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ENERGY LOSSES IN DISTRIBUTION SYSTEM OF KEK AND MEASURES TO REDUCE LOSSES

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Abstract

Calculation and analysis of technical energy losses, as well as measures to reduce them, represent important task and challenge to the distribution system. Assessment and analysis are usually based on data which we possess on the measurement of energy, which may have been not very accurate due to non accurate and very old meters. In this paper is assessment the power and energy losses in Power Distribution System in Kosovo with the software Power Factory application.

INTRODUCTION

Electricity transmission from thermal power plants to substations and its distribution through medium voltage lines, transformers and low voltages lines up to the costumers is associated with considerable power losses in all parts of distribution network.

Power electrical system is technical complex system consisting of numerous numbers of elements as: generators, transformers, lines and auxiliary elements, current and voltage transformers, insulators, circuit breakers, dividers, surge arrestors etc, from who is required normal operation under certain condition.

Elements of power system during their operation are exposed to permanent operation requirements for a long period of time, but during this time also require permanent maintenance and equipment adoption to consume requirements-loads.

Despite the fact that significant investments in power system are used for development of distribution system, this system is still unable to implement a modern technology, in order to increase reliability, efficiency, supply quality, and reduction of losses in general.

Energy losses in distribution network represent the difference between energy sources delivered to the customers who are connected to the network. Analyses of power losses are very complex issues who are conditioned by many factors. Planning and monitoring of losses as well as their reduction are main objectives and legal obligation of distribution system.

COMPARISONS OF LOSSES IN KEK DISTRIBUTION SYSTEM WITH SOME EUROPEAN AND REGIONAL COUNTRIES

Total Energy Losses in Distribution Network (technical and non-technical losses) presents the difference between entire energy that entered into the system (from energy transmission system produced in the Power Plants connected to the Distribution System) and energy delivered to the customers connected to the network. According to KEK annual statistics, total losses in 2007 were 40% (1,674 GWh from 4,134 GWh of total annual energy in distribution system). The trend of reduction of losses significantly started in 2008 with

41.85%, then continued to reduce in 2011 with 36% (1.806 GWh from total 4.962 GWh of total annual energy in distribution system). The main reason of reduction of losses is sustained from activities of reduction of non-technical losses as well as investments in order to improve distribution network.

From entire energy losses in 2010, non-technical losses have participated with 22.47% compared with technical losses which have been 17.05%. Having in mind the objective of this work, the following will not be analyzed non-technical losses although they have significant participation in total energy losses in the distribution system.

The data presented shows that energy losses in KEK distribution system are very high. Before we give thorough analysis of the causes which lead to us, such high value of technical losses in the distribution system, we will give the values of total losses in Distribution Systems of some European and Regional Countries. In the following table (Table 1) are given the values of losses in distribution system of relevant states in 2011.

Table 1 Values of energy losses in different countries

Values of total losses (%)	Country
Up to 5	Belgium, Spain, Germany,
5 - 6	Austria, France, Slovenia, Swiss
7 - 10	Norway, Sweden, England
10 - 15	Rumania, Bulgaria, Turkey, Croatia
15 -20	Serbia, Leetonia, Bosnia and Herzegovina
Above 20	Albania, Kosovo

From values of energy losses in different countries of Europe, there is seen a trend of increasing losses in Eastern European countries. At the same time, these countries are less developed and have lower standards, but they also have less consumption of electricity per consumer. Based on the similarities and differences they are: the quantity and distribution of electricity consumption, economic

development, social characteristics, and the mentality of the population, it is easier to identify the factors that most affect the energy losses.
The large values of energy losses in the power system of Kosovo are due to the political situation in the first ten-year of period 1989-1999, when the country went through a period of economic destruction, the collapse of standards in general and particularly the cessation of investments in the distribution network. Then, we have the post-war period (after 1999), where at the beginning of this period, investments were made mostly in generation units and in enabling destroyed network. In this period we also have a very large annual increase electricity consumption (which is around 8% per year), which requires to be followed by a request for capacity building of existing distribution network.

