Control level losses of electric powers distributing network company at market conditions

N.V. Savina, Y.V. Myasoedov

Abstract – **The technology of the choice optimum toolbox reductions of the losses to electric powers in conditions of the uncertainties for network distributing companies are designed.**

Index Terms - **losses to electric powers, distributing network companies, liberalization, control, information, uncertainty, efficiency.**

I. INTRODUCTION

In connection with development of the market relations in country value problems spare electric powers, the integral parts which are a loss to electric powers, greatly increased.

This is conditioned firm trend of the growing of the share of the energy expenses in prime cost of the product under continuing growing specific consumption product in all branch of the economy practically, increasing tension fuel-energy balance of the country, under which reduction of the losses to electric powers becomes one of the most important aspect energy-saving politicians.

Liberalization market to electric powers in Russia has brought about ubiquitous growing of the losses to electric powers, in spite of essential progress in a part of the technical condition of the systems of the account to electric powers. Herewith increase both forming reporting of the losses: technical and commercial. Their correlation and track record differ in different network company not only, but also inwardly companies themselves. The General is a trend of their increase.

Big bifurcate and extent of the distributing networks, sloppy and lumpy nature of the load, low observation electric networks, absence to information on topologies and load for considered length of time do not allow the working personnel to get reliable importance's of the losses to electric powers that reduces efficiency of the measures on spare electric powers and is indicative of that generally accepted approaches to decision of the considered problem turned out to be insolvent.

Obviously that decision of the problem of the losses to electric powers, directed on reduction of the technical losses only, will not give the significant result. Because of slip-up in evidence counter to electric powers, non-account factor to uncertainties is distorted real picture of the losses to electric powers.

Consequently, and actions upon their reduction, designed on base existing methods and approach to determination and analysis of the losses to electric powers in set, where great share to uncertainties, will not give the desired result.

Thence follows that problem of the reduction of the losses to electric powers in electric set not only has not forfeited to urgency, but also became one of the important problems of the provision to financial stability of the distributing network companies.

The Intensification of this problem has required active searching for of the new ways of her decision, which must be chosen and realized with provision for essential change, contributed liberalization power energy that intensifies the degree to uncertainties in choice action, directed on reduction of the losses to electric powers.

The Purpose of the work is a development to technologies of the choice toolbox, providing optimum reduction of the losses to electric powers in distributing network company, at condition liberalization energy.

For achievement given purposes are solved following problems: development of the methods of the complex analysis of the losses to electric powers in distributing network company at incompleteness and invalidations to source information; the development of the program of control level losses to electric energy, identical particularity of the distributing networks.

II. CHOICE TOOLBOX, PROVIDING OPTIMUM LEVEL OF THE LOSSES

A. Influence liberalization energy on level of the losses to electric powers and efficiency action upon their reduction in distributing set

The structure changed at liberalization electric powers to branches that has brought about mismatch her technological and organizing structures and essential complication of management to her. Established economic situation with fundamental characteristic of the power systems has brought about intensification of the problem of the reduction of the losses to electric powers and has translated her in category of the problems, correct decision which possible in condition of the uncertainties only and with provision for regularities of the development market to electric powers. Given position is conditioned following factor.

Continuing liberalization economy has brought about creation competitive market to electric powers. The carry out restructuring is connected with decomposition of the structure to branches, introduction to competitions, and choice of the supplier to electric powers and has brought about need of the decision of the inconsistent problems of the efficient work market and conservations normative level to reliability of the power supply of the consumers.

When operating and development wholesale and retail market to energy and powers accident and ambiguity, conditioned by high instability mode, stochastic change parameter mode, only increase that tells both on most value of the losses, and speaker of their change. Exists essential increasing to uncertainties to mode of information because of big uncertainty of the market conjuncture.

Thereby, in modern market condition, which are characterized by ensemble independent subject, together functioning in united system, but having own interests, role to uncertainties at decision of the problems of the determination and reductions over normative losses, appearing at usages of the distributing networks, increased and translated their decision, in absolutely other rank.

In the opinion of international expert, the relative losses to electric powers under her transmission and distribution in electric set majority countries possible to consider satisfactory if they do not exceed 4-5%. In ditto time in Russia relative losses to electric powers in 2-2,5 times exceed the level of the losses in industrial developed country. Herewith in electro network organization their value reaches 20% from furlough of the electric powers in network, in row region - 30-40%, but often well above. In recent years, as from 1994 year, absolute losses to electric powers in set increased on 37,6%, but relative – on 18,8% when increase the furlough to electric powers in network on 7,2% only [1].

