ELECTRIC ENERGY LOSSES CALCULATION

Daniel Hlubeň

ABSTRACT

This paper entitled "Electric energy losses calculation" deals with the problem of the losses calculation in the Slovak Republic, the Czech Republic, Poland and Hungary. At the end of article are shown possibilities in the energy losses, costs and services minimisation.

1 INTRODUCTION

In this work calculation methods in the Slovak Republic, in the Czech Republic, in Poland and Hungary are briefly described.

2 ENERGY LOSSES CALCULATION

2.1 Losses Calculation in the Slovak Republic and in the Czech Republic

In the Slovak Republic and in the Czech Republic electric energy losses calculation is based on the Regulation of Ministry of Industry and trade of the Czech Republic [3].

The main goal is to show details about efficiency assessment of the electric energy usage in a transmission and a distribution network and an interior wiring.

The efficiency of usage of electric energy in a distribution and in an interior wiring is defined by technical losses caused by operation of equipment.

The regulation is the result of several year research in this field in the Czech and Slovak Republic. This rule describes how to assess and calculate electric energy losses in each voltage level.

Losses can be divided:

A. Permanent technical losses:
   - corona,
   - leakage,
   - dielectric losses,
   - open-circuit losses,
   - losses caused by continuous load of measuring elements,
   - losses caused by continuous load of control elements.

B. Variable technical losses
   - joule losses in lines in each voltage level,
   - impedance losses,
   - losses caused by contact resistance,
   - joule losses in protection components.

This methodology unifies losses calculation in the Czech Republic and in the Slovak Republic. It is possible to compare electric energy losses in networks.

In order to investigate these losses it is very important for distribution companies to update their data about

networks. In distribution companies in the Slovak Republic GIS systems are not used or their usage is at its start and therefore nowadays it is impossible to calculate electric energy losses with sufficient precision, mainly in low voltage networks.

Therefore in the future it is necessary to update data about networks and use these data for research of losses in these networks.

2.2 Losses calculation in Poland

Basics of electric energy losses calculation in Poland were described by J. Horak [2].

Electric energy losses calculation in Poland is based on several year of research. The methodology based on this research takes into account a lot of parameters of network e.g.: the load changing in a system by daylight, historical development of the network, network conditions, type of the network, load asymmetry, point of the supply, different distances between customers and different demands, different daily maximum demands, etc., but a lot of them are optimized during calculation.

The main goal of this methodology is to calculate electric energy losses, but it is not necessary to know each line in region. Generally, it is necessary to enter values:

In low voltage and medium voltage networks we need the following data about network e.g.: surface area, the number of consumers, number of meters (1-phase, 3-phase), the number and power of transformers, length of lines (cables, overhead lines), power of capacitors, …

In high voltage (110 kV) networks we need e.g.: the number and power of transformers 400 (220) kV/110 kV and 110 kV/medium voltage, power of capacitors, length of overhead lines (OHL).

In the next part of the calculation the following data are needed.

In low voltage and medium voltage network e.g.: devices connected to the network and the energy flowing through these elements e.g.: supply, transit and energy transmission caused by liberalizations, illegal consumption, public lighting and traction, balance losses in low voltage and medium voltage network, export to other distribution companies (medium voltage).

In high voltage network we need e.g.: energy supply to medium voltage and high voltage networks, transit, export to other distribution companies, balance losses in high voltage (110 kV) network, energy import.

This methodology based on global parameters and energies flowing through the network provides fast calculation of electric energy losses and therefore the methodology can be used for electric energy losses calculation in the future.

The very useful feature of this methodology is the possibility for eligible losses calculation in each voltage level. Then, it is possible to lower these losses in given points of networks [1, 2, 5] without big investments, e.g. it is impossible to lower losses in meters, in connection lines, but it is possible to lower losses by compensation, by service or by energy quality improvements in each voltage level.

2.3 Losses Calculation in Hungary

Basics of electric energy losses calculation in Hungary were described by L. Hiblár in his graduation thesis [4]. The methodology of electric energy losses calculation is similar to methodologies of electric energy losses calculation in the Slovak Republic and the Czech Republic.

This methodology takes into account the following losses:

A. Electric energy losses in high voltage level (110 kV):

- corona,
- leakage,
- joule losses in lines,

- losses in transformers (no-load, impedance losses).

B. Electric energy losses in high voltage level (< 110 kV)

- losses in reactors
- joule losses in lines,
- losses in transformers (no-load, impedance losses).

C. Electric energy losses in low voltage level

- joule losses in cable lines,
- joule losses in over head lines (OHL)
- losses in connection lines
- losses in voltage coils of meters

This methodology also includes inaccuracy of meters.

2.4 Energy losses minimisation

There are two directions, how to minimise losses.

- Investments
    - Higher voltage 110 V -> 230 V, 6 kV – 22 kV, …
    - PF correction (compensation)
    - Replace lines (higher diameter)
    - Replace old lines with new lines
    - To use better materials in machines
    - Power quality improvement

These possibilities are usually used, e.g. higher nominal voltage in case of reconstruction of an old installation.

PF correction is very efficient way of electric energy losses minimisation, but these days, mainly in towns and factories, there is a big problem with quality of power – harmonics. Therefore it is necessary to use devices improving quality of power, e.g. harmonic filters.

