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Analysis of Transmission losses in Transmission Area Rijeka

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SUMMARY

During the last decade and in the beginning of this century there have been significant changes in the electrical sector. The electrical power sector has entered the process of liberalization and market opening and thereby has gone through major changes. In the process of liberalization of the electrical sector, special attention is given to an important process in the network power system, distribution and transmission. The process of liberalization and opening of the electricity market, from fully closed to fully open market, also changed the status of electricity losses in the energy systems.

With the opening up of the electricity market, losses became even more important and are being devoted more and more attention, from the technical as well as from the economic point of view. Determining the source and level of losses is one of the most important issues from economic and technical view. Determining and analysing the losses in the electricity network should be given special attention in order to reduce them and also to bring losses to acceptable levels.

In order to achieve the reduction of transmission losses, it is primarily necessary to analyse the existing losses.

Transmission losses are determined by the technical condition of the network, its components and units as well as by links to other power systems. As each element of the transmission network with their individual losses contributes to the overall loss of the observed transmission network, the age of the primary equipment and operation conditions are the main parameters that influence the operation of the system and also the cost of regular and emergency maintenance.

This paper will generally describe energy losses that occur in the transmission network with special attention dedicated to electricity losses on transmission lines in Transmission Area Rijeka.

Croatian Transmission System Operator has been using multiple sources of electrical energy from a number of complex information systems. Data warehouse of the HOPS has been archiving measurements for the system control and for the calculation of electricity.
The measured data is obtained from multiple sources. The main source of data for storage systems are from metering system - ADVANCE, control and monitoring systems - SCADA (Supervisory Control and Data Acquisition) and the system for managing market functions.

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SCADA system archives the current values of the various measurements such as power, voltage, frequency, current, etc. System measurements are recorded in different periods, from 2 seconds to 15 minutes. We analysed the data from SCADA system, based on an hourly time interval, resulting from the integration of the power measured on both sides of the power line.

KEYWORDS

Energy losses, transmission system, data warehouse, measurements

1. INTRODUCTION

Losses in the electric power grids are a common subject of various discussions, professional and business consultations, and their analysis is a complicated question. Electrical energy losses of every electric power system have their technological, economic and ecological dimension.

When we talk about the demonstration of losses, this influences directly the entire business on one hand and the final price of electricity, which is being paid by the customer, on the other. Each operator of the electrical power grid dedicates special attention to electricity losses, especially when losses exceed the predetermined threshold. Losses are one of the key factors which indicate the degree of business efficiency and the quality of performing the activity of transmitting and distributing the electrical energy. Because of these reasons planning, monitoring and reduction of losses are one of the priorities of business goals of each operator, as well as a legal obligation. Systemic undertaking of the above mentioned activities resulted with a satisfactory trend of reduction of losses; however it did not result with a satisfactory level of losses. In the upcoming years, in addition to already initiated activities of increased investments and reconstruction of electric power system, a significantly greater attention should be dedicated to the achievement of an acceptable level of losses.

2. LOSSES IN ELECTRICAL ENERGY TRANSMISSION GRID

Transmission of electrical energy is an activity in electrical energy system, which implies a balance between production and consumption, safety and stability of the system and appropriate quality of electricity. Transmission grid indirectly enables at any given moment the combination of production of electrical energy with current demand of consumer, allows the export of electrical energy across state borders or import for own purposes, or only transit from one country to another.

Transmission grid in market conditions represents the infrastructure on which the wholesale market of electrical energy is being carried out, and during system activity there is an inevitable amount of losses. Together with maintenance of a stable and safe system the operator that manages the transfer of the electrical energy is also responsible to provide the energy which will make up for losses according to the principle of minimal costs. In addition to adequate market mechanism of providing the electrical energy, achievement of minimal cost also comprehends continuous monitoring, analysis and calculation of losses and their reduction if possible, with consideration to the safety of electrical energy system.

