Influence of Harmonics on Medium Voltage Distribution System: A Case Study for Residential Area

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- The influence of harmonics on medium voltage distribution system of Bogazici Electricity Distribution Inc. (BEDAS) which takes place at Istanbul/TURKEY is investigated.

- A ring network consisting of residential loads is taken into account.

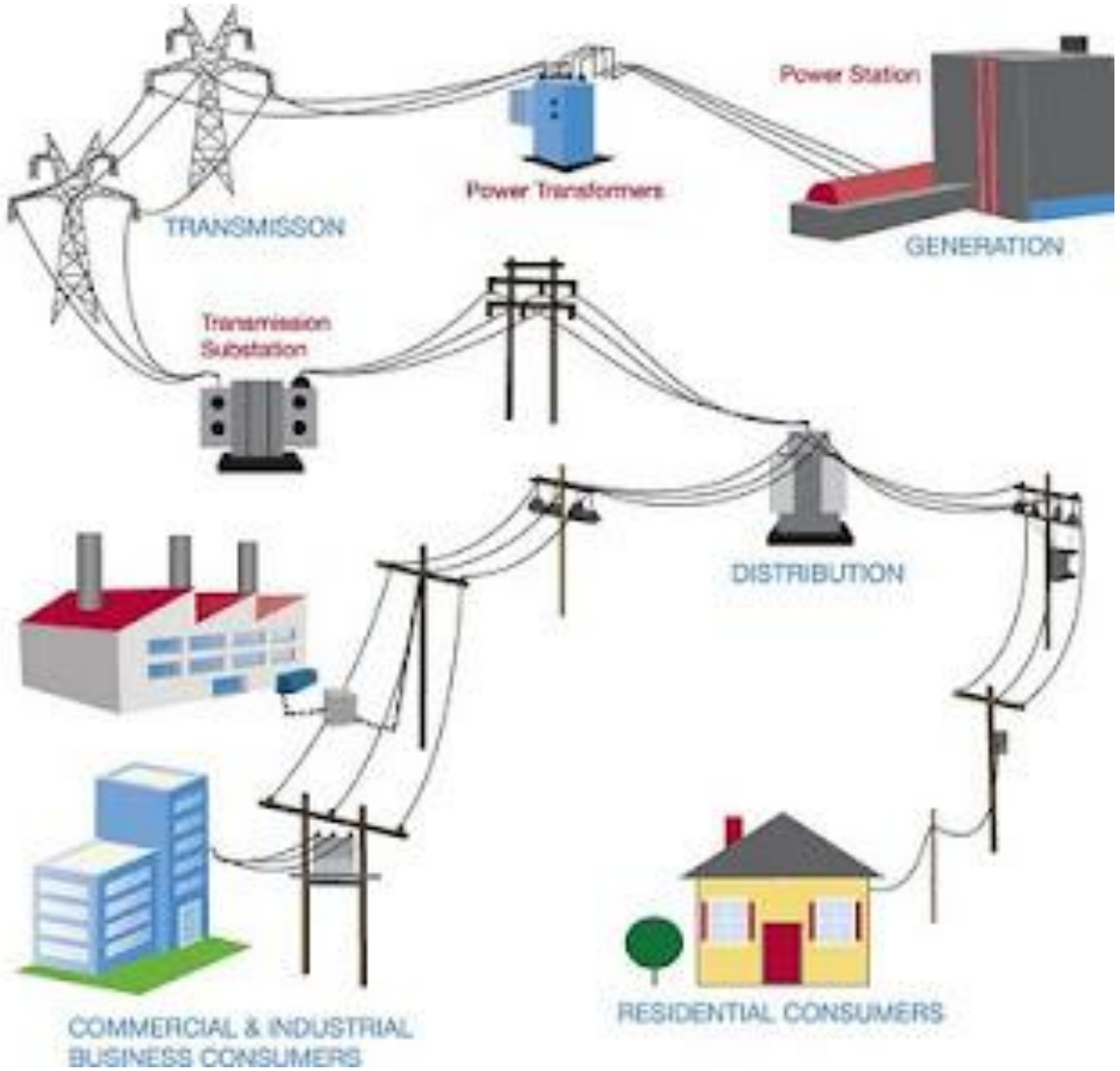
- Real system parameters and measurement results are used for simulations.

