Methodology of smart planning of Distribution transformers with Smart Meters Data and Enhancement of life using Active Power Filter

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Introduction

- Methodology for the Optimised Planning of Distribution Transformer based on Smart Meter Data.
- Methods to enhance the efficiency in Planning of Distribution Transformer by eliminating abnormal readings.
- To achieve capex savings.
- Harmonics and high neutral current pose major challenge on distribution transformer's health and can further lead to poor power quality.
- Distribution transformers were analyzed on the basis of high load unbalance and total harmonic distortion (THD).
- Active Power Filter (APF) pre and post installation study done on 630 KVA DT placed at Amba Bagh S/S. It had 7% of load unbalancing and 5% THD.

Context

- Tata Power – DDL has installed 5000 Smart Meters on it's Distribution Transformers for energy audit purpose.
- Each Smart Meter generates lots of data with parameters like V, I, KVA etc. with 30 Min interval which can gives the insight of actual loading and loading patterns of different ratings of transformers.
- Due to uneven loading of distribution transformer, high neutral current is inherent.
- Addition of non-linear loads and PV penetration results in introduction of harmonics in network.
- High neutral current and harmonics lead to –

1. Failure of Transformer HT windings
2. High Neutral to Ground voltage
3. Unwanted heating can lead to Fire Hazards
4. Reduced life of transformer
5. Nuisance tripping of relays
6. Voltage Unbalance
7. Underutilization of transformer
8. Low power factor
9. Neutral failure leading to floating neutral

Relevance

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Improvement of transformer efficency

- Reduction in THD
  - APF injects the harmonic current in the system, same as was present in load
- Load Balancing
  - Injecting negative phase sequence current
- Neutral current reduction
  - Injecting out of phase current in neutral cable

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Active Power Filter (APF)

Problem statement

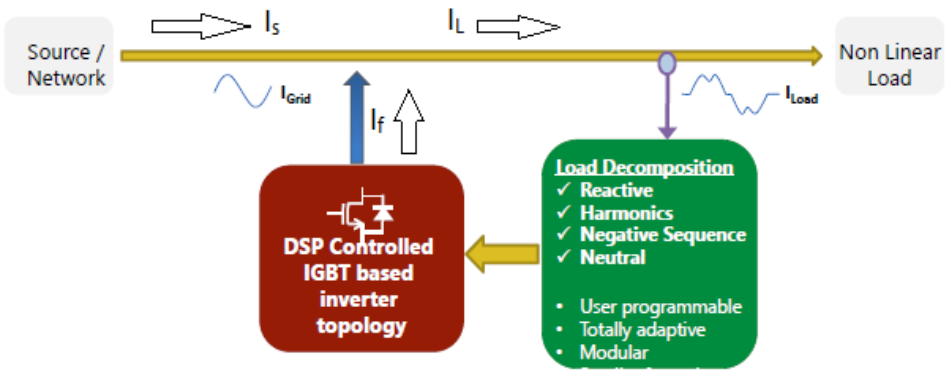
- To study the methods to reduce transformer losses
- To study the methods to improve power factor and reduce neutral current in transformer.
- To determine the impact of integrating renewable energy sources into the grid and its effects on power quality.
- To explore methods to mitigate over heating of DT winding due to 3n harmonics get trapped in delta winding.

Active power filter installed on 630 KVA DT installed at Amba bagh S/S based to mitigate high unbalance in phases.

DT NAME	DT rating (kVA)	Is EAG Data Ok (Y/N)	Peak Load provided by Zone(In Amp.)			
			R	Y	B	N
			A	A	A	A
AMBA BAGH DT-1	630	N	703	657	747	217

Peak DT loading before installation of APF

- Current transformer is installed on each phase and its output is given to APF.
- Microprocessor of APF analyses the current waveforms, and injects feedback current (I_F) in main line to enhance power quality.
- APF can simultaneously correct all current related issues like reactive demand, harmonic distortions, high unbalance, and high neutral.
- The ultra-fast sensing and advanced control algorithm ensures step less correction and instantaneous compensation.



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Here, various platforms

Criteria 1 - Max of IR, IB and IY greater than 50 A and Min of IR,IB and IY less than 10 A.
Criteria 2 - Max of IR, IB and IY greater than 50 A and Percentage unbalance current

