

Original Research Paper

# An Overview of Energy Loss Reduction (ELR) Software Used in Pakistan by WAPDA for Calculating Transformer Overloading, Line Losses and Energy Losses

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## Article history

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**Abstract:** This paper is about the use of ELR software for different analysis on distribution system up-gradation. It can be used in low budget countries in which distribution system is already overload and it is too much costly to replace the whole structure to overcome overloading. So this software helps in providing information to upgrade the whole system or to upgrade some components of distribution system and meet the consumer demands.

**Keywords:** Upgradation, LT-Analysis, HT-Analysis, ELR, WAPDA, Overloading of Transformer

## Introduction

This Electricity is the basic need of life and its demand is increasing day by day with the advancement in technology. As a result the load or demand on the power system also increase. For load calculation of an area different types of analysis techniques are used in different countries.

[http://en.wikipedia.org/wiki/Water\\_and\\_Power\\_Development\\_Authority\\_Pakistan](http://en.wikipedia.org/wiki/Water_and_Power_Development_Authority_Pakistan) the Water and Power Development Authority (WAPDA) is a public utility and is government-owned maintaining water and power but WAPDA does not supervise thermal power. WAPDA includes Mangla and Tarbela dams among its resources. Its headquarters is in Lahore.

## Problem Statement

This To become familiar with the use of ELR software and how it can be used for finding different parameters like transformer overloading, line losses, transformation losses, power losses and total annual energy losses in High tension lines and Low tension lines.

## Literature Review

There is a reason to look for improvement, changes and losses reduction in the current LT infrastructure distribution systems. This has been suggested in various reference analysis (Lanka, 2010; Corporation, 2011; ETSA, 2011; JENDS, 2011) on this matter that how the existing structure could handle maximum load in the future (ETSA, 2011). Future (non-committed) large customer connections, where the customer maximum demand increase exceeds the forecasted annual load

growth of the relevant network asset, are not included in the plan. The planning criteria used to develop the distribution capacity plan are designed to meet the Electricity Distribution Code and maintain historical levels of network performance (JENDS, 2011). General examples of augmentation works, which may be necessary to meet increasing demand on Jemena's electricity network and alleviate network inadequacies and constraints:-

Re-conductor overhead power lines (sub-transmission and/or HV distribution) with larger conductors; Establish new sub-transmission lines and rearrange existing sub-transmission loops; Establish new high voltage distribution feeders; Add transformers to existing zone substations; Establish new zone substations; Installation of capacitors and reactors; and Installation of line voltage regulators (Corporation, 2011). The licensed electrician only proceeds with the customer's wiring installation after receiving approval stamped on the above mentioned drawings for construction (Lanka, 2010). The Project will reduce distribution losses by (i) reconfiguring electrical equipment through optimization of its location and size, (ii) reconductoring or replacing old low and medium-voltage overhead distribution lines, (iii) replacing overloaded low- and medium voltage transformers with new transformers of appropriate specifications (ETSA, 2011). Nowadays the need for more flexible electric systems, the changing in the regulatory and economic scenarios, the importance of harnessing energy savings and minimizing environmental impacts have been providing the impetus for the development of Distributed Generation (DG). For these reasons, DG is predicted to play an increasing role into the electric power system of the near future.

## Introduction to ELR Software

ELR means Energy Loss Reduction. It is used by Water and Power Development Authority (WAPDA). It can be used for the analysis of following results:

- Line losses
- High tension analysis
- System parameters
- Low tension analysis
- Transformation loss
- % power losses
- Annual Energy losses
- % Annual energy losses
- Transformer loading

In High Tension analysis we do analysis for a single feeder i.e., transmission line from substation to distribution transformer. In this analysis we put all the nodes data, distance between two nodes and the transformer installed at each node. Node is actually pole on which transformer is installed and distance between two nodes is the distance between two poles.

In Low Tension analysis we do analysis for the transmission line between distribution transformer and

consumer. In this analysis we put the data of each node (distance between two poles), 3 phase consumer and single phase consumer at each node, conductor size or used between two poles and other required data. ELR is actually used to find the loading of transformer, line losses and system parameters. When we do Low tension analysis the end result displayed shows us how much the transformer is over load, line losses, transformation losses, power losses and total annual energy losses.

## Use of ELR Software

This software runs on Windows Xp as it is 32 Bit software and it is in dos mode. To use this software we do the following step. Here we do analysis for Low tension.

It involves the following step to run it.

