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Facilities of energy security projection of the Northern region

In the article the significance and current preconditions for sustainable development of the Russian northern cities are considered and analyzed. Necessity of strategic management methods use for achievement of sustainable development goals by the cities is proved.

Problems of perspective estimation of energy security are designated in the paper. Using hierarchies analysis method is proposed for making such estimation; the method allows to rank alternative scenarios of social-economic development of a region by criterion of achievement energy security. The results of the first attempt to apply the method to Murmansk oblast are given. Restrictions of using hierarchies analysis method and the necessity to combine it with indicative analysis method are specified.

Perspective estimation of energy security, European North of Russia, hierarchies analysis method.

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The systems of power supply (electric and thermal energy supply, all kinds of boiling-furnace and motor fuel) anyhow cover all the vitally important spheres of a contemporary individual. The advanced fuel and energy complex is necessary for the normal functioning of all economic branches. It causes the necessity of protection the "power interests" of a person, of the society and the state; guaranteeing their power safety. According to the interpretation given by the World Power Council, power safety means "the confidence that energy will be available in the quantity and of the quality which are required under the existing economic conditions" [9, p. 25]. "The power safety doctrine of the Russian Federation" is based on this interpretation [3]. The analysis of the works on the mentioned issue [3, 6, 8, 9] allows drawing a conclusion, that the power safety as an economy's component is its basis and is necessary for its retaining at a high level.

In Russia the problems of the power safety increased in 1990th changing-over to the market economy. At that time the crisis affected all the power sectors, and it proceeded simultaneously with the national economic crisis. It is also necessary to mention that Russia has some special peculiarity. On the one hand the extensive stocks of natural power resources and the existing industrial potential of the fuel and energy complex allow not being bewared of easing the country's power independence as a whole in the foreseeable future. On the other hand disproportions of the productive forces' and the power budget's accommodation cause serious problems in power supply for many regions [9].

Thereupon the questions of diagnostics and providing power safety of the northern regions by virtue of their specific features, namely by virtue of their cold climate and high power consumption of the economy deserve separate consideration. The latter can be explained by the fact that the northern regions are rich in mineral and forest resources that determines the industrial structure with the prevalence of

such branches as the mining industry, black and nonferrous metallurgy, and cellulose and paper industry.

The Far North Regions occupy 11 million sq. km or nearly two thirds of the country's territory[1]. Because of these territories' variety it is appropriate to narrow the purview of the analysis. In the given article the northern region can be defined as a subject of the Federation located in the European part of the country. The regions of the Asian North are excluded from consideration as they have their own peculiarities (big sizes of the territory, isolated power supply systems, a smaller degree of the developing, etc.).

The Institute of Economic Matters of the Ural Branch of the Russian Academy of Science develops the technique of the power safety diagnostics, based on the indicative analysis' method which application allows to define the level of the power safety threats quantitatively [6, 8, 9]. This method assumes calculation of the indicators' set grouped in separate indicative blocks. These blocks reflect various aspects of the power activity, among them can be the following ones: the block of the electric energy supply; the block of the thermal energy supply; the block of the fuel supply; the structural and regime block; the block of the basic power reserves' reproduction; the financial and economic block, etc. For each indicator there is the estimation of the existing situation by means of comparison of actual and threshold indicator's value. By means of such comparison the situation can be appreciated as a normal, a pre-critical or a critical one. Further the estimation in indicative blocks and the estimation of the power safety level are made as a whole.

The mentioned technique has spread[2]. It allows to reveal the threats for a region's power safety that gives the information for the development of the program-principal actions directed on the improvement of the current situation. However for some reasons application of the indicative analysis for the power safety estimation in the long-term prospect is difficult.

Firstly, the socio-economic development of a region can be carried out according to different scenarios. Realization of some of them can lead to the essential change of the conditions of the electric or thermal energy's or the fuel and energy resources' deliveries, to the sharp change of the demand or the prices for them, etc. In the work [6] it is marked, that for so nice parameters as the numerical estimations of the safety threats' level, the long-term prognosis at the significant work content of calculations will be hardly productive.

Secondly, the power engineering development is determined by many factors, among them are: state, fuel and energy complex's enterprises, somewhat population. In the long-term prospect there can appear new factors, for example, enterprises of the power-intensive branches of the federal or the international levels. While estimating the power safety it is necessary to take into account the influence of these factors.