The existence of losses in operation and functioning of the transmission electrical energy system is an inevitable fact from the technical and economic point of view, thus leaving behind consequences in both segments.
Speaking of losses they can be distinguished by:

- The location of their origin (elements of the transmission grid)
- Dependence of the load (losses independent from the load – permanent losses and losses dependent of the load – variable losses)

Factors that influence the level of losses in transmission electrical energy system are:

- Technical state of the system, construction and configuration of transmission grid (conducts and transformers parameters, age on individual grid elements, structure and position of source and consumers…)
- The manner of system exploitation (load distribution among sources, switching state of grid, transmission of the electrical energy through the grid…)

Electrical energy losses in transmission grid have different consequences:

- A supplementary production and consumption of energy-generating product in thermal power plants or water in hydropower plants
- Increase of investments in production and transmission facilities
- Losses make an extra load to the transmission grid thus decreasing transmission capacity that would otherwise be available for market activities and they worsen voltage conditions.

3. INFORMATION SYSTEM AND MULTIPLE DATA SOURCES FOR THE CALCULATION OF ENERGY LOSSES

The concept of a Data Warehouse is several years old but only in recent years an increase in the number of implementations can be seen, and slowly but surely accepted as a solution for the analysis and presentation of information. Reasons for this success we can find in the advancement of technology and understanding the benefits of one such system. Except the question of how well and quickly store large amounts of information there is a need for effective and efficient way to use the knowledge from these data. [4]

The need to store data and information permanently, for the reuse in later stages, is a very relevant problem in the modern world. The storage and subsequent use of data can indeed be a valuable source for decision making or to increase work efficiency. Besides to data storage, the efficient and effective use of information is particularly important. This is typically done with Business Intelligence – BI, at whose base is the implementation of a Data Warehouse – DWH. BI pulls out all the data together and puts them in the report. BI does not generate new data it simply makes it easier to explore the relationships between data.

In the following article will talk about the implementation of a Data Warehouse for the Croatian Transmission System Operator (HOPS).

Croatian Transmission System Operator has been using multiple sources of electrical energy from a number of complex information systems. Data warehouse of the HOPS has been archiving measurements for the system control and for the calculation of electricity. The main source of data for storage systems are from metering system - ADVANCE, control and monitoring systems - SCADA (Supervisory Control and Data Acquisition) and the system for managing market functions. Each source has its own specifics and different views on the same element of the transmission network.

In HOPS, this combination of sources of data with different views to the same entities resulted with a need for a unique way of data processing which will enable a unique view on all the data in the warehouse. As a solution the CDM (Common Data Model) was

implemented. The Common Data Model is a standardized definition of how system solutions and technologies represent resources and their relationships. The Common Data Model is a logical, semantic informational data model that brings together various data models, consistently describing details and identity of resources.

Data flow is established in a manner that it goes from different sources to data warehouse and then continues to the Reporting system. Reporting system enables the interaction of the end user with the warehouse. This system's tasks comprehend shaping and visualization of data, report production, analysis, trends etc. The implemented system is performed on modern reporting technology. [4]

Example of dashboard report for the Transmission Are Rijeka is demonstrated in Figure 1.

