STUDY OF POOR POWER QUALITY IN ZECO DISTRIBUTION SYSTEM

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Abstract

- Electrical power quality has received a significant attention nowadays. The performance of electrical devices is directly linked to the levels of power quality, and as such electrical devices react adversely when exposed to poor power quality.
- Although many efforts have been taken to achieve high power quality, ZECO distribution system (ZDS) is still facing poor power quality.
- In this paper, poor quality issues facing ZDS are investigated and analyzed with their associated contributing factors. Using power quality analyzer, the present type and levels of poor power quality are identified. Finally, some reliable and cost effect solutions to mitigate the problem are proposed.

The Existing ZECO Distribution System

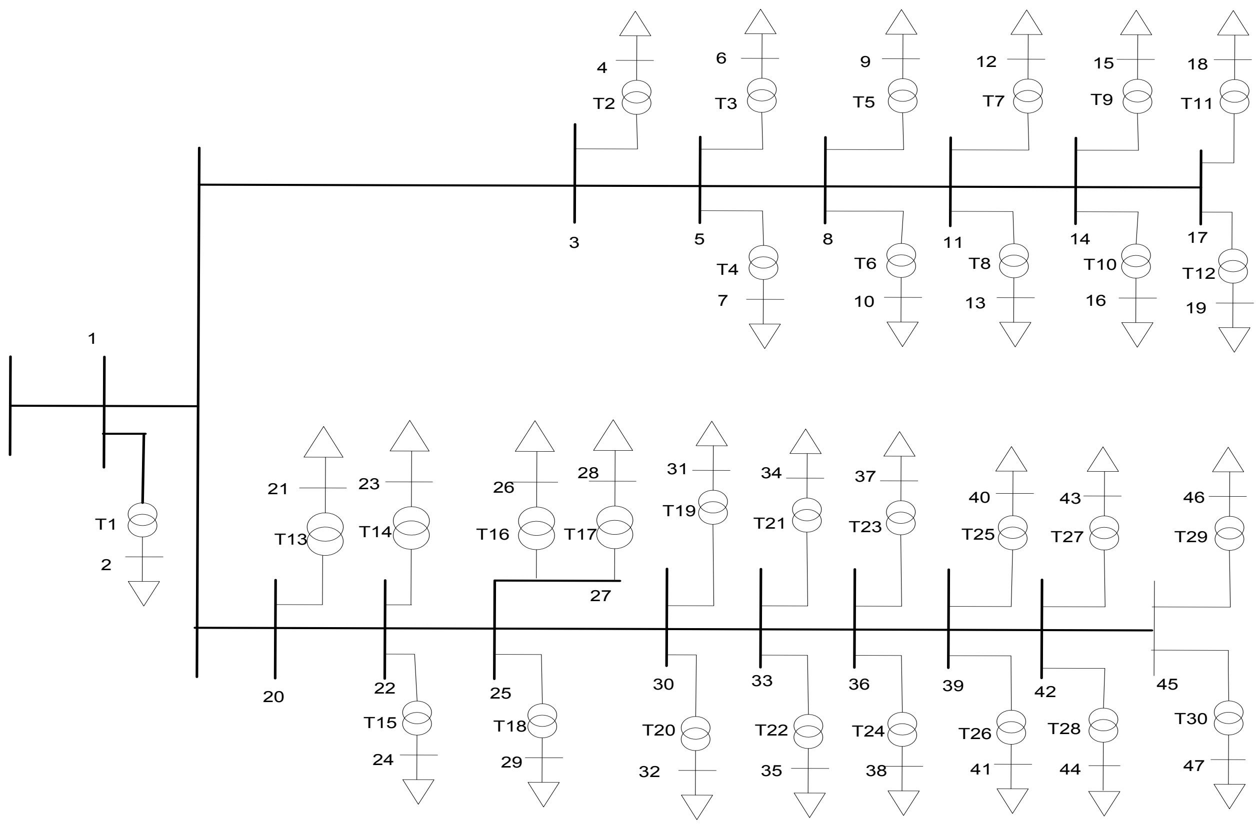

Figure 1: 11 kV North feeder –Pemba island

Problem Statement

- The ZECO Distribution System is Facing the Problem of Poor Power Quality.
- Problems of Overloaded Distribution Transformers and Distribution Lines.
- Problem of Reliability of Electrical Power
- Revenue Loss Due to un-reliable Power Supply to Customers.

Research Objectives

- This paper aimed at Study of Poor Power Quality issues facing ZECO distribution system (ZDS). Specifically,
  - It identifies the present type and level of poor power quality in ZDS.
  - It investigates several factors that contribute to poor power quality in ZDS.
  - It analyzes different mitigation measures for solving the poor power quality problems.
  - Finally, it proposes reliable and cost effect solutions to mitigate the problem.

