QUALITY OF ELECTRICITY SUPPLY INDICES – JP ELEKTROPRIVREDA BIH

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ABSTRACT

Reliability of electricity supply, as an aspect of power quality, is given significant importance in power markets. Due to different practice of power distribution utilities in calculation of quality of supply indices, some expert associations on power quality (EURELECTRIC, CEER and others) are continuously working on regulatory framework harmonization in European countries. In Public enterprise Elektroprivreda BiH, monitoring system for outages on middle voltage (MV) distribution network was introduced in 2005, and from January 2006 quality of electricity supply indices are calculated according to international standards and practice of various European distribution utilities. Results of quality of electricity supply monitoring system both for Elektroprivreda BiH and its five branch offices, obtained during recent period, are presented in this paper.

INTRODUCTION

Liberalization and deregulation of power system market actualize the problem of quality of electricity supply, thus giving the greater significance and new techno-economical dimensions to this issue. Power quality is usually observed through: (1) reliability of electricity supply indices and (2) voltage quality indices at supply point. This paper deals with quality/reliability of electricity supply indices in power distribution network and presents the results of systematic registration process of these indices in power utility JP Elektroprivreda BiH (EPBiH), one of three power utilities in Bosnia and Herzegovina (B&H). EPBiH performs the activities of electricity generation, distribution and supply, based on license issued by Regulatory Commission for Electricity in Federation of Bosnia and Herzegovina (FERK) in December 2007. According to the License for Power distribution [4] EPBiH, as a distribution network operator, is obliged to distribute electricity in accordance with the quality requests defined in valid regulations on electricity supply (General Conditions for Electricity Supply and Distribution Grid Code), to establish outages and interruptions database and to register number and duration of customers interruptions. EPBiH has first outage monitoring system for outages on MV distribution network and selected reliability of electricity supply indices before it was granted with license for distribution. Chosen solutions are based on international standards and practices of European distribution utilities thus providing to meet most of the conditions of FERK.

RELIABILITY OF ELECTRICITY SUPPLY IN EUROPEAN DISTRIBUTION UTILITIES

According to references on practice of distribution utilities [1], [2] for the evaluation of the reliability of electricity supply from distribution network, about a dozen indices defined by IEEE Standard 1366-2003 "Guide for Electric Power Distribution Reliability Indices" [3] are used. Calculation of indices is based on registration of number and duration of interruption and on determination of the interruption consequences. Depending on the chosen way of monitoring the interruption consequences, reliability indices are expressed by number of customers interrupted or by energy not supplied. According to recent documents that study the practice of distribution companies in European countries [1], [4], it can be concluded that:

- Differences in understanding the concept of quality of service and quality of electricity supply exist and they lead to differences in the choice of methodology for interruption monitoring and the calculation of reliability of electricity supply indices.
- Obtained results show that the values of indices largely depend on type of interruptions (planned, unplanned), the structure of distribution network (voltage levels of distribution network, customers’ density, the share of cable in distribution lines) and weather conditions in observed period of computation of indices (i.e. natural weather disasters).
- Permanent pressure from regulatory agencies on distribution companies to reduce costs of business, leads to lowering investments in distribution network, thus directly affecting the lowering quality of electricity supply. At the same time, some countries in Europe tend to introduce more strict requirements for quality of electricity supply indices than the requirements from applicable standards (usually from standard EN 50160) what imposes greater costs for utilities.

Regulatory agencies, according to defined regulatory framework mechanisms, require from utilities to monitor and to publish indices of electricity supply in order to benchmark themselves. In current regulatory framework of each country, but with the appreciation of the specific conditions, appropriate methodology for monitoring of indices and evaluation criteria are defined. Both needs and expectations of customers on electricity supply are reviewed through regulatory mechanisms and the willingness of consumers to pay the higher price of electricity for the
improved reliability of supply, or so-called willingness to pay, is also analyzed simultaneously. Council of European Energy Regulators - CEER has formed a working group for quality that published Third benchmarking report on quality of electricity supply in 2005. Aim of this publication was to provide mutual comparisons for distribution utilities, to harmonize existing practices in monitoring the reliability of electricity supply and to assist distribution utilities that are in the initial stage of establishing the monitoring system for reliability of electricity supply. Analysis of results [1] points to the need for improvement of existing systems for calculation of reliability of supply indices in distribution utilities in Europe. The most relevant key findings and recommendations are:

