Substantiation of the need for long-term planning of hydropower development as an element of energy management in Russia

O.V. Novikova, L.L. Kamenik, A.S. Furtatova, P.I. Denisova and S.A. Livshits

1Peter the Great St. Petersburg Polytechnic University St. Petersburg, Russia
2Kazan State Power Engineering University, city of Kazan, Russia

Abstract. At the present stage of social development, the need to assess the prospects for the rational use of the hydropower resource potential in Russia had been manifested as an independent unresolved problem, which urgently requires the study of its essence, regularities, the specifics of manifestation and the mechanisms for its solution. This testifies to the urgency of the conducted research, whose purpose was to conduct analytical work on the evaluation of current priorities and directions in energy development and the study of new approaches to long-term planning in hydropower development. The solution of the task was accomplished on the basis of a systematic approach to forecasting the resource potential, energy, hydropower and economic development of the country, which is the novelty of the work. The conclusion is the increasing role of hydropower. The article is interest to scientists, government employees, professors, students and all those who are interested in sustainable development of the society.

The need to build a stable foundation for the modern economy, create conditions for the development of the internal market, concentrate resources and capital to solve the strategic tasks of the energy sector is becoming especially necessary nowadays.

The previously developed scenarios for the socioeconomic development in Russia have lost their relevance and require revision by far, taking into account the newly discovered external and internal factors. For example, in the normative document "Scheme and program for the development of the unified energy system of Russia for 2017-2023", approved by the Order of the Ministry of Energy of 01.03.2017, the average annual increase in demand for electricity in 1.0%. These days, the forecast demand for electricity is formed on the basis of the medium-term forecast about the main macroeconomic parameters of the basic scenario in Russia's socioeconomic development forecast. According to this scenario, prepared by the Ministry of Economic Development, until 2023, the annual average growth in Russia's GDP is expected to increase over 2.0%.

Thus, today, the development of the energy industry (including the power grid infrastructure) is directly related to the forecast of the state's economic development, and the pace of this development, with objective reasons, for the accepted scenarios essentially lag behind the pace of development of the economy itself. [1] How true is this approach? Moreover, Russia today is one of the few non-volatile states, and in the future the country has every reason to claim the role of an energy leader. Such a statement of the question requires serious consideration.
1. Analysis of the current development trends in energy

Currently, the leading role in the energy sector of Russia is played by thermal stations that represent more than 65% of the electric power production structure, which is about 160 GW of capacity and more than 670 billion kWh of electricity generation (230 million tce). More than 70% of the electricity produced by TPPs is provided by gas stations. It can be assumed that, for objective reasons, during the planning horizon of 25-30 years, there will be a decrease in the share of thermal generation in the structure of electricity generation. The main replacement of this will be because of nuclear energy. [2] This trend has already evidence with the approval from the Ministry of Energy "Scheme and program for the development of the Unified Energy System of Russia for 2016-2022".

Today, there is a strategy for the development of the electric power industry in the conditions of the depletion of hydrocarbon resources and the predicted ever-increasing redistribution in favor of the chemical industry. At the same time, one should not discard the energy sector based on traditional renewable resources. These resources don’t contemplate a lack of fuel component and is highly maneuvering, providing system services in improving the quality of electrical energy and creating conditions for more efficient operation of nuclear power plants. [3]

Hydroenergy potential of water resources in our country is used only by 20% of its capacity, and in the Far East - only by 6%. Replacement of thermal generation due to the development of nuclear and hydropower will allow to build a balanced high-efficiency power system, reduce the load on the environment, reduce the final cost of electricity, release hydrocarbon raw materials (for export, chemical industry), solve flood protection problems and flood river transport infrastructure. [4]

In the conditions of limited financial resources, one of the main tasks for the state and energy companies is to reduce the capital costs per 1 kW of installed capacity, then, under the existing conditions of the economy, the payback period. [5] At the same time, there is an unrealized potential in the hydropower industry to increase the investment attractiveness of hydropower facilities due to the introduction of modern technical and technological solutions, the use of modern materials, a new, more efficient approach to the organization of interaction between scientific and design organizations, the introduction of a unified information space for design, construction and operation of hydropower facilities.

