltage relation

Smart Meters …….. Tool empowering endless benefits

Objective Mapping – For Power utility…….



To achieve utility objectives – associated abnormalities to be addressed

Why SMART Metering ……

- **Raising consumer bill is main application for that only billing data is required**
- **Lot of meter data application are based on Historical data , their trend.**
  - Network planning,
  - Theft detection, (up to level)
  - Long term demand planning
  - Planning for preventive and predictive management

- **However for many application and to address uncertainty, one needs current data.**
  - Monitoring & controlling of Actual power usage… calling DR/ Voltage control
  - Outage management … Where is fault, Isolation of area alternate supply.
  - Co-relation of event with any happening…. Energy Gap Vs event in consumer meter.
  - Dynamic tariff ….. Usage of load based on Tariff
  - Correction to improve power quality … smart APFC
  - To detect/minimise accidents and thus damage – Disconnect consumer
  - Monitor breaker operations/ sensor output.
  - Power quality – monitoring and correction

Smart Metering Sy…. Ensuring ROI

Parameter	…pact	Financial impact
Cost of smart meter and meteri… system		To invest more for same billing operation
Technical loss	…elps to	Lower loss and thus gain to utility
Network asset failure	…n loss , lower asset failure	Lower failure lower O&M cost and thus gain to utility
Power Reliability	Lower asset failure , faste… outage management	Lower outages means More power sale opportunity. Happy consumers
Lower asset capacity to peak ratio	Lower Capex	Lower impact of capex on tariff.
Demand curve management	Lower power cost spl during peak	A big saving in terms of investment in Genco.
Enriching consumer experience	Empowering consumer,	Consumer engagement - DR
Revenue leakage protection	smart meter data analytics help in revenue leakage detection	Lower revenue leakage / lower loss
Collection efficiency	Better recovery	Better recovery

Leverage benefits

Key is proper metering system, knowledge about meter data usage and team capacity building

Leverage maximum benefits

Think beyond prepaid/ meter reading and outages messages. You can reduce loss due to system (faulty meter/ meter reader manipulation) but detection theft is crucial

Asset metering is most crucial. Network health report , Energy Audit reports are critical. Make report with defined aim and user. You can have correct Energy Gap report only if have correct GIS/ SLD/ Mapping.

Smart Apps – not just report but Abnormalities detection, finding causes, corrective action and most important Involve field staff and why not consumer. Smart meter – smart Apps – smart report , smart manpower

Consumer notification – build consumer trust / offer flexibility .. Give services related to protection/ safety / high bill analysis / subsidy.

Capacity Building – Only utility engineers understand utility need/ pain & expectation. Need to be trained – Regarding power / capabilities of smart meter, importance of data , objective Vs data vs report vs smart Apps.

Smart metering is high-cost project – unless leverage full benefits – it will adversely affect utility balance sheet. ….
First step maintain voltage

Governance Structure for DISCOMs

HQ Data Analytics Cell

- Standardize reporting formats
- Finalize dashboards for real-time monitoring
- Disseminate actionable insights to field team for action
- Monitor resolution timelines
- Track accuracy of outcomes
- Conduct training programs

Divisional Engineers

- Review, prioritize and fine tune Analytics insights
- Assign field verification
- Escalate non-resolution to HQ
- Ensure timely closure of flagged cases
- Analyze division-level trends and recurring issues
- Provide mentoring/support to sub-divisional teams

Sub-Divisional Engineers

- Validate and fine tune Analytics insights
- Implement corrective actions
- Submit structured feedback to division
- Capture photographic/ digital evidence during field visits
- Maintain records of resolved vs. pending cases

Way forward .....

Involvement

Only utility team can leverage maximum benefits .