Thirdly, the multi-variant approach of the socio-economic development essentially limits the opportunity of the perspective power safety's estimation on the basis of the available statistical information. Formalized methods do not work in such conditions. On the contrary, the role of the expert estimations sharply grows. The high-quality informed experts' opinions concerning the regional development in the long-term prospect can appear more adequate, than the existing tendencies' extrapolation.

Thus, it is the extremely difficult to define quantitatively the safety threats' level in the long-term prospect. The other approach is necessary for the perspective estimation. Ranging of the alternative scenarios of the socio-economic development of the northern

[1] The problems of the North. Scientific analytical report. – Apatity: Kola SC RAS Publishing House, 2005. – P. 5.

[2] One of the examples of indicative analyses' applying to the matters of the northern regions' power safety is the following research: Barannik B.G., Kalinina N.V., Tuinova S.S. Estimation of the power safety condition of the Murmansk area (preliminary results). – Apatity: Kola SC RAS, 2004. – 34 p.

regions, revealing of the scenarios preferable from the power safety point of view can become the result of such estimation.

This problem's solution demands the account of the interconnected elements influencing the socio-economic development and the regional power safety's achievement. The brief characteristic of such elements is given below. It is necessary to note, that for each northern region their structure will differ taking into account the specificity of their economic, social, and geographical conditions.

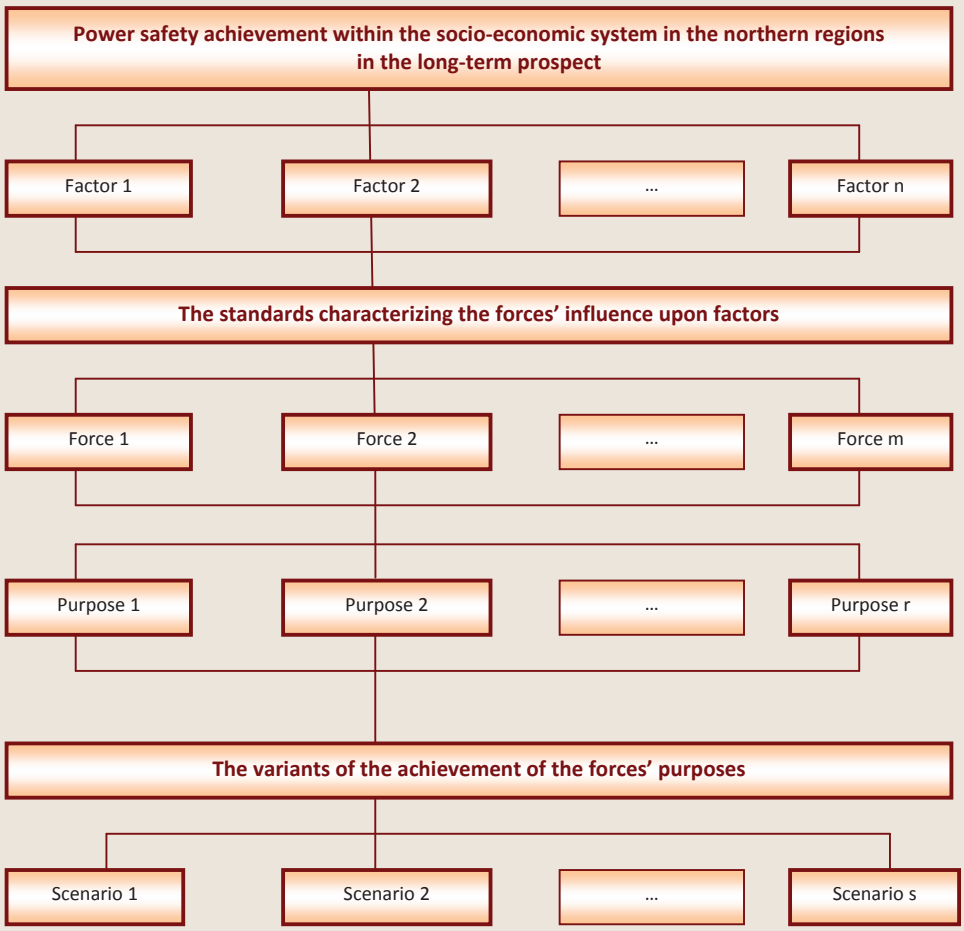
Firstly, it is necessary to take into account the factors influencing the power safety's achievement in the northern regions in the long-term prospect. Among them can be the following ones: the necessity of preservation of the sufficient capacity balances for the electric power industry, the remoteness of a region from the centers of the oil-and-gas processing, the development of the hydropower engineering or atomic engineering in a region, the presence of the fuel and energy resources' deposits and the degree of their developing, the connection of the regional power supply system with the neighbor systems, etc.