The share of energy consumption for industrial needs in Kosovo is around 20%, compared with the household consumption which is about 80%. This is one of the factors which have led to higher energy losses. To confirm the fact that the non-participation of affordable electricity consumption structure affects the value of the increased energy losses, if we start from EUROSTAT report, which shows that Luxembourg has about 65 %, Romania 60 %, Slovenia 56 % energy consumption in the industry compared to net consumption, this is one of the factors that affects the small amount of electricity losses in these states.

FEATURES OF LOSSES IN NETWORK DISTRIBUTION

State of distribution network is characterized by the following features:

Existing network that we have inherited has been designed for smaller loads. Today, with the difficulties is facing with the higher current loads.

Slow development in modernisation and automation of the network.

A large number of equipments in network distribution are outdated and at the end of their operation live.

The level of 10 kV network is in poor condition, were most of the lines are under the section of 50 mm^2 Al/Fe and relatively have great length.

Most of the lines (feeders 10kV) are radial type, which does not provide good opportunities to reduce technical losses without having to invest more

Low voltage distribution network is mainly overhead network with a conductor Al/Fe with insufficient and outdated section and in the end of its lifespan.

One issue of importance are the places of connection objects, which do not meet the technical requirements, in order to enhance the ability of unauthorised expenditures of energy.

The main part of expenses (80%) comes from low voltage network and small portion from high voltage network, as well as maximal expenses during winter months (the main energy expenses during winter months are used for heating).

All mentioned features affect significantly the increase of energy losses. In order to determine energy losses, an appropriate treatment of energy balance is needed.

Energy losses are characterised in: technical and non-technical losses. Technical losses are divided into: constant losses which do not depend on the situation of the network load and losses depending on load of distribution network.

Constant losses occur during all the time of network operation. This group includes losses in transformers core, losses due to corona and transmission into insulators of transmission lines, dielectric losses in the cables and condenses, winding losses of the meters etc.

The losses which depend on the load increase with the square of the load current, and flow into lines conductor as well as into transformers windings.

Non-technical losses can be defined as the difference between all losses and technical losses. Non-technical losses are primarily due to unauthorized expenditure or electricity theft, illegal connections in the distribution network etc.

Non-technical losses are primarily due to unauthorized expenditure or electricity theft, illegal connections in the distribution network.

CALCULATION OF TECHNICAL LOSSES IN DISTRIBUTION NETWORK

The calculation of technical losses is a complex issue because of the large number of network elements, which operate at different voltage levels. This requires a broad base of data for all network elements. Kosovo's distribution network modelling is realized with the help of software Power Factory, for the calculation of power flows, technical losses and other technical information about lines and transformers.

Energy losses can be divided into active power losses and reactive power losses. Active power losses cause by the resistance of lines, and reactive power losses cause by the reactive elements. Normally, active power losses have more attention, as they reduce the efficiency of power distribution to the consumer. However, the reactive power losses are no less important. This is due to the fact that the reactive power flows must be maintained at certain values in order to maintain the voltage at the proper level. Total active and reactive power losses in the distribution system can be calculated using the expression:

$$P_h = \sum_{i=1}^{n_{branches}} |I_i|^2 \cdot r_i \quad (1)$$

$$Q_h = \sum_{i=1}^{n_{branches}} |I_i|^2 \cdot x_i \quad (2)$$

Were $n_{branches}$, number of total branches in the system, $|I_i|$ absolute current values which flows into branch *i*, r_i and x_i resistance, respectively resistance in branch *i*.

Distribution network is the last part of the electricity system, which ends on consumers, so the problems in distribution network affect consumers and services. One of these problems is voltage drops, which should be kept within certain limits, in order to place load voltage value to be determined by the standard value. This applies especially to radial network with long lines and supply loads. Therefore, the voltage at different nodes of the system should be checked, which means that the reactive power flows must be checked. Consequently, the control of reactive power flow and the regulation of voltage at nodes will result with a reduction of energy losses, which represents a great deal of concern for distribution system.