Research Methodology

- *Case Study:* 11 kV North line of Pemba Island with total distance of 32 km length and consist of 30 substation.
- *Instrument:* The power quality analyzer model 3197 instrument was used to collect the data.
- *Data Collection:* Measuring at the low voltage side (400 V) of distribution transformer.
- *Measurements:* Line voltages, line current, three phase active power, three phase reactive power and power factor.
- *Data Analysis:* Done by the 3197 Data Viewer Software.

Findings/Results

- Voltage imbalance
- Undervoltages
- Voltage Dip
- Transients
- Overloaded Distribution Transformers
- Overloaded Distribution Lines

Voltage Imbalance

- *Observation:* It is observed that voltage variation in a power system ranges between 0.51% to 9.35%.
- *Causes :* Unequal loads on distribution lines and running a single phase line at a long distance.

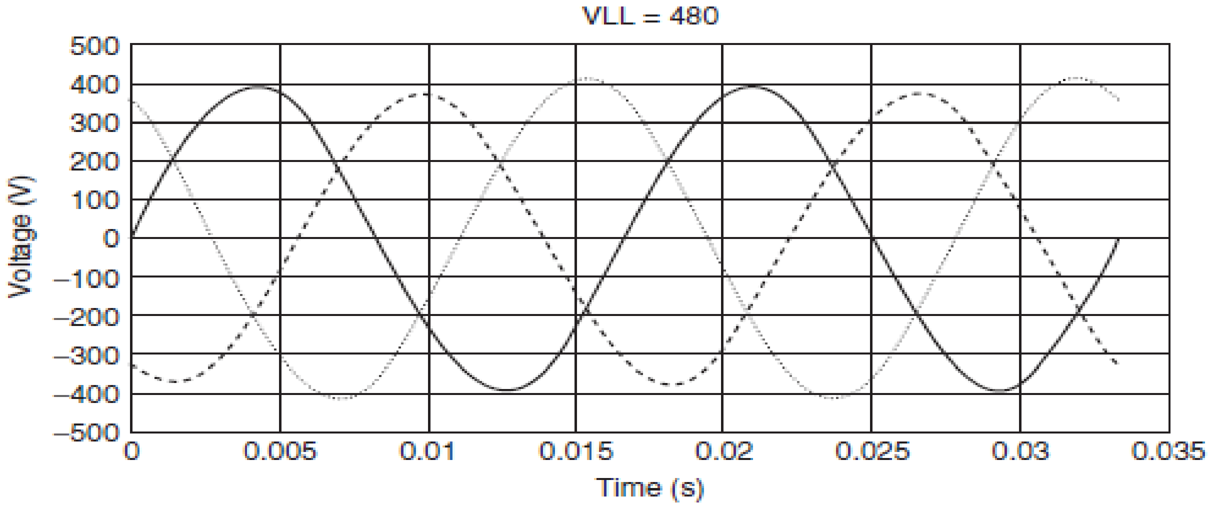

Figure 2: Voltage imbalance wave form

Undervoltages

- *Observation:* The root-mean-square (rms) value deviates at power frequencies for longer than one (1) minute, with the magnitudes range from 78.52% to 90%.
- *Causes:* Heavily loaded circuits that lead to considerable voltage drop.

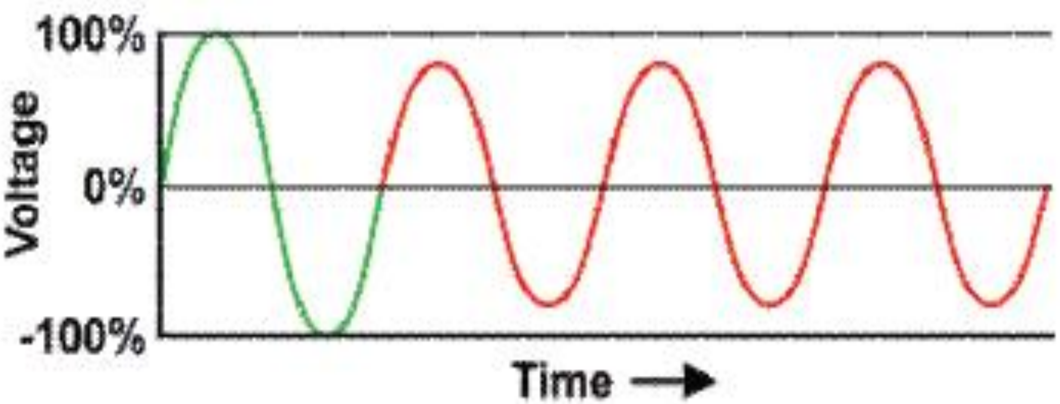

Figure 3: Undervoltage wave form

Voltage Dip

- *Observation:* A voltage *dip* or voltage *sag* observed are from 10 ms to 500 ms with magnitude of 0.25 to 0.89 pu.
- *Causes:* Line to ground fault and accident in power lines such as lightning or falling of trees on the lines.