- The simulations are realized by using CYME Power Engineering Software.

LOSS CALCULATION PROJECT

"Methodology and Software Development For Determining The Most Real-like Technical Lost Levels Dynamically in Distribution Networks“

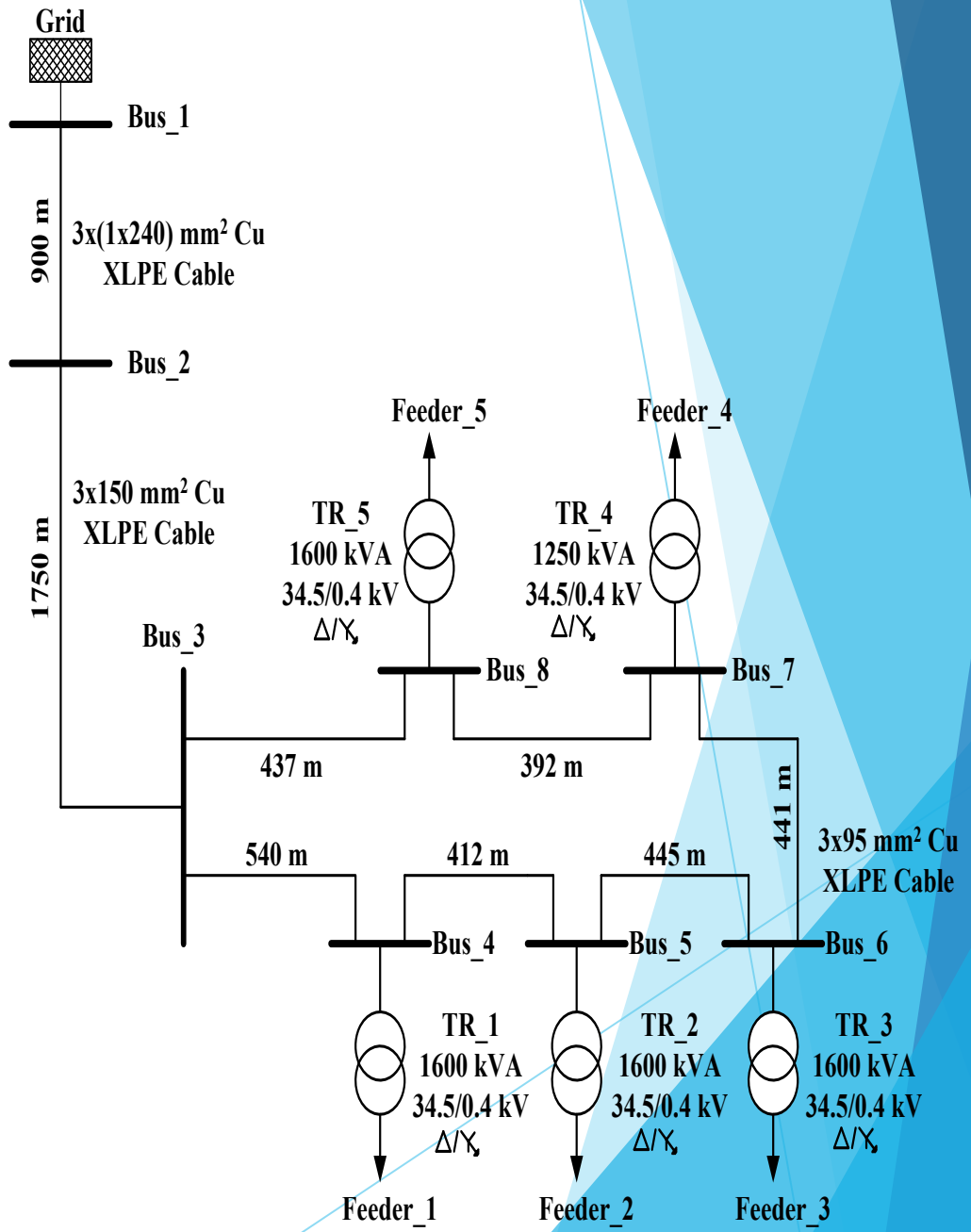
Supported by “Energy Market Regulatory Authority (EPDK)”



