IMPROVING THE ENERGY EFFICIENCY IN POWER DISTRIBUTION NETWORKS THROUGH LOSS REDUCTION

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SUMMARY

In the present energy crisis, saving power has become a major problem at an international level. Studies have showed that reduction of losses in the power networks is much safer than the increase of generating capacities, and energy efficiency represents the cheapest resource of all.
The Romanian national strategy for energy development also includes as a main objective the improvement of energy efficiency through the entire chain: resources – production – transportation – distribution – energy consumption.
Replacement of the centralized type network by the decentralized one was proposed as a method of loss reduction in the distribution networks.
The comparative technical and economic calculation was based on the following criteria: updated maximum net income (UNI), updated minimum total expenses (UTE) and minimum return of investment (ROI).
The suggested method represents a measure of control and supervision of the power consumption (which means the technologic own consumption of the network operator), without involving the resources or consequences over the environment.

Key words: energy efficiency, descentralized network, loss reduction.

1. POWER LOSSES IN ELECTRICAL NETWORKS IN THE PRESENT ENERGY SITUATION

In the present energy crisis, saving power has become a major problem at an international level. Studies have showed that reduction of losses in the power networks is much safer than the increase of generating capacities, and energy efficiency represents the cheapest resource of all.

The special technical literature has highlighted new conditions for the problem of power losses after the appearance of the power crisis (during the '70s), from the point of view of their price as well as of the necessity of saving power as such. Nowadays, it is univocally acknowledged that the reduction of losses – especially in the distribution networks – leads to power and energy cheaper than building new capacities of production and transmission.

On the other hand, power has been more and more perceived as a public service for the benefit of the population as well as a need for the economic activity. The consumers must perceive the responsibility to be provided with this service not only as the right to be served, but also as an obligation to rationally use power, under conditions of energy efficiency. This is one of the messages in the Green Card of EU when referring to a new method of managing power needs.

Under these circumstances, the persistent energy policy aims at maximizing the citizens' long-term welfare, keeping a dynamic, reasonable balance between safe supply, competition in the energy service and protection of the environment, in response to the needs of the energy system.

Many communities, in both developed and developing countries are seriously concerned with the problems stemming from energy production and use. Increasing demand and costs, along with environmental and social impacts are most serious of them.

For the most part, developed countries have created vast and complex networks for supplying their communities with electricity. However, this centralized system is unable to handle all the problems effectively.

For this reason, communities should begin to rethink their energy systems. Developed regions can move towards a flexible, efficient descentralized energy system that is sensitive to social concerns. As for communities in developing countries, instead of investing in costly large power plants and transmission and distribution (T&D) infrastructures, they can create, from the outset, local energy power systems.

Descentralized energy can work with ordinary or innovative, conventional or renewable technologies, and can provide energy in the form of electricity, heat or cooling. The use of small-scale and modular technologies can properly match supply and demand on-site.

The actual share of descentralized power in the world market is about 7% and it is expected to continue growing.

Distributed generation has many potential benefit. These include the reduction of line losses, deferral of investments in transmission and distribution networks and new central station facilities, providing additional reliability through the supply of back-up power and ancillary services and, in electricity markets, helping mitigate potential market power abuses.

In this context, the Romanian national strategy for energy sector development also includes as a main objective the improvement of energy efficiency through the entire chain: resources – production – transmission – distribution – consumption.

Energy efficiency is accepted by the specialists as the most available, the least pollutant and cheapest resource of all. In order to explain this, it was proved that 1 installed kW is four times more expensive than 1 saved kW.

Through the regulation system the interest of the operators in the power distribution and provision was stimulated in order to improve efficiency of the power distribution networks. It

is the very case of the efficiency target factor – Kef, which is present in the income calculation of the price for the power distribution service. The quality of the distribution service can be "measured' by the performance indexes (number and duration of the interruptions) and taking into account the values of these indexes, the distribution operator can be fined or rewarded for the inobservance or overpass of the quality indexes.

2. THE BASIC IDEA OF THE WORK

Keeping these considerations in view, replacement of the centralized type network by the decentralized one was proposed as a method of loss reduction in the distribution networks.

- the centralized low voltage network (created in Europe) is based on a high number of transformation stations of high voltage and an extinguished low voltage network for 10-200 consumers.

- the decentralized low voltage network (created in North America) is based on small transformers, mounted at the consumption centers or very close to them, being provided or not with a small distribution system of low voltage, each transformer supplying power for about 1-15 consumers, according to the charge density.

The main differences between these two concepts are as follow:

- in the centralized systems, power is being distributed to the consumers through the low voltage lines, while decentralized systems practically distribute power in the consumption centers at a medium voltage.

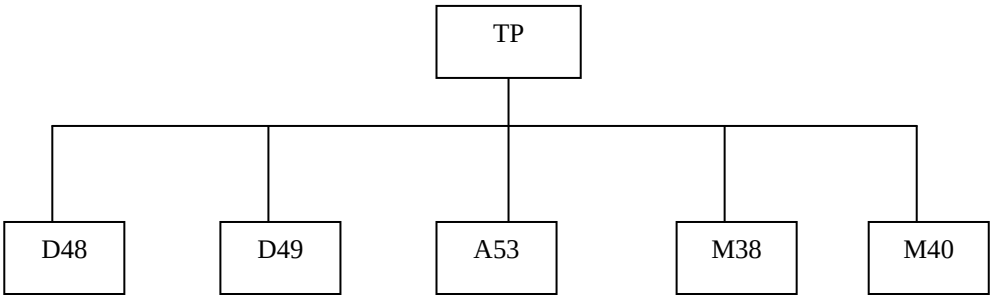
- decentralized systems require about 6% higher investments, because of the extension of medium voltage lines and of the higher number of small unitary power transformers;

- the centralized system proves to be economically more efficient, without taking into account the network losses, but observing the ones at the actual value, the system is practically disqualified.

