# CLASSIFICATION AND CALCULATION OF ELECTRIC ENERGY LOSSES IN DISTRIBUTION NETWORKS

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*ABSTRACT*

*The paper entitled "Classification and calculation of electric energy losses in distribution networks" deals with the problem of the losses division for an operative calculation in distribution companies.*

## *1. INTRODUCTION*

The price calculation of electrical energy in Slovak republic is based on the regulations of Regulatory Office for Network Industries, but it is usually made yearly. In this work we would like to show other way of the losses calculation based on global values in the distribution networks viewed as a set of elements.

The research and analysis of network parameters has been studied in Poland since 1961, based on the methodology of the founder Janusz Horak. Polish books devoted to this methodology of the calculation include practical losses measurements of installed devices in distribution networks in Poland. The main goal of this method is the network losses calculation in the networks with variable loads and with absence of the detail network information. The program EuroStra2004 provides the losses calculation on the based of this methodology.

The goal of the paper is to present the losses calculation in Slovak distribution networks by using the mentioned program.

## *2. CALCULATION*

At first, it is needed to discuss different types of losses usually rising up in various voltage networks. Conditions of the losses calculation in the given network is the transformation of this network to the ideal network (the network with lowest losses) – radial or planar network. In the account there are taken several factors, which cause the losses increase e.g.: the load changing in a system by daylight, historical development of the network, network conditions, type of the network, load asymmetry, place of the supply (figure 1), different distances between customers and different demands, different daily maximum demands, etc.

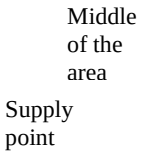


Figure 1: Point of the supply

Figure 2 shows one of the taken factors: Extension factor, which in a real network cause increased losses, because a real consumer is not feed directly from the source, but via existing lines and it is the main reason of increased losses. In Table 1 there are shown factors derived from Figure 2.

| Network | Factor of lines extension | Factor of increased losses |
|---|---|---|
| Low voltage cable network (town) | ~ 2,00 | ~ 1,30 |
| Medium voltage cable network (town) | 2,20 | ~ 1,23 |
| Overhead medium voltage line | 1,42 | ~ 1,37 |
| Overhead high voltage line (110 kV) | ~ 1,5 | ~ 1,30 |

Table 1: Factor of line extension and factor of increase in losses

The calculation discussed in [1] is based on statistical methods. For all networks (low voltage, medium voltage and high voltage (110 kV)) used in the calculation there are described reasons and presumptions for the inclusion in the calculation. Because of the lower losses in new devices there is in the algorithm included historical development of the devices used in the networks.

At the beginning of the calculation there are used default values of several parameters for solved network, which are changed during the calculation for given network and they are incident to the energy entering the given network in this order: low voltage, medium voltage and high voltage (110 kV).

Figure 2: Extension factor

The parameters changed in the calculation are used for the calculation of justified losses.

The last part of this work is the justified losses calculation. The main goal of this calculation is to show, where the distribution company could decrease these network losses without further investment. Below we can see algorithm of this calculation.