First of all consider an Area or a street for which we want to do analysis. Here we select one of the Gulbhar Colony Peshawar street. We draw its single line diagram in which all the points are shown i.e., distance between nodes, conductor size and consumer at each node and transformer location. Figure 1 shows single line diagram. Clear diagram refer annexure 1. This is the single line diagram of a street in which shows the location of transformer, consumer at each pole, length between two poles and conductor size between poles.

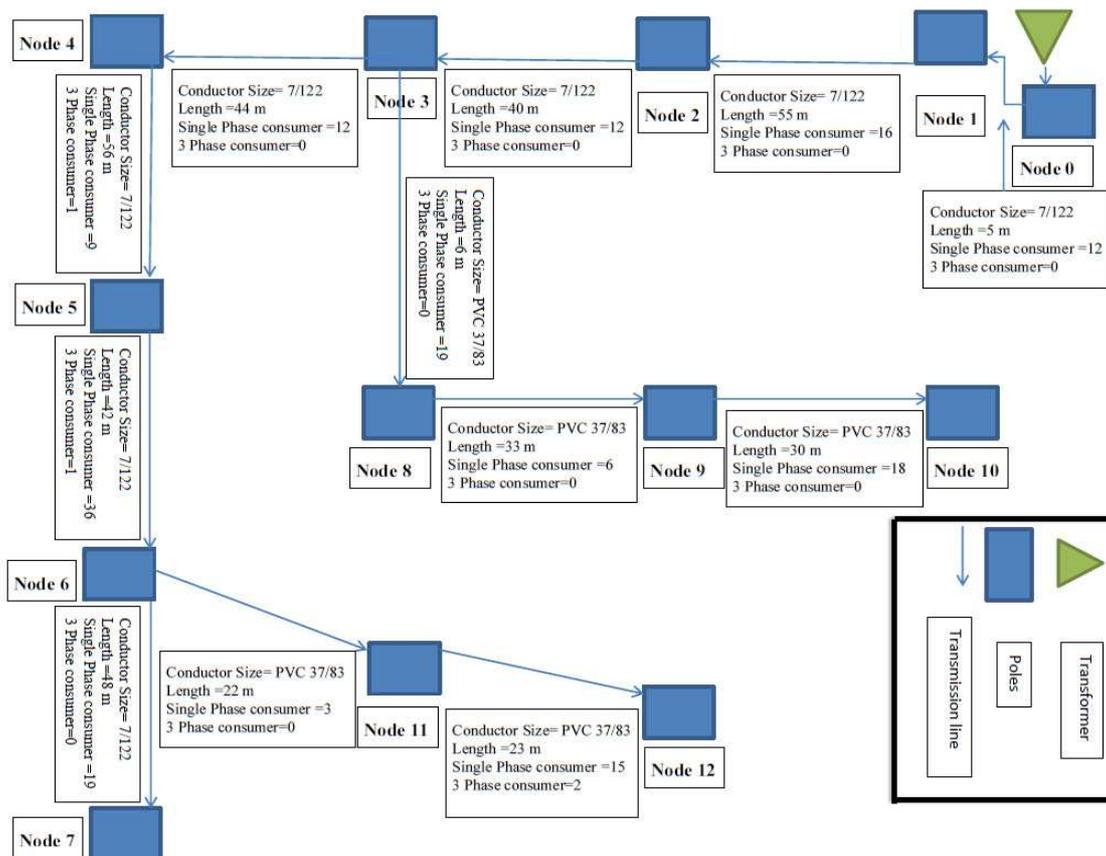


Fig. 1. Single line diagram

When we run ELR this windows appears. Here we are asked which analysis we want to do i.e., High Tension Analysis, Low Tension Analysis, System Parameters, Print Result and Data Conversion. Let suppose we can to do analysis for Low Tension Analysis.

We create a new file with any name. After naming it a new window opens at top of which distance in meter or kilometer is mention let we select distance in meter. Then we are asked load per single customer here we select 2 KVA load per single phase customer (WAPDA standards).

Then we start to put data starting from node 0 to node 1 and put its distance in meter, single phase consumers, 3 phase consumer and which conductor size. As shown in Fig. 2.

After putting all the nodes data press F to finish the analysis and if there are more nodes press M to add more nodes data. If some data is entered incorrectly so by pressing E we can edit it.

After pressing F to finish analysis a new window opens in which the following things are asked define spot loads, install existing capacitors and proceed for analysis.

If we press define spot loads, a new window opens in which we can change voltages, load current and power factor at any node as shown in Fig. 3.

If we press install capacitors a new window opens in which we can enter capacitors of any rating at any node as shown in Fig. 4. If we want to add more capacitor enter Y else enter N.