- A precise definition for quality of electricity supply and harmonization of existing practices are still needed.
- A clear definition for appropriate protocols for monitoring the reliability of electricity supply within previously defined methodology is needed.
- Publishing of results is very useful and helpful for distribution utilities.
- Setting the right targets of indices by network operators in order to improve results is very important.
- There is very important request for distribution utility to be aware of its own capital structure of costs (CAPEX) and operating expenses (OPEX), so that it could give advanced assessment of the costs that are related to improvement of quality of electricity supply.

**OVERVIEW OF QUALITY OF ELECTRICITY SUPPLY SYSTEM IN ELEKTROPRIVREDA BIH**

In EPBiH as part of distribution activities, system of permanent monitoring of outages in MV distribution network is established since March 2005. Indices for quality/reliability of electricity supply are calculated since January 2006, according to international standards and practices of distribution utilities in Europe. Hereafter, those indices will present indices for quality of electricity supply. The entire system for monitoring of outages [5] is based on dispatching reports that are prepared by dispatching services and contain further data: (1) voltage level and type of element in outage, (2) type and cause of outage, (3) duration of outage and (4) the consequences of electricity supply interruptions. Information about outages are registered through dispatcher reports on a daily basis for all five distribution branch offices of EPBiH. The processing of data and the calculation of indices are done on a monthly level for EPBiH and its five distribution branch offices. In the first phase of development of systems for monitoring outages, during 2005, certain testing of defined systems are done and quality of supply indices calculated for distribution branch offices are used for mutual comparisons and benchmarking. Since 2006, quality indices are defined according to IEEE 1366 (SAIFI, SAIDI and CAIDI). Some specific indices accepted during previous period are also used since that time. Statistical data analyses of outages on MV network, as well as the results of indices SAIFI, SAIDI and CAIDI [6] for EPBiH are given below. Basic data for distribution branch offices of EPBiH are given in Add. 1.

**Number and duration of outages and interruptions on MV distribution network in 2008**

Data for total number and duration of outages and interruptions on MV distribution network during 2008 are shown on figures below.

**Figure 1.** Total number of outages and interruptions on MV distribution network in 2008 for five distribution branch offices of EPBiH

**Figure 2.** Total duration of outages and interruptions on MV distribution network in 2008 for five distribution branch offices of EPBiH

On the basis of statistical data for the total number and duration of outages and interruptions on MV distribution network in 2008 it can be said that:

- more than 91% of the total of 14,387 outages registered at the level of EPBiH led to the interruption of electricity supply (13,027 interruptions)
- the monthly average number of outages was 1,199 outages and the average number of interruptions was 1,086 interruptions;
- total duration of outages at the level of EPBiH amounted to 30,262 hours, and duration of interruptions amounted to 26,519 hours.

These data confirm the dominant influence of the distribution network configuration and structure on the
quality of electricity supply. The majority of outages on MV distribution network elements lead to the interruption in electricity supply for customers. It is also confirmed that the period of suitable weather conditions for maintenance and investment works leads to significant increase in the number of outages on MV distribution network.

**SAIFI, SAIDI, CAIDI for period 2006 - 2008**

![Figure 3. SAIFI on MV distribution network for five distribution branch offices of EPBiH, period 2006-2008](image)

By comparing the obtained results for quality of electricity supply indices SAIFI, SAIDI and CAIDI with results of indices from other European distribution utilities [1] significant differences can be seen. There is an urgent need for improvement of quality of electricity supply for customers in EPBiH, what can be accomplished by improving the network structure and introducing the distribution automation system. In future, additional investments in distribution network should be taken in order to accomplish the improvement of quality of electricity supply.

**EXAMPLES OF USAGE OF QUALITY OF ELECTRICITY SUPPLY INIDCES**

Since 2007, in EPBiH certain usage of quality of electricity supply indices can be found in practice i.e.;

- it is used for evaluation of improving reliability of electricity supply as one of business targets and
- it is used for improving the maintenance process of power distribution network elements.