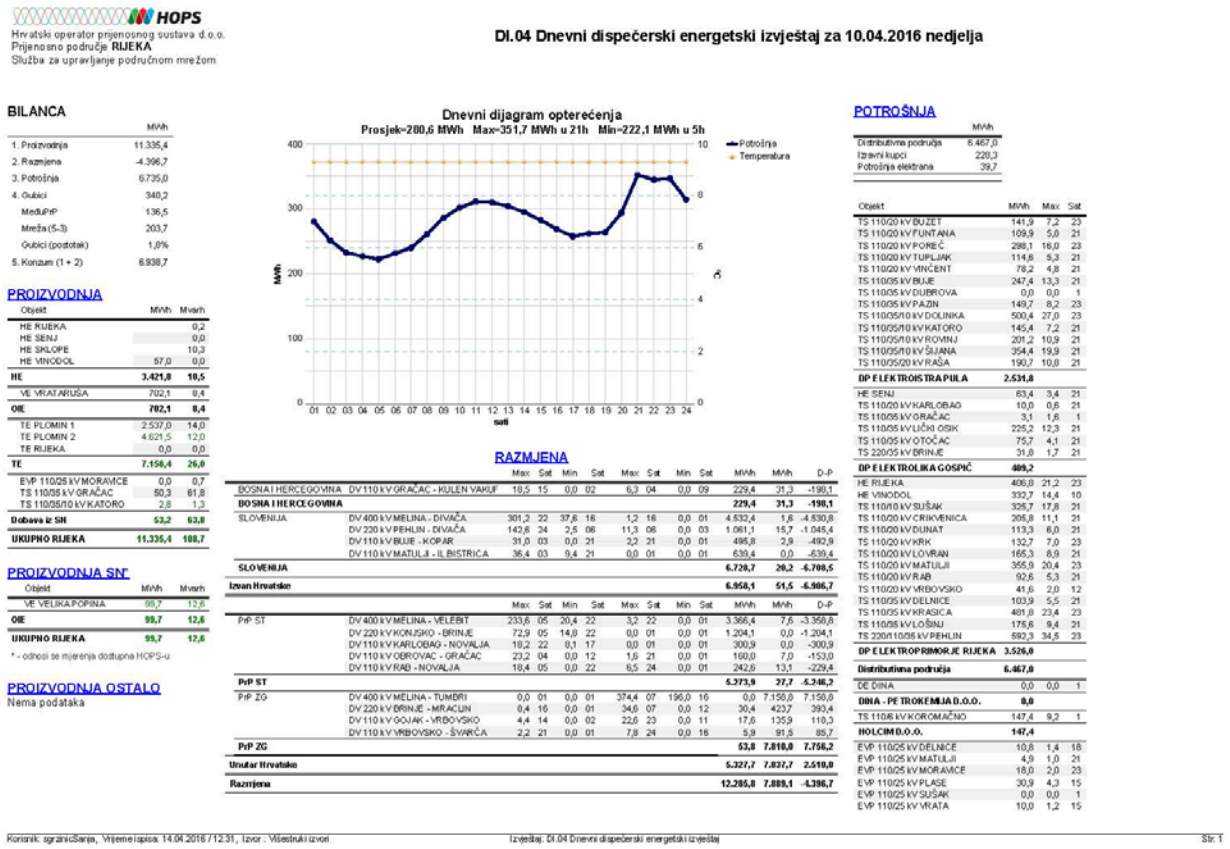

Figure 1. Example of dashboard report for 10.April.2016.

4. LOSSES IN TRANSMISSION AREA RIJEKA

Analysis of the losses had made on the basis of the data from 1 March 2016 till 31 March 2016. Reporting system enables view for this period summarized data in percent for Supply (Figure 2.1), Delivery and Losses. Losses for whole March in this case are less than 1%, as we can see on Figure 2.2.