Secondly, it is necessary to take into account the factors influencing the power safety achievement. The major factors are the state federal and regional authorities, the population of a region, and the commercial structures. Among the last great role, firstly, the fuel and energy complex and secondly, the enterprise energy-intensive industries that can have a significant impact on forward power. The northern regions' specificity concludes in the fact that the interested economic structures are not only enterprises working in a region, but also holdings integrating them.

Thirdly, the perspective estimation of the power safety demands the account of the purposes which various forces pursue in the mentioned sphere. It can be the purposes in the sphere of their own power safety (industrial enterprises, population) or the power safety of a region (bodies of the government, power enterprises). The actions directed on these purposes' realization, will influence the economy's and the regional power system's development and, finally, on achievement and maintenance of the power safety. Among the purposes of the governmental bodies is the reliability of the power supply and heating for the consumers under acceptable tariffs, the reliability of the fuel supply for the consumers, completion of the budget due to the tax collections from the enterprises of fuel and energy complex. The purpose of the enterprises electro-and-heating system is its effective work, carrying out their functions of the power supply to the consumers under the condition of getting profits and realization of actions on the renewal and the development of the basic production reserves according to the needs of the developing socio-economic system of a region. The purposes of the enterprises engaged in extraction, processing, transportation of fuel and energy resources (if such enterprises operate in a region) can include the growth of extraction, creation of the capacities for processing and transportations of hydro carbonic raw material, etc. The power-intensive industrial enterprises are interested, first of all, in the reliability of the power supply under acceptable tariffs. Among the purposes of the population it is possible to specify acceptable tariffs for the electric power, heating, household gas, acceptable prices for the motor fuel, and the reliability of the power supply and heating.

Thus, the power safety achievement in the northern regions in the long-term prospect is influenced by the set of elements, and these elements are interconnected by the relations of subordination. It makes for presenting the problem of the perspective power safety estimation as hierarchy *(figure)*. In the hierarchy's focus there is "the power safety achievement within the socio-economic system in the northern regions in the long-term prospect". Lower it is situated the hierarchy levels where the elements influencing its focus are represented. The structure of the levels differs from the structure of the elements mentioned above, and it includes:

Hierarchical representation of the problem of the power safety estimation in the northern regions in the long-term prospect



1. The factors of the power safety achievement in the long-term prospect (they are mentioned above).

2. The standards describing the forces' influence upon factors. (This level is stipulated for the purpose of the more full consideration of the forces which are present at a region or can appear there in the long-term prospect. The force's influence on the factor can be characterized, for example, as "insignificant", "significant", "strong", "very strong". Such characteristics represent the standards, appropriated to the forces at the estimation of their influence on different factors).

3. The economic, political and social forces influencing the factors (they are mentioned above);

4. The forces' purposes in the sphere of the power safety (they are considered above);

5. The variants (the standards) of the achievement of the forces' purposes corresponding to different scenarios of the northern region development. (A purpose can be achieved, can not be achieved or achieved partly. Each of the alternative scenarios of the socio-economic development corresponds to some variant of the achievement of each force's purposes. For example, the realization of a script can provide the diversity of the fuel-and-energy balance of a region due to gasification, but it will not provide a high level of reliability of power supply for consumers owing to the occurrence of the generating capacities' deficiency. The other scenario can mean the

development of the electric power industry's capacities and the strengthening of the connection between the regional power supply system with the neighbor ones, that will positively affect the power supply reliability, but there can be the cost increase for the thermal energy owing to using by some part of thermal power stations and boiler-houses of more expensive kind of fuel. In the similar way each of the alternative scenarios can be compared with the variants of the achievement of the forces' purposes);

6. The scenarios of the socio-economic development of the northern regions.

Hierarchical representation of the problem of the power safety estimation in the northern regions in the long-term prospect.

Representation of the problem as such decomposition allows to apply the method of the hierarchies' analysis (which is described in the work [1]) for its decision. This method allows ranking the alternatives concerning the main criterion (represented in the focus), in this case it allows ranking the alternative scenarios of the socio-economic development of the northern regions by means of the criterion of the power safety achievement in the long-term prospect.