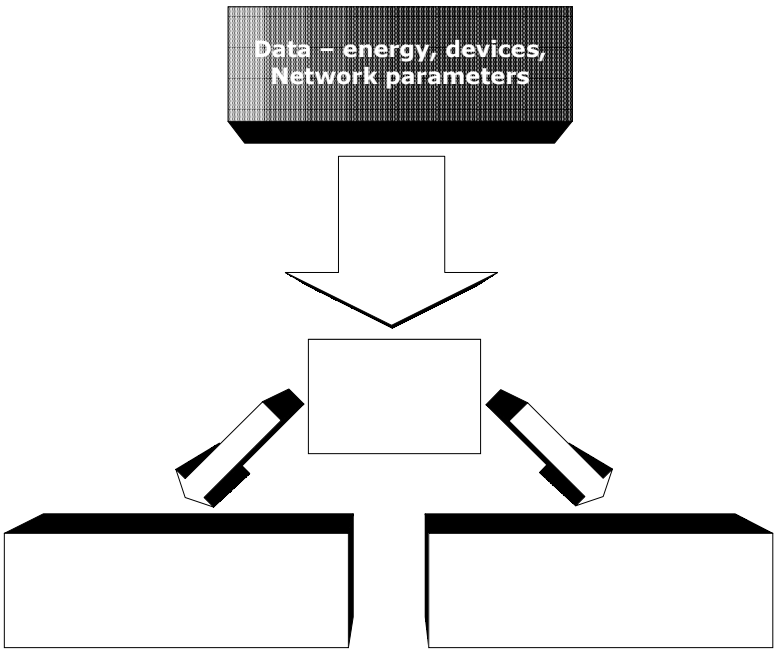


Figure 3: Principle of operation

For the losses calculation this method uses global values of the network and energy to the given networks with regard to the type of the network.

In low voltage and medium voltage networks we need the following data about network e.g.:

- surface area,
- the number of consumers,
- 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.

In the next part of the calculation there are needed energy data.

In low voltage and medium voltage network e.g.::

- devices (e.g. the number and power of transformers and capacitors) 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,
- transit, export to another distribution companies (medium voltage).

In high voltage network e.g.:

- energy supply to medium voltage and high voltage networks,
- transit, export to another distribution companies,
- balance losses in high voltage (110 kV) network,
- energy import.

And finally, in the program there are compiled hidden data for the particular company, e.g. older devices, length of lines in 1976, the number and power of transformers in 1976.

The procedure of the calculation is shown in figure 3. In the calculation there are used default parameters about networks, entered values about devices and energy data.

At first, during the iteration process there are evaluated and corrected network parameters used in the next step for the losses calculation. The calculation is divided into the 2 steps.

In the first step there are calculated real losses in the network.

In the second step there are calculated justified losses for the calculated networks, but with some changes in the calculation procedure. The main change is that calculated parameters are used for the losses calculation in the network with ideal operation. The next change is that in some cases it is not possible to decrease losses, e.g. in meters and technical losses in low voltage connection line and they are copied from the real losses calculation. And finally there are calculated other losses. This program is not for the draft of optimal operation, but it shows, where could be the optimal operation.

The result of the calculation shows losses in low voltage network, e.g.:

- Losses in meters,
- Capacitors losses,
- Losses caused by load,
- Leakage losses, etc.

In medium voltage network:

- Capacitors losses,
- Losses caused by load,
- Leakage losses, etc.
- Winding and core losses, etc.

In high voltage (110 kV) network:

- Capacitors losses,
- Losses caused by load,
- Current and voltage (corona) losses.
- Winding and core losses, etc.

Described methodology of the losses calculation was applied to the losses calculation using the program EuroStra2004 in the distribution networks of the distribution company VSE a.s. and in the imaginary village. Total technical losses per year of VSE a.s. were at the level of 10,25%, in low voltage network at the level of 6,26 %, in medium voltage network at the level of 6,78 %, in 110 kV network at the level of 1,77%.

Figure 4 – Total losses in meters in year 2002 and figure 5 – Total technical losses in Year 2002 show losses progress/development in year 2002.