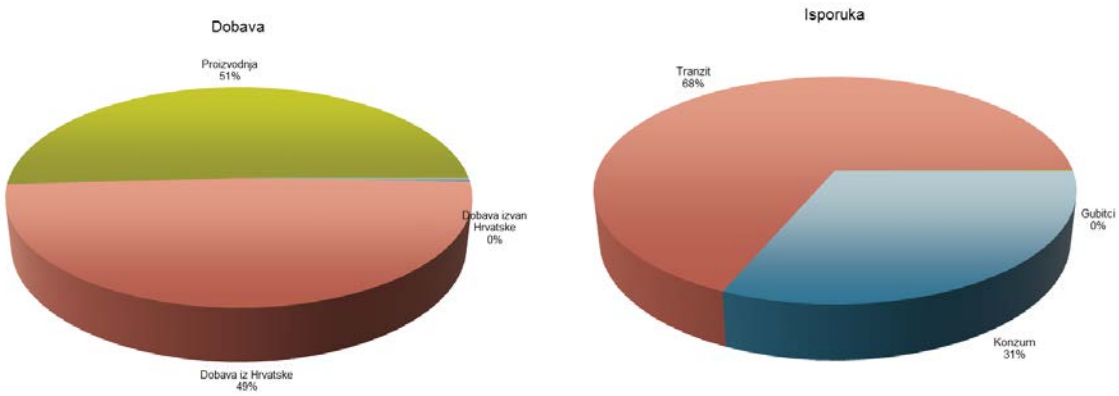

Figure 2.1 Supply from Production and Exchange 2.2 Delivery to Consumption, Transit and Losses

Losses had been observed for hour data losses in MWh. Calculation is based on data of Exchange receives and returns from other Transmission Area, Production and Consumption.

The calculated frequency is hourly losses which are shown in Figure 3. This calculation didn't take amount of the supply from Distribution, what will be part of future development of the applications for detailed analysis of the losses.

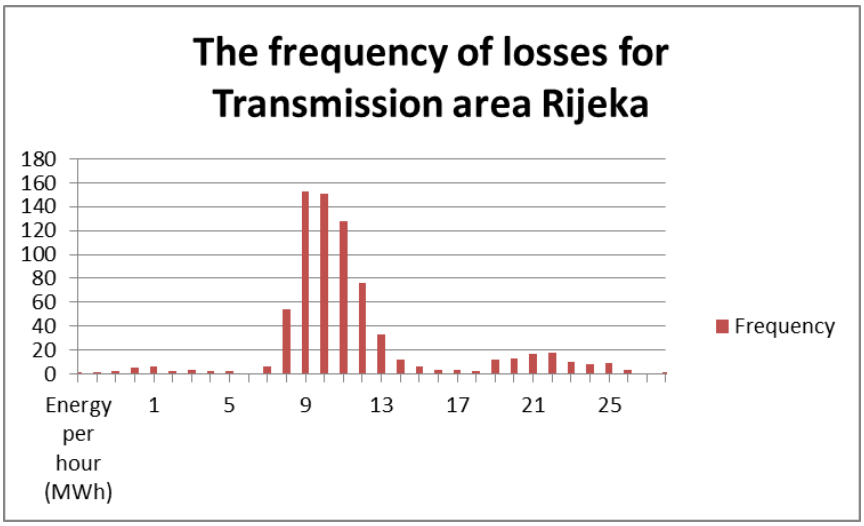

Figure 3. The frequency of losses for Transmission area Rijeka

Processed is 744 hourly data loss in MWh. Figure 3. shows some negative amount of the frequency which is caused by the value of production on medium power level, and extremely large losses can be associated with extremely large Exchange according to the

neighbouring Transmission area. A detailed view of the loss for 8 March 2016 of Transmission area Rijeka is located in Figure 4.