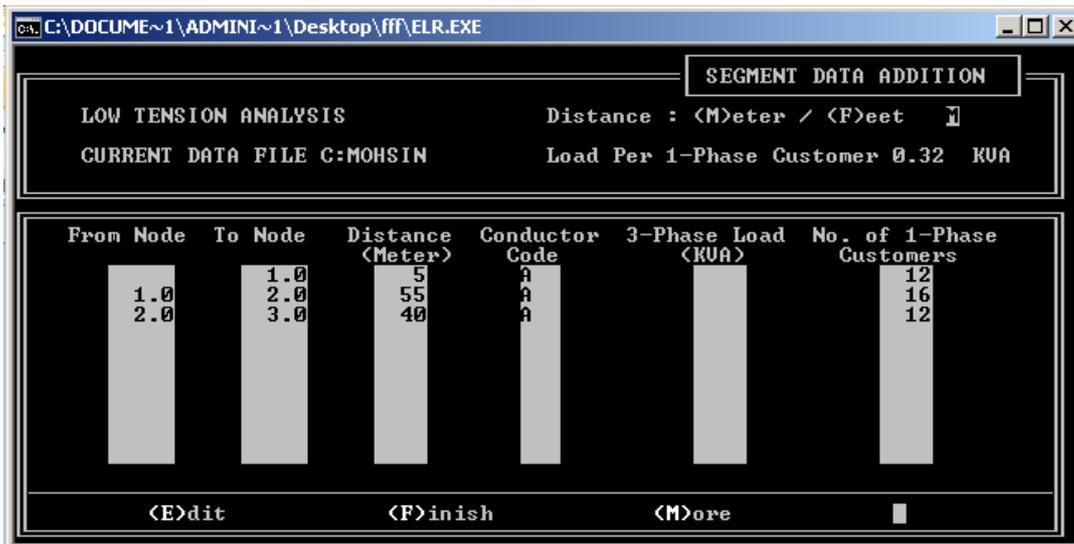


Fig. 2. Entered node data

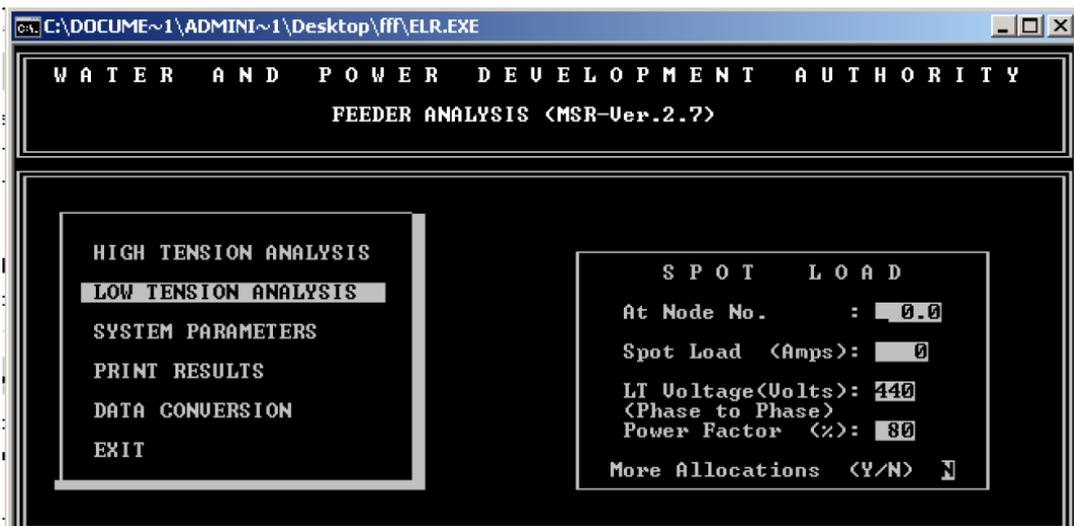


Fig. 3. Spot loads

We want to display results so we enter proceed for analysis, here a new window opens in which some parameters are asked like transformer capacity in KVA (that transformer which is already installed in the street here 100 KVA), proposed transformer capacity (in case if the installed transformer is over load and we want to check overloading of transformer with some high rating suppose 200 KVA), load per single phase customer (2 KVA), current in ampere (180 amp,  $\{I = KVA/(1.732*400)\}$ ), LT voltage (400 v), Power Factor (assume 85%), Load factor (assume 60%) as shown in Fig. 5.