The High level of the losses to electric powers in distributing network company is basically conditioned following factor: non-optimal state of working networks, which are characterized big dispersion active and reactive powers, deflection of the voltage in nodes - up rated in set of high power and understated in removed from the centre of the power supply point networks of the classes of the voltage 35, 10, 0,4 kV; the defect adjusting facilities, absence and unsatisfactory compensation to reactive power; unevenness graph electric loads with greater peak in watch of the maximum of the loads and collapse in watch of the minimum, low observing of the networks because of insufficient amount measuring complex to electric powers, absences of the facilities tele-measurements, inefficient account to electric powers.

Insufficiency of the facilities of management flow active and reactive power affects on level of the losses. Broad introduction on industrial enterprise of the specific loads, - such as rectifier device, welding, electro thermal installation, arc steel-melting stove and others - conditions increase the losses to electric powers to account of the distortion current and voltages. Increased and loss on own necessities substation.

As source information at determination of the losses in distributing set are used results of the

integral account to electric powers that brings about significant mistake.

In distributing network company actual not balance electric powers often exceed possible importance's and vary within from -80% before +60% from furlough of the electric powers in network. Their track record, both on substation and on networks as a whole characterizes the accident, trend to increase.

It is not enough counter for account of the furlough on step of the voltage of the distributing networks, particularly low and average voltage though in these set concentrated main share commercial losses exactly.

The Analysis given about instrument of the account to electric powers in row of the network companies has shown that less half's of them meet the requirements normative document, and majority single-phase counter requires change. In ditto time economic unbeneficial tie around facility of the measurement to electric powers all leaving joining substation distributing networks.

Presenting distributing networks as complex managerial system, possible approach to decision of the problem of the reduction of the losses, using bases of the system analysis that will allow her solve in complex by loss level control in condition of the uncertainties.

At problem of control level losses to electric powers consists of two stages: complex analysis of the losses; the choice optimum toolbox for minimization of the losses.

B. Methods of the complex analysis of the losses to electric powers

For exception of the uncertainties of any sort at study of the losses to electric powers reasonable to use the structure of such losses, in which they are divided into component, coming from physical nature information flow and losses themselves, real conditions to usages of the electric networks.

Such approach conditions the structure of the losses to electric powers in distributing set on the following sign: in element of the network; depending on parameter of the mode; on

quality of source information. Herewith stand out the loss from inferior electric powers, metrological and commercial losses, to which also pertain the loss to electric powers, conditioned inaccuracy of the calculation of the technical losses to electric powers.

The Structured analysis of the losses to electric powers supposes their study in speaker: on class of the voltage; on type forming losses; on type of the equipment; on types of the consumers to electric powers and their percent contents in electroconsumption; on dependencies from furlough of the electric powers in network; on loading element to network; on dependencies from gap of the electric powers through element, the area to network (apart for each type of the losses); on quality information flow; on temporary interval.

The Study of the losses reasonable to conduct with attraction theory of chances, for instance, by collations speakers to density of the distribution factor loading power transformer and density of the sharing the losses to electric powers in them or speakers to density of the sharing the losses to electric powers in element of the network and in network as a whole and gap through them electric energy, density of the distribution conditionally-constant losses and level of the voltage in network.

The Detailed analysis of the losses to electric powers in concrete electric network will allow choosing the optimum toolbox upon their reduction and forecasting and getting most profit in condition of the usages.

For efficient control level losses to electric powers their complex examination in distributing network company reasonable to realize in the following order.

The Study track record to realization to electric energy with division her on furlough of the electric powers in network and furlough consumer.

Collation track record reporting and technological losses with track record of the furlough to electric powers in network

Detailed structure of the losses in track record.

3

Study track record all forming loading and conditionally-constant losses.

Estimation of the share of the losses on own necessities.

The Analysis of the commercial and metrological losses.

The Collation with relative loss in the other region RF and in the other country.

Discovery "centre" raised losses on all their leaving with detailed analysis.

The track record of the furlough to electric powers in network and from network and level of the losses to electric powers in distributing set reasonable to conduct for three - five years on network as a whole, and on class of the nominal voltage apart.