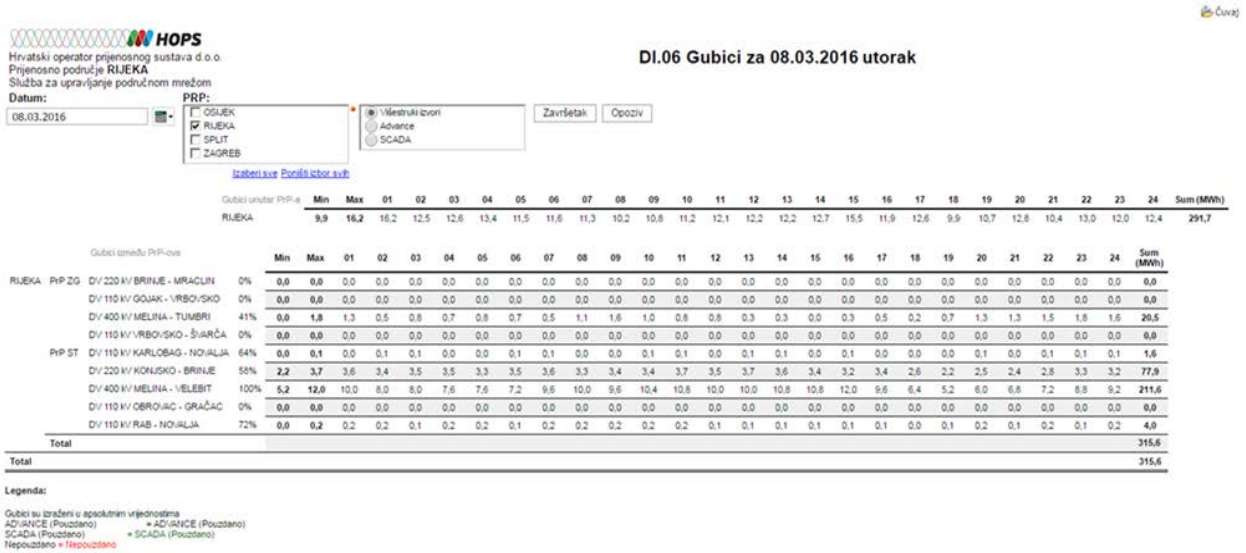

Figure 4. A detailed view of the losses for the day 8 March 2016 of Transmission area Rijeka

The structure of the losses consists of losses from exchange between neighbouring Transmission area of Rijeka and makes 48% of the losses, and losses inside area Rijeka is 52%, as it is shown for 8 March 2016 in Figure 5.

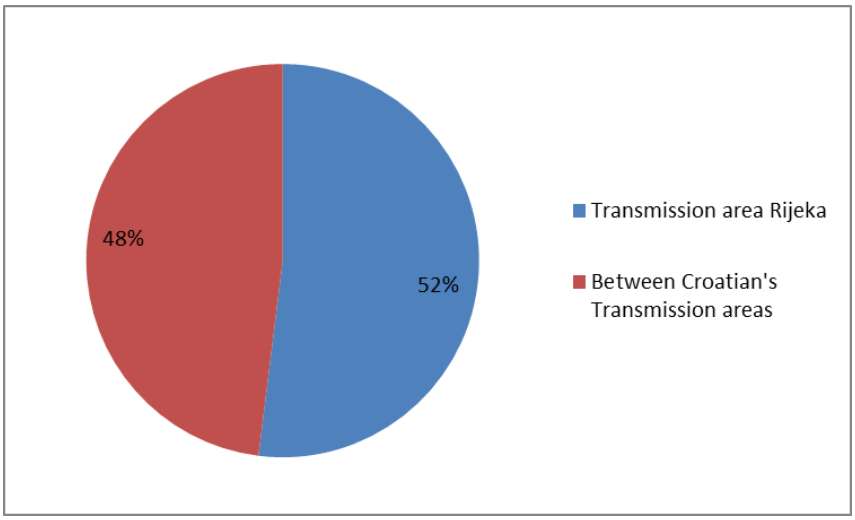

Figure 5. Structure of the losses on 8 March 2016 for Transmission area Rijeka

From the above it is evident that a large part of the losses relates to exchange of electricity between regions, so it is very important to plan production and consumption in certain areas, on the other hand connection to other system provides security of electricity supply.

5. CONCLUSION

Power and energy losses in electrical energy system are natural phenomenon and can't be avoided during the system operation. The transmission network is a wholesale market infrastructure and for successful system operation it's necessary to know precise amount of the total losses. Creation of single European electricity market has made apparent the need for compensation of losses of electrical energy between TSOs. Data on the total losses in the electrical energy system of Croatia and Europe are continuously monitoring and publishing.

For better understanding what we can do with measured data of energy losses in the transmission network, in this paper is describe how Croatian Transmission System has been using multiple sources of electrical energy from a number of complex information system (Advance, SCADA and the system for managing market functions) and how is presented to end user using Data Warehouse. Data storage and information retrieval is a very important topic nowadays and affects a large number of people. Besides to data storage, the efficient and effective use of information is particularly important.

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