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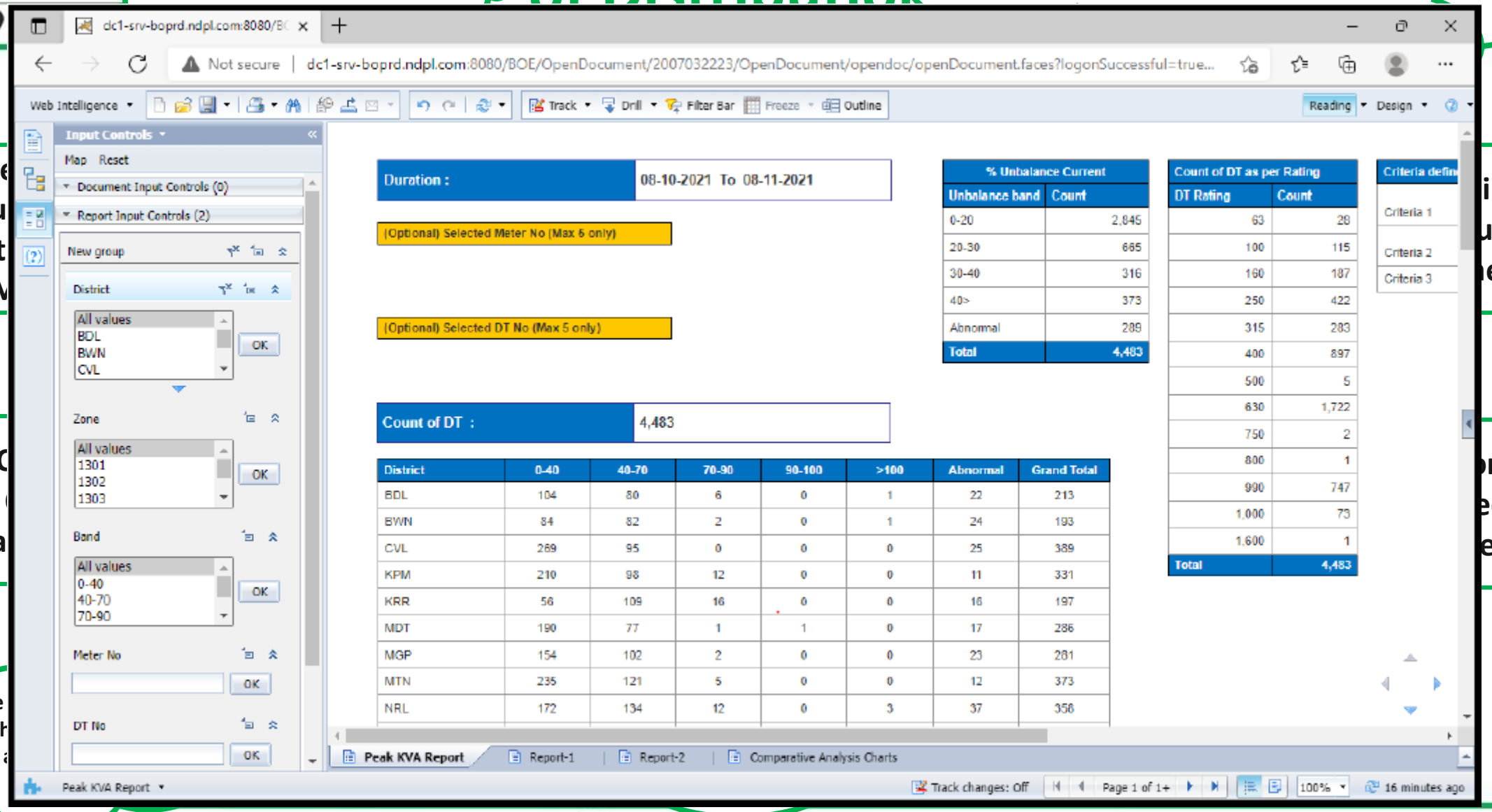

Case Studies-(1/2)

S.No.	Feeder Name	Active filter	Case s	Arms (A)				Aun b	iTHD(%)			Urms (V)			Vrms (V)				vTHD(%)			Power			PF
				R	Y	B	N		R	Y	B	R	Y	B	R	Y	B	N	R	Y	B	kW	kVAr	kVA	Mean
Transformer(630kVA),Active filter-150A(p2p-415-apf4-150)																									
1	Main LT Incomer	OFF	I	393	411	361	74	7	5	5	6	415	416	418	243	237	242	3	1	2	1	276	44	280	0.98
			II	399	379	301	104	9	6	5	8	421	423	424	246	240	245	3	2	2	1	261	31	265	0.98
		ON	I	422	414	409	36	1	3	2	3	419	422	422	245	239	245	4	1	1	1	302	-8	303	1.00
			II	397	388	369	22	3	3	2	5	418	421	421	244	239	244	4	1	1	1	280	-5	280	1.00

Case Studies-(2/2)

Case Study 1 – DT Not Overloaded (Temp. Load Shifting)

Case Study 2 – DT Not Overloaded (Erroneous Data)

Abnormal Reading case : -

Circle	District	Zone No	DT GIS ID	DT code	Substation Name	DT Name	DT rating	MF	2 Hrs Sustained Peak (kVA)	% Loading	Reading Date	Slot
UC	ROHINI	571	23054872	920105	S/S - 5/7	S/S - 5/7 DT-1	990	12	1063	107	24-05-2021	12:00 to 13:30

Analysis : Load curve of this DT was analyzed, it was found that readings were abnormally high on some slots (reading upto 2500 kVA) which is practically not possible. This may possibly be happen due to miss out of decimal in communication. So, Due to these erroneous readings , recorded 2 hrs sustained peak was also on higher side.

Key Takeaways/ Recommendations

- Effective DT planning & analysis based on loading trend and enhanced Asset sweating.
- Maximization of DT utilization factor with swapping of lightly & over loaded DTs.
- Reduction in transformer copper Losses by 4% and Total Harmonic Distortion (THD) reduction by 40%.
- Reduction in tripping and reduced heating of transformer's HT winding due to high neutral current.
- Harmonic impact reduction of Photo voltaic and EV charging station for long term sustenance.
- Improved power factor and capacity utilization of transformer by 2% which can be used to service more connections.
- It is recommended to use active power filters on distribution transformers feeding EV charging stations, industrial loads and areas where PV penetration is high.
- It is recommended to install active power filter in proper ventilated area and conformal coated to be used to protect against dust, chemicals and temperature extremes.

Thank You

For discussions/suggestions/queries email: www.indiasmartgrid.org
www.isgw.in
Links/References (If any)

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