- Electric power distribution system losses are classified into two groups: technical losses and non-technical losses.
- Technical losses occur due to energy transfer. The main sources of them can be described as line conductor losses and transformer no-load and load losses.
- The general causes of non-technical losses are electricity theft, metering problems, problems of billing and collection, loose connections, etc…

SYSTEM DESCRIPTION

- There are 8 buses, 5 transformer substation, 5 feeder and 3 type of underground cable system is placed at the investigated part of distribution system.
- Characteristic parameters of transformers, lines and measured feeder loads are given in Table I, Table II and Table III respectively.
- Residential loads with more or less same characteristics are connected to the feeders



Characteristic parameters of system components

Table I CHARACTERISTICS OF TRANSFORMERS

Transformer No	Nominal Power (kVA)	Voltage Level (kV)	No Load Losses (kW)
TR_1	1600	34.5/0.4	2.8
TR_2	1600	34.5/0.4	2.8
TR_3	1600	34.5/0.4	2.8
TR_4	1250	34.5/0.4	2.25
TR_5	1600	34.5/0.4	2.8

Table II CHARACTERISTICS OF LINES

Cable Type	Ampacity (A)	R (Ω/km)	X (Ω/km)
3x(1x240 mm^2)	510	0.099	0.1277
3x150 mm^2	400	0.1658	0.2435
3x95 mm^2	335	0.2529	0.1484

Table III LOADS OF FEEDERS

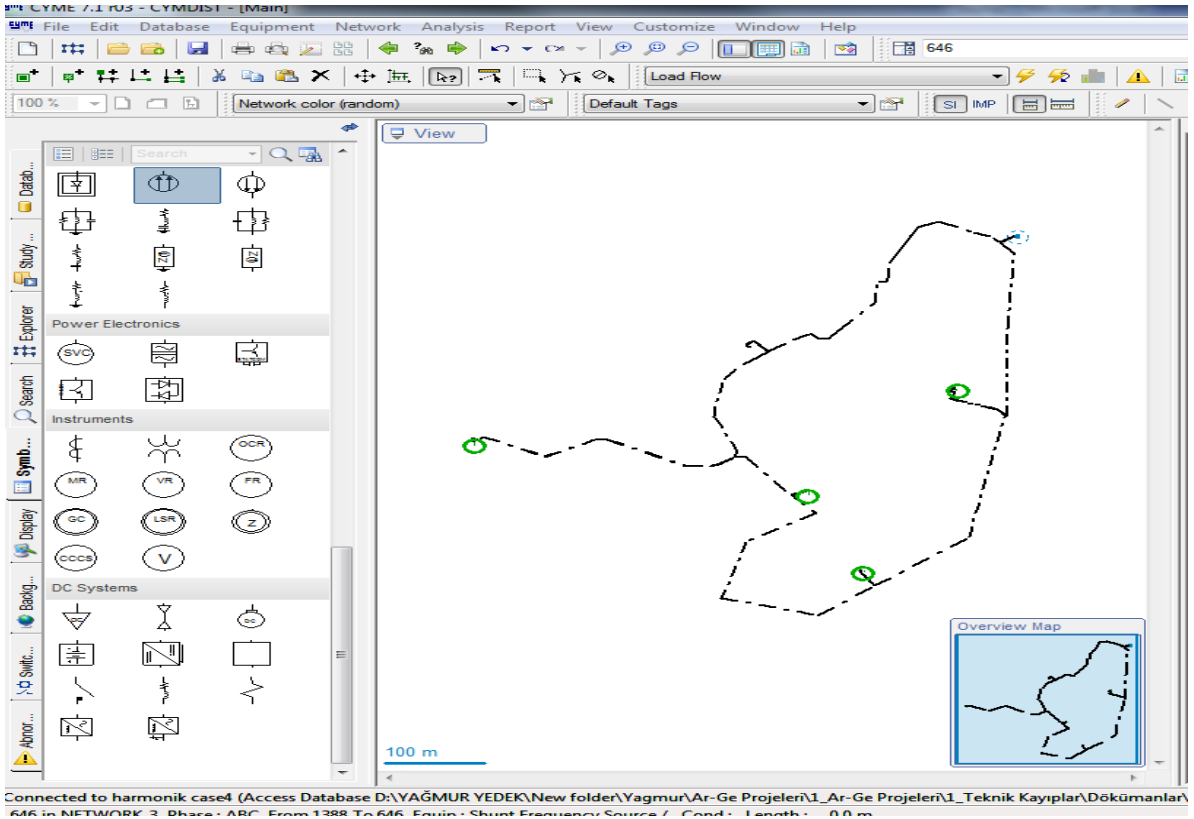
Feeder No	Load (kW)
Feeder 1	908
Feeder 2	853
Feeder 3	708
Feeder 4	518
Feeder 5	652