The risk analysis of the materials of the Energy Strategy of Russia from the point of view of the development of the energy management system begins with the analysis of energy policy. Even in the case of realization with possible risks they are not able to change the purpose, tasks, priorities, directions of development and basic elements of the state energy policy. Observed shifts in the timing to achieve the specified values of some of the target indicators in 3-5 years. Selected perspective directions are being revised. The target scenario is taken as a basis and the backlog from it was solved with relatively low costs. It was corrected by a slowdown in the implementation of energy programs and projects. The initial orientation in the forecast for the slow development of the economy and the fuel and energy sector is fraught with excessive damage - down to the reduction of export niches and containment of the country's economic growth lack of energy capacity. [2]

The authors of this article agree with this forecast and consider its implementation a necessary condition for an intensive, breakthrough development of the Russian economy.

At the same time, it should be noted that the draft energy strategy envisages an increase in electric power generation by 2020 by 6%, and by 2035 - by 27-43% (from 1,062 to 1,352-1514 billion kWh) with an increase in the installed capacity of power plants at 13-25% (from 250 to 282-312 million kW). [2]

Taking into account the need to modernize the obsolete and exhausted equipment of power plants, which now represent more than 60%, this forecast looks more than ambitious. In fact, if we take into account the main power equipment, the production capacity will be the double.

Moreover, there are already serious concerns about the possibility of realizing the target scenario of development, primarily for the electric power industry. This is due to:

- the absence of well-developed mechanisms and plans aimed at implementing the tasks outlined in the Strategy to achieve the set goals;
- the presence of serious limitations in the possibility of attracting long-term investment resources, which is not enough even for a comprehensive modernization of existing energy capacities;
- direct linking the pace of development of the industry with forecasts of the growth rates of the Russian economy;
- the dependence of the Russian energy sector on foreign technologies, equipment, materials, software and services, which in a number of areas has reached a critical point and created threats to Russia's energy security. First of all, this relates to TPPs and oil production;
- shifting the priority of development in favor of carbon-free energy (wind and photo energy), which has a low economic return and requires the creation of capacity reserves.

These constraints must be lifted in the shortest time possible, otherwise the declared goals cannot be achieved. A starting momentum is needed, which would be the starting point in the implementation of the Strategy and in the breakthrough development of the economy of the Russian Federation. This starting point is definitely to be searched inside the fuel and energy complex. [6]

Today we must use the existing foreign policy and economic situation to create and develop internal conditions for increasing with efficiency the development of our industry, using the existing potential and developing a promising one. The priority here must be the energy, whose main tasks should be a significant increase in energy efficiency in a short term or in a medium term - creating the conditions for reducing the costs of industry. [7]

Separately, it should be noted that the implementation of the target scenario for the development of energy in Russia requires the availability of appropriate scientific and technical competencies, production capacities and profile contracting organizations. To solve the stated ambitious tasks, this entire complex requires the rapid and serious qualitative changes.

2. A new approach to long-term energy development planning

A new approach to long-term energy development planning is required in connection with the following needs:
- accounting and linking the development of the country's energy industry with the development of industrial production;
- the creation of competitive advantages in the near future for the domestic industry;
- stimulating the development of the domestic market due to the current profound transformations in the global economy;
- opening of "bottlenecks" and expanding the boundaries of the area of decision-making it seems advisable to shift the time horizon for the planning of the new Energy Strategy of Russia for 2050.

Until the end of the 2030s, it can be assumed that the development of the world and Russian energy will be determined mainly by the usual fuel energy and its problems. But, since 2050, a profound transformation in the direction of renewable energy sources, a new way of energy, a fundamentally new structure of world energy services and technologies is possible.