Is it Herewith valued correlation losses and their forming as with furlough of the electric powers in network, so and with furlough her from network, with loading power transformer and line electrical transmission.

It Is Defined nature trend furlough to electric powers in network and matches up with trend of the losses. Herewith actual losses are divided on technological and commercial. The Structure normative and over normative of the losses in network company required for separation that network region, in which value of the losses to electric powers inadmissible big.

The Further analysis of the losses is realized in these regions on class of the nominal voltage in the first place. It Is Produced estimation of the share technical and non-technical of the losses, as well as correlation of the losses, including their component, and furlough to electric powers in network on season of the year.

The Losses are grouped on type of the equipment substation and line electrical transmission. Stand out importance forming losses to electric powers in percent from furlough and consumptions to electric powers, and is conducted their analysis with allocation technical and metrological forming.

The similar analysis is Realized on joining substation, are defined over normative of the loss, and are revealed that joining, in which exists inadmissible big their level. They Are Revealed and analyzed reasons established to situations.

For instance, such analysis has allowed to select the network 35 kV Mihaylov district Amur region, where actual losses from furlough 54,8 % have formed in network. In percent attitude growing furlough to electric powers for the last three years has formed 14 %, with corresponding growing of the losses on 26,5 %. Sharply increased the share a non technical losses.

The Analysis of the considered period on season has shown that increases the share of the year load with simultaneous reduction of the year actual losses.

Considering relative growing of the annual actual losses on 26,5%, obviously that falls the share an loading losses comparatively reporting. At trends to increase electro consumption for three years growing technological losses exists on 14% in network 35 kV on 8 % at growing of the actual losses for the same period on 26,5 % that speaks the share of the commercial losses of increase.

At, importance of the technological losses increases in year months of the year, at reduction of the furlough to electric powers in network. At reduction electro consumption at year months occurs the typical reduction of the actual losses. T

he Growing of the technological losses in these months speaks of increase metrological forming losses. The Losses on own necessities 7 % have formed in network 35 kV. Low loading power transformer exists In network 35 kV with the result that loading of the loss small for losses of the castrated move.

The Analysis of the losses in equipment substation (except power transformer) has shown that the most significant share in they contribute the loss in transformer of the voltage, equal 6% from technological losses.

The Analysis has also shown that commercial losses change in it is enough broad limits, herewith have not determined to dependencies.

Having diarrhea correlation actual losses with furlough of the electric powers in network is caused commercial loss moreover they have most importance's in heating season.

The Analysis of the metrological losses has shown that not before account electric powers exists in network 35 kV.

Organized ranking the joining substation on this value. In row leaving joining exist the inadmissible greater over normative of the loss. Will Realized their ranking and is revealed reasons of the high losses.

C. Technology of the choice optimum toolbox for minimization of the losses to electric powers

In market condition when operating the distributing networks by specific particularity of the problem of the reduction of the losses is their uncertainty and joint her decision integer beside owner of the power system. Looking into a matter of the reduction of the losses to electric powers as complex problem, necessary to bear in mind that there is principle difference in efficiency of the reduction of the technical losses from commercial.

The Effect from reduction of the technical losses to electric powers is expressed in direct her spare, in partial increase of reception capacity element.

The Effect from reduction of the commercial losses to electric powers of the direct advantage does not give, but on essences allows sparing the financial facility and obliquely influences upon reduction of the technical losses to account of more exact information on flow of the electric powers on networks and more exact choice action on reduction of the losses.

This leaves its mark upon on determination criterion to efficiency - generalized factor, allowing chooses the optimum toolbox for reduction of the losses i.e. collection best action upon their reduction in distributing network company.

The Choice such toolbox must be realized in the following order: development of the comprehensive program of the reduction of the losses to electric powers on base of the analysis

of the revealed reasons of the high losses with delimitation of the zones to responsibility; the development action on reduction of the losses to electric powers on base optimized methods in condition of the uncertainties with separation expenses; the estimation to cost-performance action and their ranking on influence upon level of the losses and on expenses; the choice of the optimum set action on minimization of the comprehensive program of the reduction of the losses to electric powers comprises of itself subroutines of increasing to accuracy of the account to electric powers, reductions technical and commercial losses to electric powers.