- Without investments
    - Advisable distribution of reactive power
    - Advisable load of lines
    - Transformer group control to lower losses, replacement
    - Network configuration
    - Decrease peak power
    - Balance network
    - Voltage control
    - Service

This type of losses minimisation is in some cases based on software control, because advisable distribution of reactive power, advisable line loading or network reconfiguration can be made only by software.

But service is also very important. Aluminium cables with paper insulation could by found in old buildings. A contact resistance is high and also losses are high. It is necessary to tighten these contacts.

But these days can be seen different approaches in energy losses minimisation:

- on-line energy measurement

- recloser usage

2.5 On-line measurement

This direction do not directly minimise technical losses, but offers possibilities of costs and losses minimisation, mainly service and illegal consumption.

Usually, it consists of a tightly integrated set of components that together provide the infrastructure to deliver networked energy services to your utility. Intelligent, communicating digital electricity meters; powerful IP-connected data concentrators; and scalable system software form its elegant system architecture.

It is possible to upgrade system online without any personal. It offers advanced metering functionality, this means, it is possible to decrease logistical expenses, realize multiple utility services at minimal costs (at even no cost).

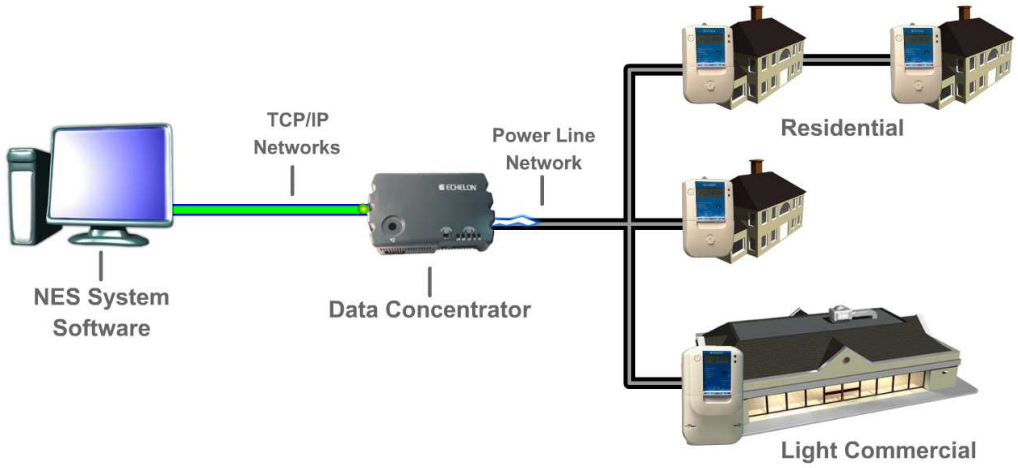

Fig. 1 On-line measurement [5]

2.6 Recloser usage

Distribution networks, mainly in villages and towns are usually radial. But, if this radial network is transformed to ring type of network, it is necessary to maintain reliability. Therefore, there can be used reclosers. The main function is to switch, but also to switch off fault. Reliability is maintained, because a new network is protected by this recloser and in a case of fault in line, only part of the supplying line will be disconnected.

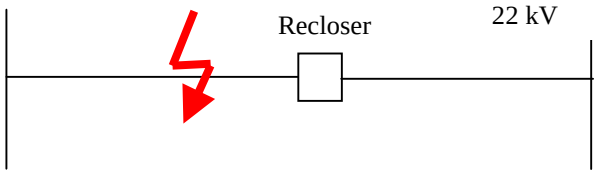

Fig. 2. New network, closed network

And, there is another factor we have to consider, the losses minimisation. In this case currents will change. Therefore it is necessary to investigate energy losses change for this type of reconfiguration.

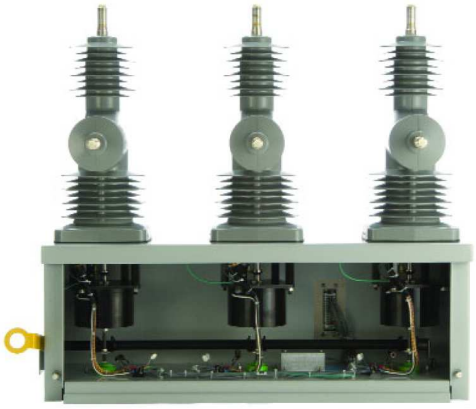

Fig. 3 Recloser [6]

3 *Conclusion*

Today it is very important for distribution companies to know energy losses at any time, because the energy, which they are ordering, involves these losses plus the load.

In this article were briefly described three methodologies used in the Czech Republic, in the Slovak Republic, Poland and Hungary. In the Czech and in the Slovak Republic is used the same methodology, because networks are similar.

Another technique was introduced by J. Horak and J. Szkutnik in their works. The methodology offers the possibility to calculate losses and it is not necessary to gain data about the whole network. By the usage of statistical functions it is possible to calculate technical and eligible losses. Program EuroStra 2004 based on this method is used in many distribution companies in Poland.

The methodology that is used in Hungary is similar to the methodology used in the Slovak Republic. But in this methodology are used different factors.

These days there are big possibilities in losses minimisation, but it is necessary to use new devices and new approaches, e.g. on-line metering or recloser usage.

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Author address:
Ing. Daniel Hlubeň
Department of Electric Power Engineering
Technical University of Košice
Mäsiarska 74
040 01 Košice, Slovak Republic
E-mail: daniel.hluben@tuke.sk
Tel: +421 / 55 / 602 355
Fax: +421 / 55 / 602 3552

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