The issue of restructuring the network, in order to reduce energy losses and voltage drop will be discussed in the paper.

RESULTS

For analysis of energy losses in distribution network system, three 10 kV feeders (lines) from substation have been considered, i.e. (SS 110/10 kV) in Skenderaj, with very special features. These three lines have a large number of substations (SS 10/0.4 kV) who supply consumers with electricity, very large length of the lines and a large number of consumers. These are mostly the types of overhead lines Al/Fe35mm^2 and Al/Fe25mm^2.

In Table 2 are shown data of the number of substations 0that are connected to these lines, installed power, number of consumers and the lines length.

Table 2 Relevant data for 10kV lines

10 kV Feeders	No. of SS 10/0.4 kV	Install. Power (MVA)	No of Consumers	Length of 10 kV Feeders (km)
J01	46	6.83	1467	51.75
J02	51	7.53	1643	62.66
J03	45	7.25	1677	52.04

While in Table 3, are given the following items for those three lines: energy (MWh), maximum power (MW), energy losses in MWh and %.

Power loss data presented in Table. 3 are taken from the calculations carried out for the month of February 2012. Calculations are made for the 10 kV lines (feeders), and represent the energy losses for lines in questions of TS 110/10 kV in Skenderaj, up to 10 kV bus bars corresponding TS 10/0.4 kV substation.

Table 3 Energy data, February 2012

10 kV Feeders	Energy (MWh)	P_{max} (MW)	Energy Losses (MWh)	Energy Losses (%)
J 1	1015	2.7	163.91	16.14
J 2	1178	3.22	300.39	25.49
J 3	993	2.57	141.89	14.29

Restructuring the supply lines and the system topology can be a measure which can be applied to reduce electricity losses in the distribution system. Distribution network is largely radial network with

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proper protection coordination. Supply lines enter or leave from work with connection and disconnection of the circuit breakers due to the load shedding or different faults. This requirement results in a proper planning system to reduce losses and increase system efficiency.

In order to reduce electricity losses by implementing the restructuring of the distribution network, energy loss calculations are made mostly for these cases:

- Increase of conductors section
- Separations of the feeder into two lines (feeders)
- Switch-over from level of voltage 10kV into 20 kV.

Comparison of energy losses which are simulated for current situation and the cases of new proposals as discussed before are shown in Fig.1.

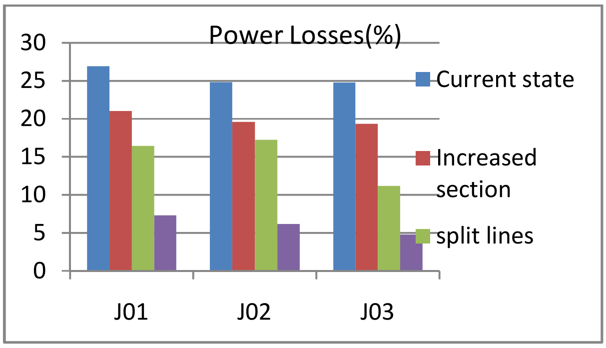

Figure 1 Comparison of energy losses for three lines

Figure 1 shows that energy losses will be reduced mainly in the case of transit of 20 kV voltage level, than have substantial reduction with dividing into two lines and will be reduced less with increasing of conductors section. Fig. 2 shows the results of the drop voltage calculations in the first line (J01 line). Voltage drop calculations are made for some characteristic points of this line, as in the case of the existing situation, then improving them by increasing the followers section, dividing into two lines and switch over into 20 kV voltage level.