**Reliability of electricity supply as business target**

Improving of reliability of electricity supply is defined as one of five business targets for quality in distribution activity of EPBiH (beside decreasing of power losses, increasing of rate of payment and improving of other economy parameters). It is defined that quality of electricity supply is measured by indices SAIFI, SAIDI and CAIDI for each distribution branch office.

In order to perform analysis, a methodology that implies planning of quality indices and monitoring of obtained results on monthly and quartile level is defined. Analysis of obtained results is performed on quartile level and certain corrective measures are defined accordingly unless targets are obtained. According to adopted methodology, planned values for reliability indices for planning year are based on results obtained in previous period of three years. Due to the nature of indices, deviations of +20% and -10% in reference with the values form last year are allowed. An example of application of the results of SAIFI monitoring system for 2008 in ED Tuzla is shown on Figure 6.

![Figure 5. CAIDI on MV distribution network for five distribution branch offices of EPBiH, period 2006-2008](image)

![Figure 6. Monitoring of SAIFI in ED Tuzla for period January-December 2008](image)

According to Figure 6, it can be concluded that SAIFI for ED Tuzla is in expected limits of planned values. In case of exceeding the planned maximum value, it is needed to check whether a major event has caused such a result, and to do more detail analysis of the causes of planned or unplanned
It is expected that further application of this methodology will lead to its improvement and development in future.

**Improving the maintenance process of distribution network elements**

Available data on outages and adopted classification for outage causes provide to do the detail analysis for distribution network elements that have mostly contributed to low quality of electricity supply indices. This allows seeing the list of network elements that:

- had multiple outages,
- caused the longest interruptions for customers,
- caused interruptions in supply for large number of customers.

These objects should be given special attention during maintenance business and investments. With introduction of new classification of outage causes at the beginning of 2007, all outages on MV distribution network are given the possibility to be analyzed more detail according to type and cause of outages. This is just the beginning of the activities that are implemented in improvement of maintenance system of distribution network elements. Detail analysis of outage causes will help to identify unreliable network equipment and to reduce the interruptions in supply for customers with better maintenance planning.

**FURTHER ACTIVITIES FOR SYSTEM DEVELOPMENT**

The further development of monitoring systems of outages is planned in several steps:

- To ensure continued application of the chosen way of calculation of quality of electricity supply indices, in order to obtain data of confidence for a period of at least three years;
- To continue with the application of the monitoring system of outages on low voltage distribution network what is first implemented in April 2007.
- To complete all necessary activities on introduction of in-house developed software application for monitoring system of outages.

**REFERENCES**


<table>
<thead>
<tr>
<th>No.</th>
<th>Data</th>
<th>Unit</th>
<th>ED Bihać</th>
<th>ED Mostar</th>
<th>ED Sarajevo</th>
<th>ED Tuzla</th>
<th>ED Zenica</th>
<th>JP EP BiH</th>
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<td>1</td>
<td>Number of customers</td>
<td>customers</td>
<td>90,952</td>
<td>34,278</td>
<td>200,581</td>
<td>166,063</td>
<td>174,426</td>
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<td>2</td>
<td>Total annual consumption in 2007</td>
<td>MWh</td>
<td>392,753</td>
<td>169,304</td>
<td>1.136,270</td>
<td>972,543</td>
<td>791,510</td>
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<td>3</td>
<td>Length of MV network</td>
<td>km</td>
<td>1,720</td>
<td>786</td>
<td>1,657</td>
<td>1,878</td>
<td>2,796</td>
<td>8,837</td>
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<td>4</td>
<td>Participation of cable lines in MV network</td>
<td>%</td>
<td>6%</td>
<td>16%</td>
<td>56%</td>
<td>14%</td>
<td>16%</td>
<td>22%</td>
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<td>Length of LV network</td>
<td>km</td>
<td>3,407</td>
<td>1,572</td>
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<td>6,188</td>
<td>8,015</td>
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<td>Surface area</td>
<td>km²</td>
<td>4,125</td>
<td>2,570</td>
<td>1,526</td>
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<td>Customer density</td>
<td>customers/km²</td>
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<td>131</td>
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<td>Consumption density</td>
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<td>745</td>
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<td>Length of MV network per 1000 customers</td>
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Add.1 Basic data of the distribution branch offices of EPBiH