The Program of increasing to accuracy of the account to electric powers consists of the following stage: determination of the optimum places of the installing the facilities of the account to electric powers; the determination to fitness measuring transformer to account; the determination to fitness to account counter to electric powers; the reduction to inaccuracy of the measurement to electric powers; change induction counter to electric powers on electronic in elements of the network in accordance with touch analysis; the reduction systematic forming inaccuracy of the account electro consumption; validation result of the account electro consumption, got by means of existing systems of the account.

The Program of the reduction of the technical losses to electric powers comprises of itself following stages: optimization level voltages in distributing set; the compensation to reactive power and control flow to reactive power; increasing quality to electric powers; the optimization mode in distributing set in condition of the uncertainties; the optimization of the scheme of the electric networks and places of the unstitching; the complex automation and tele mechanization electric networks; the reduction to duration non-optimal repair and post breakdown mode; sequencing the powers transformer on substation and provision their economic expedient mode; the translation long networks on more high level of the voltage and change not insulated wire on insulated.

The Program of the reduction of the commercial losses to electric powers contains the following subroutines: modernization of the systems of the account to electric powers; the determination and reduction to methodical inaccuracy of the calculation of the technical losses; the fight with misappropriations of the electric powers; the system development of the encouragements for reduction of the losses to electric powers; increasing to efficiency of the functioning the metrological services of the companies; the reduction of the losses when exposing count; the calculation of the commercial losses as financial losses of the power system.

The Ways to realization of the chosenned complex of the programs on reduction of the losses to electric powers are in detail presented in designed recommendation [2], which are a generalization big amount functioning, denoted problem of the reduction of the losses to electric powers.

The Choice concrete action, providing optimum level of the losses for concrete network object, associate with beside difficulties.

Thence appears the task of the estimation to efficiency and ranking action and their collections in condition of the uncertainties.

To her decision possible to approach, using system analysis. For this is formed matrix to efficiency action on reduction of the losses to electric powers in the manner of, shown in table 1.

TABLE 1. MATRIX TO EFFICIENCY PROPOSED ACTION

a_i	n_j						$K(a_i)$
	n_1	n_2	n_3	$\cdots$	n_i	n_m	
a_1	k_{11}	k_{12}	k_{13}	$\cdots$	k_{1i}	k_{1m}	
a_2	k_{21}	k_{22}	k_{23}	$\cdots$	k_{2i}	k_{2m}	
a_3	k_{31}	k_{32}	k_{33}	$\cdots$	k_{3i}	k_{3m}	
$\cdots$	$\cdots$	$\cdots$	$\cdots$	$\cdots$	$\cdots$	$\cdots$	
a_n	k_{n1}	k_{n2}	k_{n3}	$\cdots$	k_{ni}	k_{nm}	

Here a_i - ensemble action, where $i = \{1,2,3...n\}$; n_j - ensemble forming losses to electric powers, $j = \{1,2,3...m\}$; k_{ij} - importance (estimation) to efficiency i- actions for j- forming losses to electric powers; $K(a_i)$ - efficiency of the program of the reduction of the losses to electric powers as a whole.

Each line of the table contains importance's of efficiency of one action for all forming losses to electric powers, chosen by structured analysis (as technical, so and commercial), each column - importance's of efficiency all action for one forming losses to electric powers.

Choice to collections action and their ranking on maximum effect can be realized by means of criterion, used in vague operation: average advantage, Valid, Maksimaks, Gurvic, Sevidzh.

The Criterion of the average advantage expects the task of probability forming losses to electric powers for under investigation object, which can be described as share these forming in the total value of the losses to electric powers. Efficiency of the program of the reduction of the losses to electric powers is valued as population mean estimation to efficiency on all forming losses to electric powers:

$$K(a_i) = \sum_{j=1}^{m} P_j k_{ij}, \qquad (1)$$

where P_j - probability j- forming losses to electric powers; under ill-defined description - a function accessories.