Entering all these required values an option comes that if we want to study it with growth or not. If we pres Y then up to 5 years we can do analysis and the results which will be displayed will show transformer overloading , line losses, transformation losses, power losses and total annual energy losses after 5 years. But if N is entered then result will be displayed for current

situation. Then do you wish to install new capacitor or not if Y is entered then it will ask at which node you want to install the capacitors. It will show that nodes on which voltage drop is high.

After doing all this results will be displayed. As shown in Fig. 6a-c.

In this software we can also do analysis for upcoming five years. In this case the following parameters changes per year at rate of Annual load growth factor 5%, Annual load rates 12%. Final results are shown in Fig. 7.

So we conclude the following results:

- Existing transformer rating =100 KVA
- Loading of existing transformer at present =118%
- Loading of existing transformer after 5 years =151%

Energy loses, power loses and line loses has also been increased. Table 1 shows the final results.

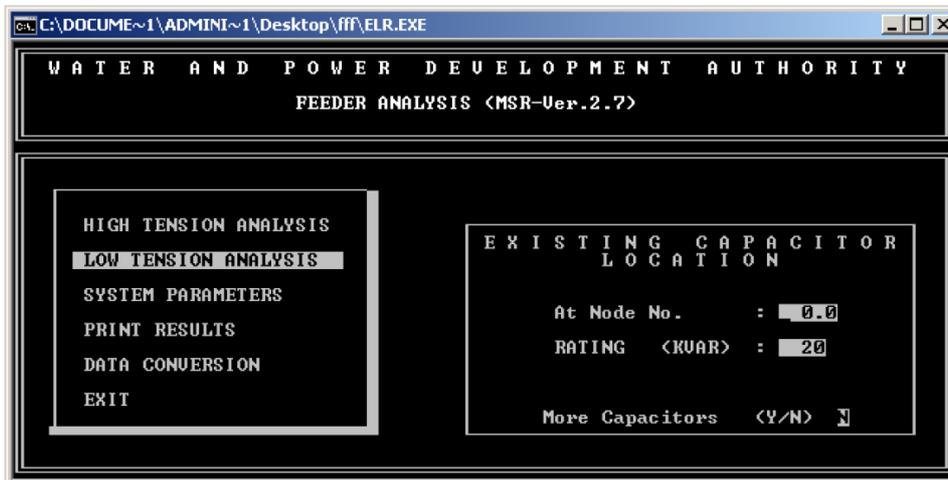


Fig. 4. Adding capacitor at any location

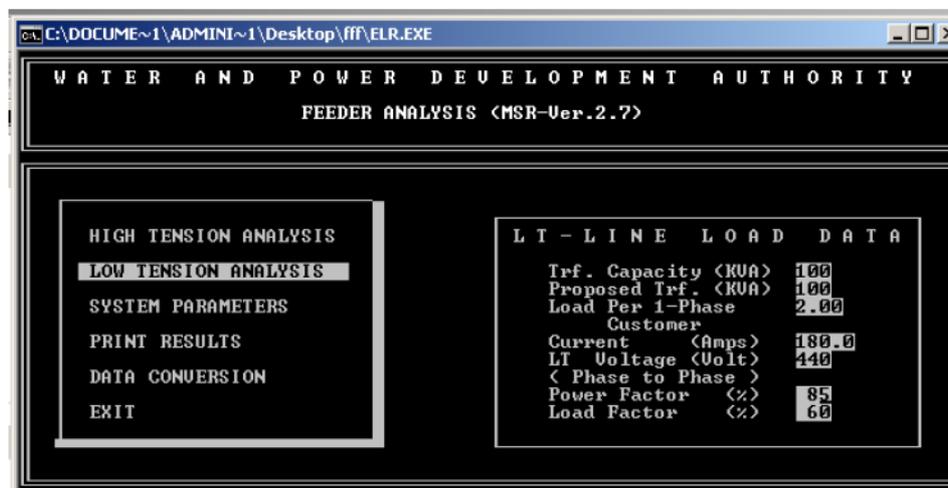


Fig. 5. Entering different parameters values for considered diagram

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DISPLAY OF RESULTS

LT File C:R2  
 Load = 180.00 AMPS Ext. PF = 80 % Total LT System Dmnd. = 118 KVA  
 B/Volt = 380 Volts Prop. PF = 80 % Spot Load Dmnd. = 0 KVA  
 Load Per Single Phase Customer = 2.00 KVA TRF. Capacity = 100 KVA