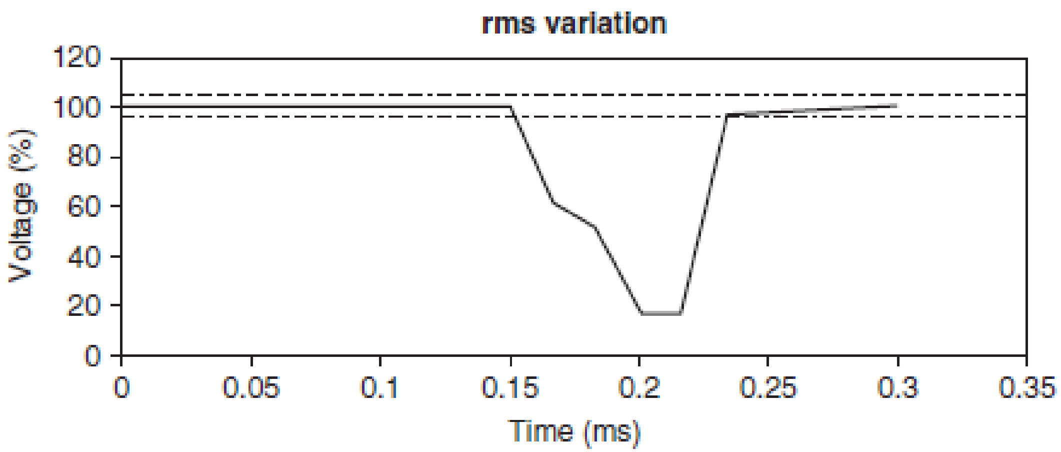

Figure 4: Rms value of sag

Transients

- ***Observation:*** Impulse transient with a duration from 2ms to 895ms.
- ***Causes:*** Lightning.