Optimum program of the reduction of the losses to electric powers (collections action) will correspond to efficiency

$$K_{opt} = max \sum_{j=1}^{m} P_j k_{ij}. \qquad (2)$$

The Criterion Valida - a maximum criterion, guaranteeing determined advantage under the worst condition. He is founded on that that if financial provision to realization of the program of the reduction of the losses unknown or indefinitely, that it is necessary be

orientated on minimum importance of efficiency of each action and their collections. Then in each line of the table to efficiency is found minimum from estimation on different forming losses to electric powers:

$$K(a_i) = \min_j k_{ij}. \qquad (3)$$

Optimum is considered action from line with maximum importance of efficiency:

$$K_{opt} = \max_i \left(\min_j k_{ij} \right). \qquad (4)$$

The Maximum criterion orientates on decision, not containing element of the risk, and allows ranking the actions for making the optimum program of the reduction of the losses to electric powers.

Criterion Maksimaks allows to value actions on maximum importance of efficiency and choose as optimum decision collection action, possessing efficiency with most from maximum:

$$K(a_i) = \max_j k_{ij};$$
$$K_{opt} = \max_i \left(\max_j k_{ij} \right). \qquad (5)$$

Criterion of Gurvic allows, considering the most high and the most low importance's of efficiency, choose intermediate position.

Factor of the optimum is entered for this b $(0 \le b \le 1)$, characterizing attitude to risk of the person, coming to a conclusion.

Efficiency of the system is found as weighted by means of factor amount maximum and minimum estimation:

$$K(a_i) = b\max_j k_{ij} + (1-b)\min_j k_{ij}. \qquad (6)$$

Condition of optimal is written in the manner of

$$K_{opt} = \max_i \left[b\max_j k_{ij} + (1-b)\min_j k_{ij} \right]. \qquad (7)$$

Here importance of the factor b reasonable to define method expert estimation.

The Sevidzh Criterion minimizes the loss to efficiency under the worst condition. For his

use matrix to efficiency must be transformed in matrix of the losses, which each element is defined as difference between maximum and current importance's estimation to efficiency in column:

$$\Delta k_{ij} = \max_j k_{ij} - K_{ij}. \qquad (8)$$

The minimax criterion is used after transformation of the matrix:

$$K(a_i) = \max_j \Delta k_{ij};$$
$$K_{opt} = \min_i \left(\max_j \Delta k_{ij} \right). \qquad (9)$$

Thereby, efficiency action at choice optimum toolbox on minimization of the losses to electric powers in condition of the uncertainties can be valued on row of the criterion, on choice which render the influence following factors: reasons to uncertainties; the nature of the person, coming to a conclusion; the purpose; the estimation of the financial possibilities; risk assessment.

Use the miscellaneous of the criterion can bring about miscellaneous result. Stability of the choice of the rational program (the actions) on reduction of the losses to electric powers it is necessary to value on base of the analysis on several критериям.
It Is Chosen that variant, on which exist the greater coincidences. Estimation to efficiency of each separate action
k_{ij} it is realized on expected clean discount income and on pay-back period.

The Broughted approach will allow in condition of the usages for each concrete network to choose that collection an action on reduction of the losses to electric powers, which and will provide the most effect.

III. CONCLUSIONS

In condition liberatization energy are saved trend of the growing of the losses to electric powers and inefficacy action, directed on their reduction that is conditioned as uncertainty of the operating the electric networks, so and regularity of the development market to electric powers.

Technology of the choice optimum toolbox is offered on base of the system analysis for maximum reduction of the losses to electric powers in distributing network company in condition of the uncertainties when operating market to electric powers.

IV. REFERENCES

[1] Methods and facility of the calculation, analysis and reductions of the losses to electric energy under her transmission on electric networks [Text] / V. E. Vorotnickiy, S. V. Zaslonov, M. A. Kalinkina and others - M. : NC ENAS, 2006. - 167 p.
[2] Savina, N. V. System analysis of the losses to electric powers in electric distributing set [Text] : monogr. / N. V. Savina; otv. ред. N. I. Voropay. - Novosibirsk : Science, 2008. - 228c. - 500 ex. – ISBN 978–5–02–023222–8.

V. BIOGRAPHIES

Savina Nataliya Viktorovna
Amur state university
Ph.Dr., prof., dean of the energy faculty
Address: Blagoveschensk, Ignatievskoe freeway, 21
E-mail: power@amursu.ru
Telephone: (4162) 39-46-31

Myasoedov Yuriy Viktorovich
Amur state university
Ph.Dr., prof., head of energy department
Address: Blagoveschensk, Ignatievskoe freeway, 21
E-mail: yu_myasoedov@mail.ru
Telephone: (4162) 39-46-33