Application of the method of the hierarchies' analysis means comparisons in pairs of the elements of different levels which are carried out with the participation of experts in the fields of economy and power engineering. The pairs of the elements are showed to the experts and for each pair it is offered to specify, what element is preferable (is more important) for the element, connected with it, of a higher level of the hierarchy. When comparing the elements the scale of relations from 1 to 9 is used, where 1 corresponds to a situation when two elements have the identical importance, 9 corresponds to a situation when the absolute prevalence of one element over the other takes place. Experts can also consider the elements incomparable; in this case the estimation 0 is used. On the basis of the results of the comparisons in pairs the relative importance of the elements which is expressed numerically as a vector of priorities is determined. The vectors of priorities show, what factors influence the focus in a greater degree; what relative importance of the standards characterizing the influence of the factors' forces is; what purposes and what variants of the purposes' achievement are more preferable for each force.

By means of the method described above the relative importance of the elements' majority will be determined. But the relative importance in pairs "forces vs. factors" and "scenarios vs. the forces' purposes" is determined differently. For each force the standards characterizing its influence on all or some factors are given. As a result the vectors of priorities for the pair "forces vs. factors" are revealed which can be used in the hierarchical synthesis after the procedure of normalizations. Each scenario of the socio-economic development of a region is compared with the variants of the achievement of the forces' purposes. As a result the vectors of priorities for the scenarios concerning the forces' purposes are revealed which are also used in the hierarchical synthesis after normalization. For the forces and the scenarios of the regional development it is appropriate to use a method of comparison concerning standards as by means of such approach it is possible to compare a plenty of forces or scenarios, and the addition of some new force or the new scenario will not result in violation of the order of the forces or scenarios ranged earlier. Even in case of the change of the current conditions of the socio-economic development, the comparison concerning standards will enable ranking the alternative scenarios of the development without cardinal hierarchy's reconsideration, it will be necessary just to add (or to remove) the new (or not so actual) forces influencing the factors of the power safety maintenance, or the scenarios of the socio-economic development of a region.

After the relative importance of the elements at all levels is determined, the hierarchical synthesis for the matrix calculations' performance is carried out. The hierarchical synthesis allows determining the normalized vector of the scenarios' priorities concerning the hierarchy

focus. On the basis of the received vector it will be possible to consider the preferable realization of a scenario of the socio-economic development of the northern regions from the point of view of the power safety achievement in the long-term prospect. The received result will give the regulating bodies the information necessary for the development of the actions, directed on the creation of the conditions increasing the probability of the preferable scenario's realization.

The advantage of the considered approach is the integrated estimation that is provided due to involving in consideration a plenty of the various elements revealed during decomposition of a problem. At the same time, the given approach has some limitations. The method of the hierarchies' analysis allows ranking scenarios, but does not state a quantitative estimation of the power safety level. Thus there can be a situation when even the most preferable scenario will not guarantee minimally allowable level of safety (the preferable script can appear only the best one of the worse ones). Therefore the revealed scenario is the subject for the additional analysis, in order to find out whether it will provide the sufficient level of the power safety or not.

As it was mentioned above, getting the exact quantitative estimations in the long-term prospect with the help of the traditional method of the indicative analysis is difficult in view of the ambiguity of the socio-economic development. But the preferable scenario revealed by means of the method of the hierarchies' analysis can be described in more details, that will enable to apply the method of the indicative analysis to this variant of the future.

Thus, the algorithm of the power safety estimation in the northern regions in the long-term prospect can be presented as follows:

1. Definition of the elements influencing the power safety achievement in the northern regions in the long-term prospect, including:

- the factors influencing the power safety achievement;
- characteristics (standards) of the forces' influence on the factors;
- the forces influencing the factors;
- the purposes in sphere of the power safety which influence the forces;
- the variants of the achievement of the forces' purposes.

2. The formulation of the alternative scenarios of the socio-economic development in the northern regions in the long-term prospect.

3. Revealing (by means of the method of the hierarchies' analysis) the scenario of the development of a region, preferable according to the criterion of the power safety's achievement.

4. The more detailed description of the revealed preferable scenario and its checking (with the use of the method if the indicative analysis), whether it provides the sufficient level of the safety.

The given algorithm shows, that the method of the hierarchies' analysis and the method of the indicative analysis do not exclude and do not replace each other. Each of them is used for the decision of the certain task. The complex use of these methods in a certain sequence can help to decide the main task that is the perspective estimation of the power safety in the northern regions.

The attempt to realize the first three blocks of the algorithm mentioned above was taken in the research [2]. The work was based on the materials of the Murmansk area. The power safety's achievement in the Murmansk area in the long-term prospect was placed in the *focus* of the constructed hierarchy. Further the following *major factors* of the power safety achievement in the Murmansk area in the long-term prospect were formulated:

1. preservation of the sufficient capacity's and power's balances in the power industry and heat-power engineering;

2. decrease of the dependence on the fuel-and-power resources' deliveries from the other areas;

3. providing the free overflow of the electric power in necessary quantities between the Kola power supply system and other regional power supply systems;

4. legislative securing the responsibility for providing the area's power safety.

