MODELLING POWER SUPPLY TO MINIMIZE ENERGY LOSSES DURING TRANSMISSION

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In the context of Ukraine's integration into the world and European society, the issues of transition to world energy consumption standards are quite acute. One of the main problems that must be solved at this stage is the problem of energy saving. The task of saving of electric energy can be solved by two ways: saving of resources by ultimate users and minimization of losses of electric power in power supply grids. If the problem of saving resources by ultimate users can usually be solved by using energy-saving devices and technologies, one of the ways to reduce losses in power supply grids can be reached by optimizing the distribution of electricity flows at suppliers' side. A scientific solution of these problems can be found by using mathematical models and optimization methods, in particular by using non-linear programming.

Consider an optimization problem of energy flow distribution in the simpliest radial electricity grid, which consists in optimal connection of n new consumers with power capacity P_j of each (j=1,2, .., n) to m distribution points Dp_i (i=1,2, … , m) in existing grid. Each i-th distribution point has maximum feasible capacity Q_i specified in kW, q_i kW of which is utilized by consumers.

An optimal plan should be found for distribution of new capacities P_j from the specified distribution points Dp_i to each new consumer. The total losses of power in the whole grid because of new connections should be minimum possible by taking into account existing consumers. In this problem we shall assume that each consumer H_j can obtain energy from each distribution point Dp_i.

Assign the capacity obtained by new j-th consumer through line L_{ij} from i-th distribution point Dp_i to the unknown x_{ij}. The system of constraints for the grid contains two groups: m for feasible loadability of each distribution point with consideration of current consumers' capacities q_s: $\sum_{j=1}^{n} k'_{ij} \cdot x_{ij} \le Q_i - q_i, \quad x_{ij} \ge 0, \; k'_{ij} = (1 + k_{ij} \cdot 10^{-3}), \quad i = \overline{1,m}$ and n constraints for ensuring capacities P_i of each new consumer H_i: $\sum_{i=1}^{m} x_{ij} = P_j, \quad x_{ij} \ge 0, \quad j = \overline{1,n}$.

It is considered that constraints for the feasible losses of voltage ΔU in power transmission lines are taken into account while defining maximum acceptable capacities Q_i of distribution points and transmission lines. Total losses of loadings in this grid (the objective function) influenced by all new consumers and known values of all electric power line parameters k, U, cos(φ). Power losses into distribution point are considered insignificant compared with losses in electric power lines:

$$S = \sum_{i=1}^{m} \sum_{j=1}^{n} k_{ij} \cdot x_{ij}^2 + \sum_{i=1}^{m} kp_i \cdot \left(q_i + \sum_{j=1}^{n} k'_{ij} x_{ij} \right)^2 \to \min .$$