E X I S T I N G										
From Node	To Node	Length Kmtrs.	3-Ph Load	1-Ph Cust	Cond. Code	Cap. KUAR	Current Amps	% Ldng.	% Volt Drop	Loss KW
0.0	1.0	0.005	0	12	A		180.0	85%	0.3	0.323
1.0	2.0	0.055	0	16	A		167.0	79%	3.5	3.060
2.0	3.0	0.040	0	12	A		149.6	71%	5.6*	1.786
3.0	4.0	0.044	0	12	A		104.1	49%	7.2*	0.951
3.0	8.0	0.028	0	6	PU3		32.5	19%	5.7*	0.023
4.0	5.0	0.056	1	9	A		91.1	43%	9.0*	0.927
5.0	6.0	0.042	1	36	A		80.8	38%	10.2*	0.547
6.0	7.0	0.048	0	19	A		20.6	10%	10.5*	0.041
6.0	11.0	0.022	0	3	PU2		20.6	18%	10.3*	0.014
<b>TOTAL</b>		<b>0.426</b>	<b>4</b>	<b>164</b>						<b>7.708</b>

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(a)

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DISPLAY OF RESULTS

LT File C:R2  
 Load = 180.00 AMPS Ext. PF = 80 % Total LT System Dmnd. = 118 KVA  
 B/Volt = 380 Volts Prop. PF = 80 % Spot Load Dmnd. = 0 KVA  
 Load Per Single Phase Customer = 2.00 KVA TRF. Capacity = 100 KVA

E X I S T I N G										
From Node	To Node	Length Kmtrs.	3-Ph Load	1-Ph Cust	Cond. Code	Cap. KUAR	Current Amps	% Ldng.	% Volt Drop	Loss KW
8.0	9.0	0.033	0	6	PU3		26.0	15%	5.8*	0.017
9.0	10.0	0.030	0	18	PU3		19.5	11%	5.9*	0.009
11.0	12.0	0.023	2	15	PU2		17.3	15%	10.4*	0.010
<b>TOTAL</b>		<b>0.426</b>	<b>4</b>	<b>164</b>						<b>7.708</b>

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(b)

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DISPLAY OF RESULTS

LT File C:R2  
 Load = 180.00 AMPS Ext. PF = 80 % Total LT System Dmnd. = 118 KVA  
 B/Volt = 380 Volts Prop. PF = 80 % Spot Load Dmnd. = 0 KVA  
 Load Per Single Phase Customer = 2.00 KVA TRF. Capacity = 100 KVA

P R O P O S E D										
From Node	To Node	Length Kmtrs.	3-Ph Load	1-Ph Cust	Cond. Code	Cap. KUAR	Current Amps	% Ldng.	% Volt Drop	Loss KW
0.0	1.0	0.005	0	12			180.0	85%	0.3	0.323
1.0	2.0	0.055	0	16			167.0	79%	3.5	3.060
2.0	3.0	0.040	0	12			149.6	71%	5.6*	1.786
3.0	4.0	0.044	0	12			104.1	49%	7.2*	0.951
3.0	8.0	0.028	0	6			32.5	19%	5.7*	0.023
4.0	5.0	0.056	1	9			91.1	43%	9.0*	0.927
5.0	6.0	0.042	1	36			80.8	38%	10.2*	0.547
6.0	7.0	0.048	0	19			20.6	10%	10.5*	0.041
6.0	11.0	0.022	0	3			20.6	18%	10.3*	0.014
<b>TOTAL</b>		<b>0.426</b>	<b>4</b>	<b>164</b>						<b>7.708</b>

<F1> To Navigate      S >> System Summary      Esc To Exit

(c)



Table 1. Comparison of losses now and after 5 years

	Now	After 5 years
Transformer		
Overloading	118%	151%
Power losses	8%	10%
Line losses	7.7KW	12.5KW
Energy losses	18693KWH	30445KWH

## Conclusion

ELR software is used for the analysis of finding overload transformer or feeder. In this software also help us to know about transformer overloading if we change proposed transformer i.e., if existing transformer is 100 KVA with overloading 118% then refer to step 9 if we select proposed transformer 200 KVA then overloading will be different. In it we can also improve power factor by improving it transformer overloading decreases. Moreover conductor size can be changed let suppose we select Rabbit conductor then what will be used. In short this software provides information about a system which component can be upgraded in terms of low cost and high efficiency i.e., transformer should be changed or conductor or power factor or install extra transformer of same rating. In future it can be used in low budget countries in which distribution system is already overload and it is too much costly to install new whole structure to overcome overloading. So this software helps in providing information to upgrade the whole system or to upgrade some components of distribution system and meet the consumer demands.

## Acknowledgement

I am thankful to WAPDA who help me in collection of data and use of software.

## Ethics

This article is original and contains unpublished material. The corresponding author confirms that all of the other authors have read and approved the manuscript and no ethical issues involved.

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