Measurement results of harmonic contents

Harmonic Order (n)	$\%HD_I$	Harmonic Order (n)	$\%HD_I$	Harmonic Order (n)	$\%HD_I$
2	2.74	12	0.25	22	0.35
3	38.55	13	4.23	23	2.44
4	1.20	14	0.00	24	0.25
5	25.25	15	3.69	25	1.99
6	0.35	16	0.25	26	0.25
7	21.22	17	3.24	27	1.05
8	0.45	18	0.25	28	0.35
9	17.28	9	1.89	29	1.29
10	1.05	20	0.00	30	1.29
11	8.96	21	2.44	31	2.69
$\%THD_I$			**50.5**		

Modelling and simulation

- The studies are realized by using CYME Power Engineering Software.



Demonstration of the simulation program

Case studies

- Case 1: Real system parameters, loading conditions and measured values are considered.
- Case 2: It is assumed that transformers loading rates are %50 of their nominal power.
- Case 3: It is assumed that transformers loading rates are %75 of their nominal power.
- Case 4: It is assumed that transformers loading rates are %100 of their nominal power.

Results

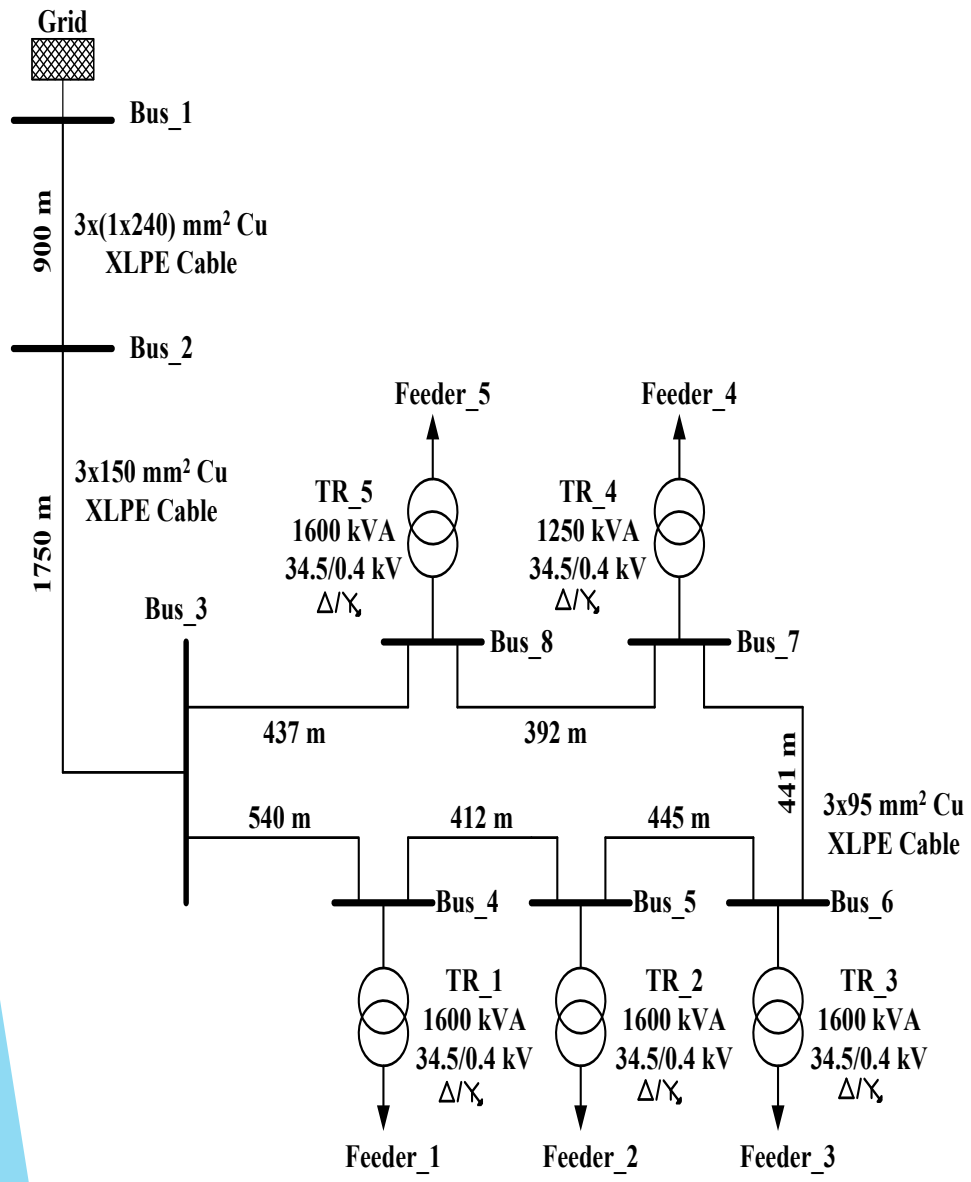


TABLE V
THD LEVELS OF THE BUSES

BUS NO	%THD_V			
	CASE 1	CASE 2	CASE 3	CASE4
BUS 1	1.50	1.03	1.43	1.75
BUS 2	1.59	1.57	2.17	2.66
BUS 3	2.53	2.50	3.46	4.24
BUS 4	2.80	2.79	3.85	4.72
BUS 5	2.96	2.95	4.08	5.00
BUS 6	3.09	3.06	4.23	5.19
BUS 7	3.16	3.11	4.30	5.27
BUS 8	2.61	2.56	3.54	4.34

TABLE VI
POWER FACTOR VALUES OF THE BUSES

BUS NO	POWER FACTOR (% P.F.)							
	CASE 1		CASE 2		CASE 3		CASE4	
	A	B	A	B	A	B	A	B
BUS 1	92.01	91.98	92.33	92.30	90.61	90.59	89.40	89.38
BUS 2	91.19	91.16	91.47	91.44	90.02	90.00	88.95	88.93
BUS 3	90.66	90.63	90.92	90.88	89.67	89.65	88.71	88.70
BUS 4	90.43	90.40	90.54	90.51	89.41	89.39	88.51	88.50
BUS 5	90.36	90.33	90.58	90.55	89.44	89.42	88.54	88.52
BUS 6	89.99	89.96	90.61	90.57	89.46	89.43	88.55	88.53
BUS 7	89.51	89.48	90.73	90.69	89.54	89.51	88.61	88.59
BUS 8	88.64	88.62	88.96	88.94	88.35	88.33	87.72	87.70