As an example, here is a real case of a centralized network, where the losses were calculated: a transformation station of 10/0.4 kW, 1*400 kVA, supplying with power 5 blocks of flats comprising 500 apartments.

3. ANALYSING OPTIONS

1. Amplification of the existing transformation station from 1 x 400 kVA to 1 x 800 kVA, as in 10 years the consumption is estimated to grow up to 700 kVA. The low voltage network will be centralized and the scheme as follows:

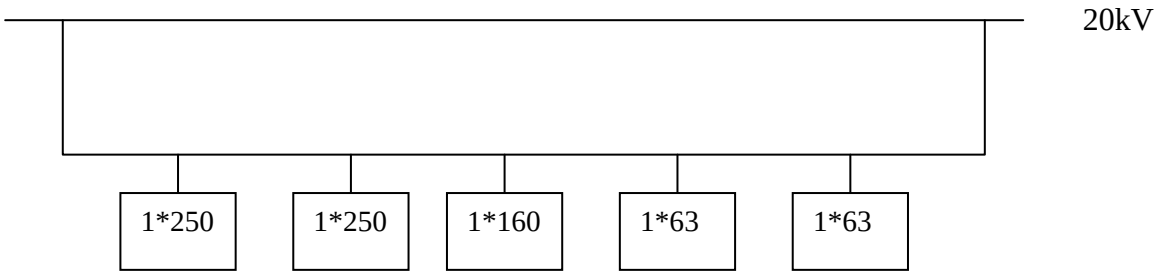


2. Decentralization of the low voltage network, by installing lower power transformers at the consumers, as close to the consumption barycenter as possible:

- 1 x 250 kVA transformer at block D48

- 1 x 250 kVA transformer at block D49
- 1 x 160 kVA transformer at block A53
- 1 x 63 kVA transformer at block M38
- 1 x 63 kVA transformer at block M40

The scheme is easy and much more reliable thanks to the equipment and can be represented as follows:



The transformers will be connected by derivation to the medium voltage network. Low voltage supply will be accomplished from the transformers low voltage panel.

Decentralization of the low voltage network by installing transformers at the consumer's and using equally powerful units of 63 kVA:

- One transformer for every two entrances at the blocks with 8 entrances
- One transformer for every two entrances at the blocks with 4 entrances
- One transformer for each of the blocks with one entrance.

The scheme contains a total of 12 units 63 kVA transformers and resembles the decentralized, five transformation stations option.

4. COMPARING OPTIONS

The comparative technical and economic calculation was based on the following criteria: updated maximum net income (UNI), updated minimum total expenses (UTE) and minimum return of investment (ROI). The results are given in the following table:

	Costs (EUR)	**Losses (kWh)**	**UNI (EUR)**	**UTE (EUR)**	**ROI (years)**
1st option	**108 173 100%**	**96 322 100%**	**173 180 100%**	**-27 554**	**-**
2nd option	**152 776 141%**	**51 012 53%**	**173 134 99%**	**9 569**	**5.7**
3rd option	**325 886 301%**	**57 945 60%**	**349 009 201%**	**-127 788**	**-**

5. CONCLUSIONS

- The supply by centralized LV distribution network has the biggest losses (1st option);
- The supply by decentralized LV distribution network with 12 equally powerful transformation stations – 63 kVA – was considered the most expensive. It induces a 40% lower loss in the network as compared to the centralized option, but the investment is 200% bigger.
- The supply by decentralized LV distribution network with 5 transformation stations was considered the optimum option from a technical and economic point of view. The economic parameters as well as those of the efficiency reached values that justified the choice and implementation of this supply option for the analyzed area as proposed for modernization. The expenses (NUI) are barely lower than those for the centralized option. There are the smallest losses (by 47.1% lower than for the centralized option) and the recover duration is the shortest and also corresponds to the recommended values for investments in energy installations (under 8 years). This is the only option where NUI > 0, which represents a compulsory criterion for accepting such an investment project.
- It is opportune to adopt the supply option in the block of flats area by a decentralized low voltage network, with 5 transformation stations installed at the consumers'. Reduction of the low voltage network will determine the reduction of losses (on low voltage).

Less powerful transformers used along with the optimization of the dimensions – in the compaction option – will determine the reduction of necessary spaces and the expenses for the occupied areas.

A simple, highly reliable scheme involves on the one hand lower maintenance and exploitation expenses and thus a reduction of the costs and implicitly a lowering of the power's price at the final consumer. On the other hand, the scheme will bring about a higher quality of the distribution (fewer and shorter interruptions), in other words, a higher continuity in power supply.

The saved energy resulting from reduction of losses can be turned into the equivalent of the unproduced emissions, as a consequence to the ungenerated energy (as it is saved) and the right to produce that insults quantity can be exploited.

A DSM (Demand Side Management) policy can be adopted, too, by involving an investor to accomplish works of efficiency growth in the distribution system. The costs will lower, following the reduction of losses, but the price will remain constant at the final consumer, allowing the investor to recover the difference, aside the already existing profit.

The suggested method represents a measure of control and supervision of the power consumption (which means the technologic own consumption of the network operator), without involving the resources or consequences over the environment.

Reduction of losses means efficiently using the energy, saved energy and less generated energy. All these lead to the rational use of the resources, that is to a durable policy of energy development

The analysis can be made for a pilot case selected on the following criterion: an area with old installations, which must be modernized or on the criterion: an area known for the losses in networks etc.

6. REFERENCES

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