In work [2] the level *of forces* was placed lower than the level of factors and the level *of actors* (concrete "players" who were present in the region and operated in the forces' interests) was placed under the level of forces. The state, the population and the leading companies of the largest holding structures represented in a region (the holding structures of the power-intensive industries, such as ferrous and nonferrous metallurgy, mining and chemical industry were considered) acted as the forces. Both the federal and the regional bodies of the government and the power enterprise, including the Kola nuclear power station acted as the actors of the state. The companies working in the region acted as the holdings' actors. It was accepted, that the population realizes its interests independently and represents itself as the force which doesn't have the actor. Public Corporation "Lukoil" (at the moment of the research's performance this company considered the opportunity of construction of the oil processing plant in the Murmansk area, that directly concerned the power safety of the region) acted as another force which worked directly in the region and did not have its actor.

Actually the only force which had some actors was the state; and later it was decided to refuse the level of actors. At the same time, with the purpose to provide the opportunity of the account of the new forces' influence, the level of the characteristics of the forces' influence on factors was introduced into the hierarchy.

Further in the research *the purposes* and *the variants of the achievement of the forces' purposes* in the sphere of the power safety were determined. Finally, *the scenarios* of the Murmansk area's development for the period till 2020 were formulated with the conventional names:

1. The "Minimal" scenario did not provide the capacities' replacement in 2018 – 2019 (the first and the second power units) of the Kola nuclear power station.

2. The "Maximal" scenario is connected with the construction of the Kola nuclear power station-2 (the opportunity of the construction of two power units with the capacity of about 1100 MWt was considered) in the terms, allowing to provide the increase in the power supply system's capacity in the considered prospect. The scenario also provided the area's gasification after the beginning of the Shtokmanovskoye gas-condensate field's development and the oil processing plant's construction.

3. The "Gas" scenario provided the construction of the Kola nuclear power station-2 and the area's gasification after the beginning of the Shtokmanovskoye gas-condensate field's development which would allow diversifying the area's fuel-and-power balance.

4. The "Oil" scenario provided the construction of the Kola nuclear power station-2 and the oil processing plant's construction that would allow lowering the dependence on the oil products' deliveries from other areas.

5. The "Minimal power" scenario meant the only large-scale project in the power industry such as the construction of the Kola nuclear power station-2.

6. The "Extended power" scenario as a whole is similar with the previous one; the difference is that it also provided the wide construction of electro boiler-houses.

7. The scenario "Gas without the construction of the Kola nuclear power station-2" provided the Murmansk area's gasification after the beginning of the Shtokmanovskoye gas-condensate field's development, but did not provide the timely replacement of the Kola nuclear power station's capacities.

The necessary information from the experts was received during questionnaire design, interviewing; also by means of the available publications' analysis, of the annual reports of the enterprises working in the Murmansk area, applications from the enterprises' and government bodies' representatives, programs of the nuclear-power engineering's development [5, 7]. The results received by means of the hierarchical synthesis are represented in *the table*.

Preliminary results of the power safety's estimation in the Murmansk area in the long-term prospect [2]

Scenario	The relative importance of the scenario
"Minimal"	0.040
"Maximal"	0.185
"Gas"	0.190
"Oil"	0.184
"Minimal power"	0.162
"Extended power"	0.178
"Gas without the construction of the Kola nuclear power station-2"	0.061

According to the received results the most preferable scenario by the criterion of the power safety's achievement appeared the scenario "Gas", very close to it are the "Maximal" and "Oil" scenarios. The results represented in the table have just the preliminary character. After carrying out the analysis the conditions of the socio-economic development of the region have changed. The forces' structure has changed too. Public Corporation "Lukoil" refused to construct the oil processing plant in the Murmansk area, later Close Corporation "Synthesis Petroleum" made the same decision. The terms of the beginning of the Shtokmanovskoye gas-condensate field's development changed, the gas extraction's volumes at it varied, etc. Actually, in many respects all these changes served as the reason for the general hierarchy's reconsideration and for the inclusion in its structure the standards' level describing the forces' influence on factors.

We consider now it is possible to carry out the research completely realizing the algorithm mentioned above for the power safety's estimation in the northern regions in the long-term prospect.

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