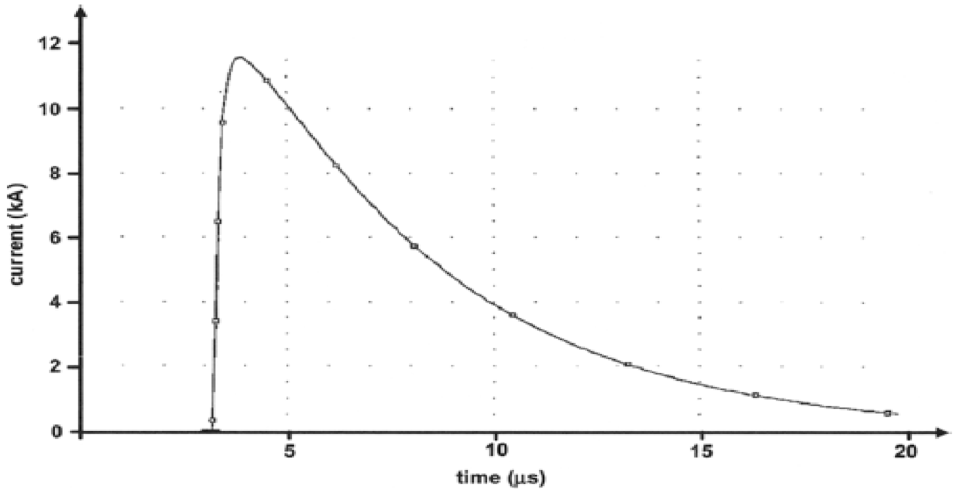

Figure 5: Impulse transient

Overloaded Transformers

Substation	Rating Power (KVA)	Rating current (A)	Load Current (A)	Remarks
Michakaini School	100	139.9	162.0	Overloaded
Machomanne	315	435.2	353.5	Within
Ndugukitu	100	139.9	59.0	Within
Makonyo	200	288	49.7	Within
Mavapacha Wawi	200	288	77.1	Within
Makondeko	100	139.9	149.8	Overloaded
Wawi Mbuni	50	72.2	22.3	Within
Kwasharif Ali	100	139.9	120.8	Within
Ali Khamis camp	100	139.9	49.0	Within
Chuo cha Mafunzo Amali	315	435.2	48.0	Within
Vitongoji Village	100	139.9	174.0	Overloaded
Vitongoji Hospital	50	72.2	32.4	Within
Mkoroshoni ZBC	200	288	160.6	Within
Gombani street	200	288	63.3	Within
Gombani Madina	100	139.9	93.9	Within
Ng'ambwa	50	72.2	75.5	Overloaded
Kwapweza P/S	50	72.2	42.2	Within
Vikunguni	50	72.2	46.2	Within
Kwale Miburani	50	72.2	22.7	Within
Mavungwa	50	72.2	27.2	Within
Ziwani Sokoni	100	139.9	29.9	Within
kisiwani kwa bint Abeid	50	72.2	99.7	Overloaded
Piki village	100	139.9	206.2	Overloaded
Bahanasa	50	72.2	101.5	Overloaded
Bagamoyo Mtabwe	50	72.2	46.5	Within
Sengenya	100	139.9	17.3	Within
Uondwe Zantel	100	139.9	26.8	Within
Uondwe school	50	72.2	150.3	Overloaded
Daya mtambwe	50	72.2	137.0	Overloaded
Makongeni Mtabwe	50	72.2	52.2	Within

Overloaded Transmission Lines

LINE	TYPE OF CONDUCTOR	DIAMETER (mm^2)	RATED CURRENT (A)	LOAD CURRENT (A)	REMARKS
L13	Copper	16	112	124.5	Overloaded
L35	Aluminium	50	178	96.8	Within
L58	Copper	16	112	69.7	Within
L811	Copper	16	112	45.1	Within
L1114	Copper	16	112	36.8	Within
L1417	Copper	16	112	17.3	Within
L120	Copper	25	138	153.2	Overloaded
L2022	Copper	25	138	141.9	Overloaded
L2225	Aluminium	50	178	95.4	Within
L2530	Copper	25	138	83.7	Within
L3033	Copper	25	138	77.9	Within
L3336	Copper	25	138	55.6	Within
L3639	Copper	16	112	23.4	Within
L3942	Aluminium	50	178	20.9	Within
L4245	Aluminium	50	178	11.6	Within

Conclusion and Recommendation

- *Voltage Imbalance:* Transposition of transmission line and distribution lines run with three phases and equal load distribution lines for each phases.
- *Undervoltages:* The use of ferroresonant transformer and voltage regulator.
- *Voltage Dip:* The use of constant voltage transformer, voltage dip compensators and dynamic sag compensator.
- *Transients:* The use of surge arrestor, filters and isolation transformer.
- *Overloaded Transformers:* Replacing with higher rating Transformer.
- *Overloaded Transmission Lines:* Replaced with higher rating capacity conductor.

Proposed Transformer to be Replaced with Higher Rating Capacity

	EXISTING			PROPOSED	
Substation	Rating Power(KVA)	Rating current(A)	Measured current (A)	Rating Power(KVA)	Rating current(A)
Michakaini School	100	139.9	162	200	288
Makondeko	100	139.9	149.7	200	288
Vitongoji Village	100	139.9	174	200	288
Ng’ambwa	50	72.2	75.5	100	139.9
kisiwani kwa bint Abeid	50	72.2	99.7	100	139.9
Piki village	100	139.9	206.2	200	288
Bahanasa	50	72.2	101.5	100	139.9
Uondwe school	50	72.2	150.2	100	139.9
Daya mtambwe	50	72.2	137	100	139.9

Proposed Line Conductors to be Replaced

	EXISTING CONDUCTOR				PROPOSD CONDUCTOR		
LINE	TYPE OF CONDUCTOR	DIAMETER (mm²)	RATED CURRENT (A)	LOAD CURRENT (A)	TYPE OF CONDUCTOR	DIAMETER (mm²)	RATED CURRENT (A)
L13	Copper	16	112	124.5	Aluminium(ACSR)	50	178
L35	Aluminium	50	178	96.8	same		
L58	Copper	16	112	69.7	same		
L811	Copper	16	112	45.1	same		
L1114	Copper	16	112	36.8	same		
L1417	Copper	16	112	17.3	same		
L120	Copper	25	138	153.2	Aluminium(ACSR)	100	271
L2022	Copper	25	138	141.9	Aluminium(ACSR)	100	271
L2225	Aluminium	50	178	95.4	same		
L2530	Copper	25	138	83.7	same		
L3033	Copper	25	138	77.9	same		
L3336	Copper	25	138	55.6	same		
L3639	Copper	16	112	23.4	same		
L3942	Aluminium	50	178	20.9	same		
L4245	Aluminium	50	178	11.6	same		

Lastly

- By Improving power Quality Reliability can be increased , hence more production/Revenue collections.

Thank you for listening