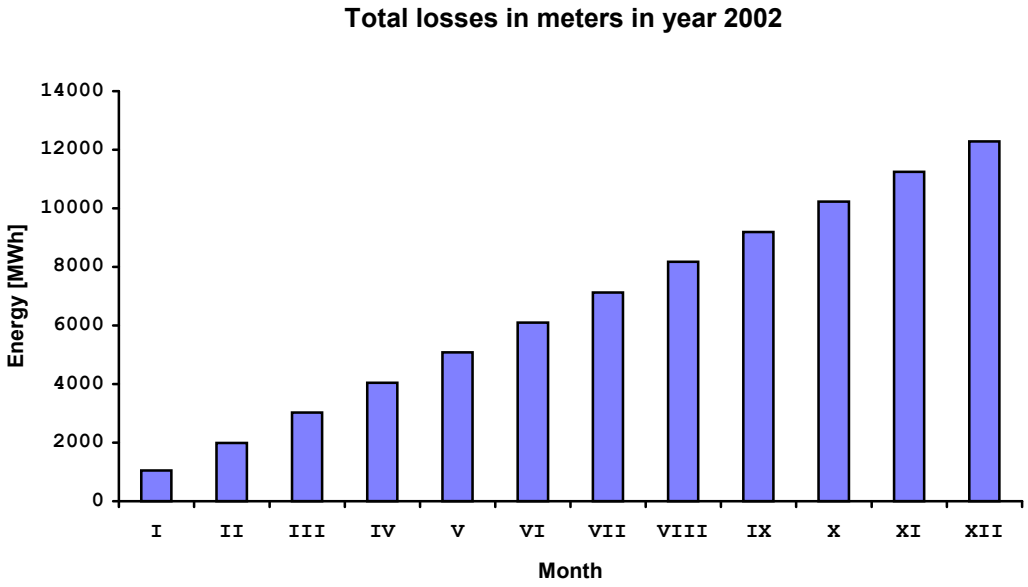


Figure 4: Total losses in meters in year 2002

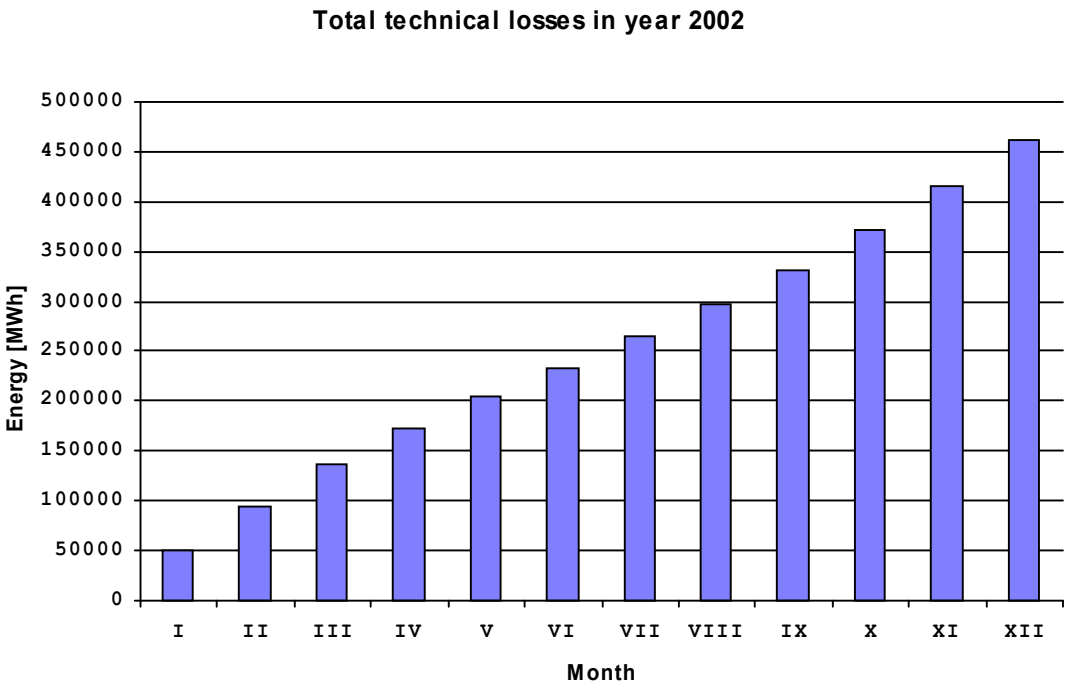


Figure 5: Total technical losses in year 2002

## *3. CONCLUSIONS*

The described methodology is suitable for the operative losses calculation in distribution networks. It is fast calculation of the losses, based on global network parameters with regard to the devices connected to the network, loads, type of the network, status of the network, length of lines, etc. at using statistical methods. At the same time it is available the calculation of the justified network losses, which could be reached without installation of any additional devices.

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## *4. REFERENCES*

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