100% involvement of all department

Capacity Building

Manpower - Training / more training / Initial Hand holding

Training from domain people

Measurement

Define objective
Define KPI
Define methodology
See impact

Recent training capacity building program……


PEA Thailand


RIyadh SEC

Sabah


Jiddah SEC

TNB Malaysia


MEA Bangkok

THANK YOU

Rajesh Bansal
Mobile +91 9350261602
Email : rajesh.bansal64@gmail.com

Load Balancing

Unbalance Phase loading

Definition

- (Max – min)/ Avg
- (Sq Ir + sq IY + SQ Ib)/ (3 * SQ (Iavg)
- Neutral current value

Causes

- Actual loading
- Fault in wire / unequal capacity
- Phase loading change with time
- Supply voltage highly unbalance,
- fault in meter / MF/ wiring

Parameter	Abnormalities	Notification
(Max – min)/Avg	> 50%*	To field staff
Neutral current	> 25% Of Iavg	Danger > 50%
Computation of Sq	> 8% higher than sq Iavg	
Actually no fix rules – it is continual exercise – pick from top All report are for field team unless loading cross capacity		

1. Actual easiest solution of unbalance is phase rotation and mixing. 2nd action is load transfer.
2. Phase unbalance is more " abnormal" if load is high.. Low load not much impact.

* Based on absolute value of load

Normally taken care in loading report

Limit varies as utility do corrective action

Reports

1. Absolute value as per definition 2. Asset loading on same source/ area 3. Abnormalities 4. Predictive (next 1 yr)

Addressing Un-balance Phase Loading-Step 01

Current / load phase wise month day report of a meter (typically at DT meter level)

day	t1	t2	t3	t4	t5	t6	t7	-----	-----	-----	-----	t19	t20	t21	t22	t23	t24
1																	
2																	
3																	
4																	
5																	
6																	
7																	
8																	

27																	
28																	
29																	
30																	
Avg																	

Prepare this report for all the three phases…. Mark load which is below " no impact level". (if current/load is too low (below impact level) even if unbalance, it has hardly any impact).

Addressing Un-balance Phase Loading-Step 02

Plot each phase in range band based on Current / load value

range	t1	t2	t3	t4	t5	t6	t7	-----	-----	-----	-----	t19	t20	t21	t22	t23	t24
V high	R														R	R	R
high		R	R					R	R				R	R			
avg				R	R	R	R			R	R	R					
	y	y	y	y	y	y	y			y	y	y	y				y
				B	B	B	B			B	B						
low								y	y					y	y	y	
		B	B					B	B			B	B	B	B	B	
V low	B																B

From above one can safely recommend to shift load from R to B

Compute = Iph/Iavg if > 150% the v high, If between 115 ~ 150% then high, if below 50% then v low and if between 85~50% then low. If all 3 phase current below impact value then mark them as avg .. Use phase color to represent phase

Addressing Un-balance Phase Loading-Step 03

Plot each phase in range band based on Current / load value

range	t1	t2	t3	t4	t5	t6	t7	-----	-----	-----	-----	t19	t20	t21	t22	t23	t24
V high	R														R	R	R
high		R	R					R	R				R	R			
avg				R	R	R	R			R	R	R					
	y	y	y	y	y	y	y			y	y	y	y				y
				B	B	B	B			B	B						
low								y	y					y	y	y	
		B	B					B	B			B	B	B	B	B	
V low	B																B

From above one can safely recommend to shift load from R to B

Handling unbalance phase wise loading
Rotate phase sequence of 3ph consumer – shift max to min and maintain sequence

Smart Apps will guide field which consumer meter / service line to be touch and where to shift load.

Handling unbalance phase wise loading
Shift sph consumer from Max load to min load

Addressing Un-balance Phase Loading-Step 04

Plot each phase in range band based on Current / load value

range	t1	t2	t3	t4	t5	t6	t7	-----	-----	-----	-----	t19	t20	t21	t22	t23	t24
V high	R														y	y	b
high		R	R					B	B				R	R			
avg				R	R	R	R	R	R	R	R	R					
	y	B	B	y	y	y	y			y	y	y	y				y
				B	B	B	B			B	B						
low								y	y					y	R	R	
		y										B	B	B	B	B	
V low	B																▮
			y														R

All three phases showing v high and v low . Balancing is complex.

In above case, identify consumer (better 1-ph) whose peak matches with phase peak and shift it on low load phase.

SOP to address Un-balance Phase Loading