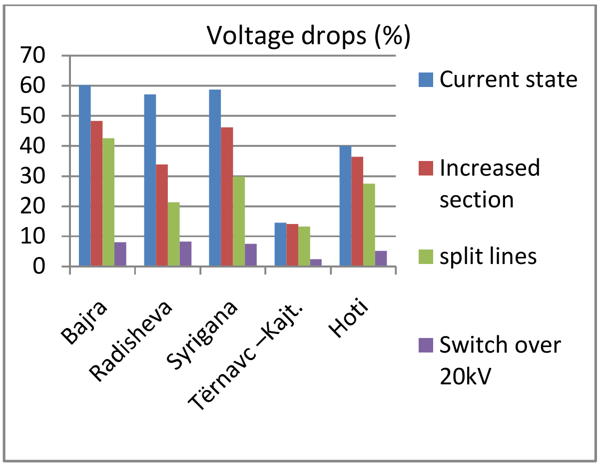

Figure 2 Comparison of voltage decrease in line J01

Same calculations were made also for another two lines J02 and J03 which are shown in Fig.3 and Figure 4.

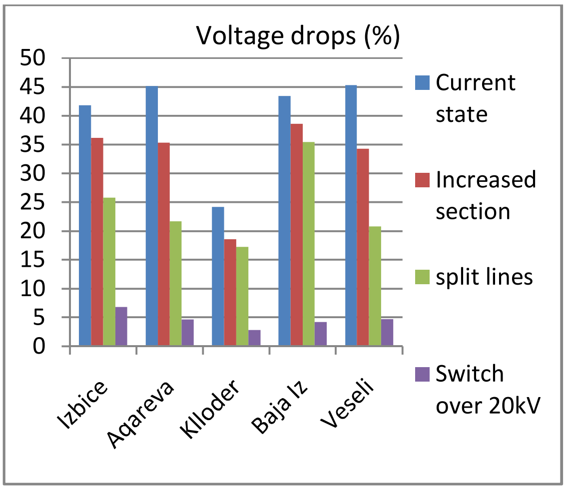

Figure 3 Comparison of voltage decrease in line J02

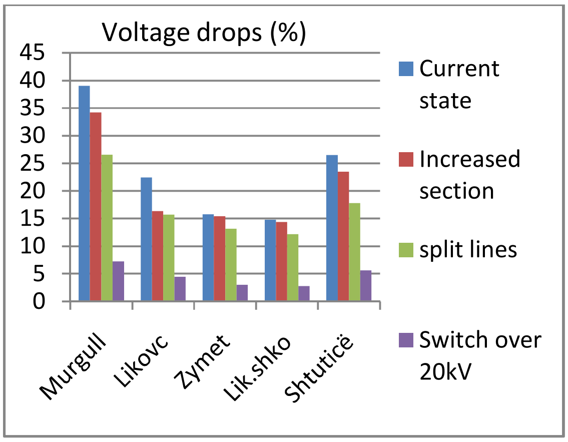

Figure 4 Comparison of voltage decrease in line J03

From the analysis carried out for these three 10 kV lines, in terms of voltage drops, is seen that we will have smaller voltage drops if lines switches over from the voltage level of 10 kV to 20 kV. In two other cases, then split into two lines and increase followers section lines, the voltage drops will be reduced but not up to the limits allowed by the standards.

CONCLUSIONS

Energy losses in the distribution network in our country are much higher than in other countries in the region, especially compared with European countries. The following factors affect high level of losses:

Un-favourable costumer structure of energy consumption (above 80% is consumption of energy in low voltage level).

Insufficient investments in the development of the distribution network, it is known that most investments are used for recovery of war-torn network and outdated network

There is very high percentage of non-technical losses - commercial losses.

From the analysis carried-out in this work paper, it can be concluded that effective measures to reduce electricity losses will be switching over to 20 kV voltage level. Since investments are huge for a shift in the voltage level of 20kV and till company can handle these investments, other measures are more efficient like:

- Separate of the lines 10 kV that are longer and overloaded,
- Increasing followers section,
- The establishment of new substations in the system,
- Setting for reactive power compensation equipment,
- Expansion and strengthening of the network,
- Optimize power flows,
- Respectively improving the voltage profile in the system,
- Symmetric load on the system, specifically, the distribution level.

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