Results

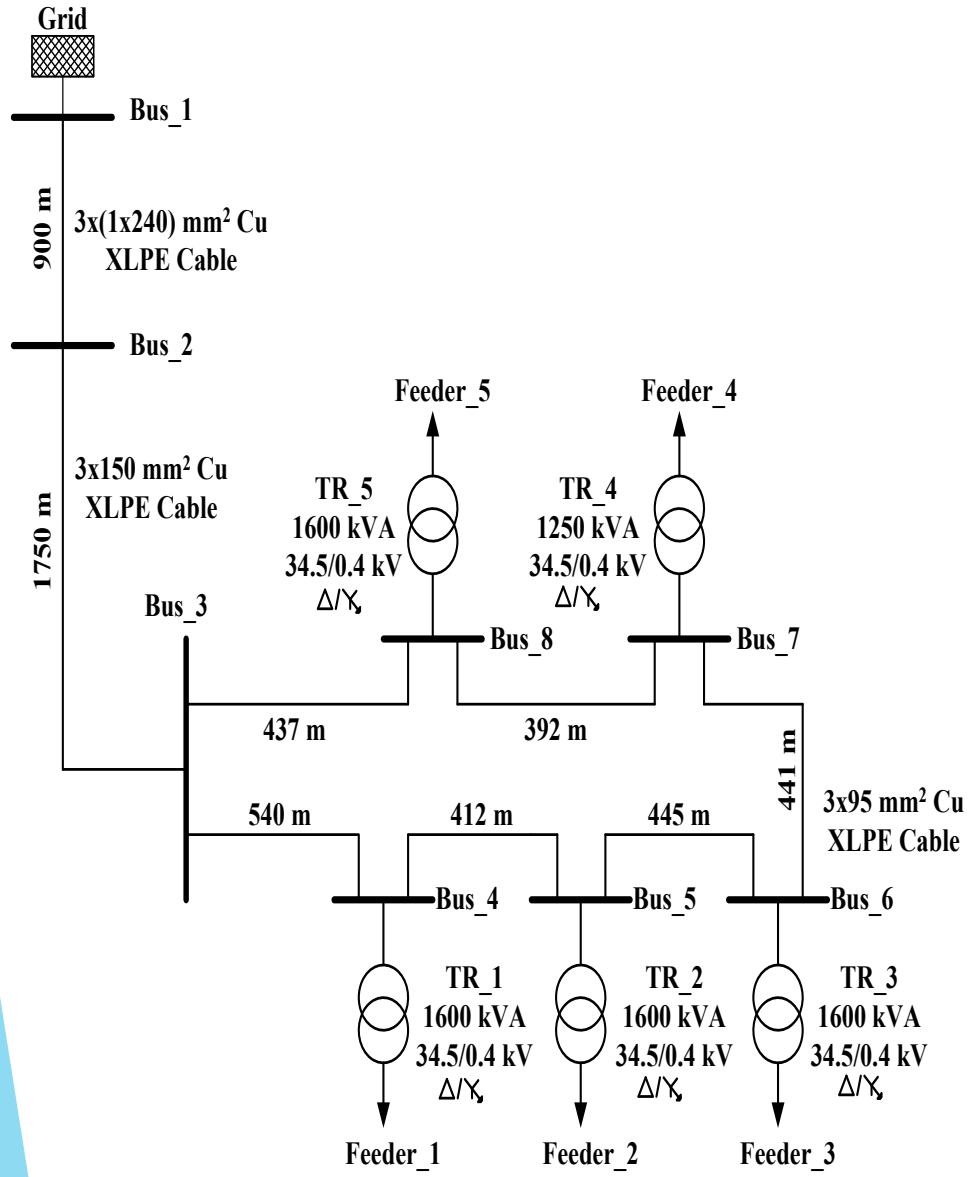


TABLE VII
TOTAL TRANSFORMER LOSSES

CASE NO		TRANSFORMER LOSSES (kW)				
		TR_1	TR_2	TR_3	TR_4	TR_5
CASE 1	A	6.40	5.05	7.06	10.19	9.90
	B	7.30	5.75	8.39	12.69	12.11
CASE 2	A	7.21	7.21	7.21	5.62	7.21
	B	7.48	8.61	8.61	6.69	8.60
CASE 3	A	12.96	12.97	12.97	10.03	12.96
	B	13.58	16.22	16.22	12.52	16.20
CASE 4	A	21.31	21.33	21.34	16.43	21.29
	B	22.45	27.33	27.34	21.05	27.27

TABLE VIII
DISTRIBUTION SYSTEM LOSS

CONDITION NO	TOTAL LOSSES (kW)			
	CASE 1	CASE 2	CASE 3	CASE 4
A	45.87	40.92	76.91	129.19
B	54.07	46.97	90.70	152.93
Loss increase	%17,87	%14,78	%17,93	%18,37

Conclusion

- $\%THD_V$ value of the busses are increasing according to the rising of the loading rate,
- $\%THD_V$ of the buses are decreasing when the bus is away from the nonlinear loads,
- The harmonic components and increase of loading rate are reducing the P.F.,
- The transformer losses and total system losses are increasing due to the loading rate and harmonic component content.

QUESTIONS…????

THANKS….

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