Simultaneously, the matrix of long-term planning for the development of the electric power industry should be based on a new approach.

Earlier, the forecasts were based on the model: "need - provision", where new available deposits were opened and put into operation to meet the demand, new generation facilities were built without taking into account the limited initial resource base, the environmental consequences, the economic effectiveness of the decisions made in the long term. [8]

In modern conditions, the situation has changed significantly. First, there is a reduction in the initial resource base for the A + B + C field groups, which leads to an increase in production costs and, consequently, a constant increase in prices for natural raw materials (gas, coal, oil). Market prices no longer cover the costs of their production. Secondly, there is an extremely slow decline in the energy intensity and electrical capacity of GDP, which, of course, affects the cost of production. Thirdly, there were strict requirements to minimize the environmental impact. All this dictates the need to create conditions for sustainable effective development in the energy sector, with support in the medium term for own carbon-free energy, domestic producers, and domestic scientific and technical potential. [9]
In the context of the new conditions for the development of the Russian economy, a new approach to building long-term development of the electric power industry is needed. The new approach should be based on a closer linkage of energy production with resource potential and environmental consequences according to the model: "capacity - demand - provision".

An integrated approach based on the unity of production of energy resources, the forecast of electric generation, the forecast and implementation of conditions for the integrated development of productive forces, should become the basis for long-term planning of the development of the electric power industry. The principle of this unity is that a comparative analysis of options for long-term development of the electric power industry should be carried out. It is necessary to avoid the "situational" solution of emerging problems, taking into account the conditions of the industry development on the basis of modeling the entire life cycle of both a single object and the entire system – in conclusion, the whole industry.

The target vision of the development of Russia's energy industry for 50 years ahead is to determine the long-term guidelines for the development of the industry with the basis of a realistic approach to the innovative development of the Russian economy, the expected structural shifts in the world economy, with an assessment of the positions of their influence on Russian energy and its place industrial economy of the world. [10]

The energy strategy should include the following tasks:
• advanced development of the electric power industry in comparison with the development of the economy on the basis of the use of the most efficient production complexes and scientific developments;
• creating conditions for increasing economic growth rates by reducing production costs both fuel and energy complex and the economy as a whole;
• expanding the resource base of fuel industries and product markets;
• develop with the support of the national scientific and technological base and branch enterprises;
• take into account the complex effect of the construction of certain types of generation on the industrial and technological development;
• ensure the creation of conditions and mechanisms for increasing the investment attractiveness of new construction projects;
• ensure the construction of a self-sufficient efficient industry with the prospect of explosive expansion to foreign markets.

At present, the most objective and complete are assessments of the life cycles of energy facilities, including nuclear power, traditional carbon energy and renewable energy. The important characteristics of energy technologies are estimated by their payback periods, as well as specific environmental assessments of their impact on it. This approach, taking into account the complex influence of the generating facilities under construction on the development of the economic complex, will allow building the most effective energy in Russia and solving the strategic tasks of the state development.

The development of the energy complex will provide an opportunity to develop natural resources in the Far East and Eastern Siberia and will ensure the conditions for the creation of large industrial power-intensive complexes oriented there, including for export.

3. Strengthening the role of hydropower in the development of the energy complex

Under the new conditions, the role and importance of various sectors of the Russian energy sector is changing: carbon (coal, gas, etc.), hydropower, nuclear and renewable.

The main goal of the Energy Strategy of Russia for the long-term perspective is "sustainable, safe and efficient functioning of the energy sector for the development of the economy and improving the welfare of the population of the country." This long-term goal has not lost its relevance nowadays. What is the role of hydropower in the future development of the Russian energy sector? What rates should hydropower develop under the new conditions and challenges? What resources are available for this? [11]
The general scheme for the development of the electric power industry until 2035 provides the construction of only two new hydraulic stations: Nizhne-Zeyskaya and Motyginskaya, with a final capacity of 1,482 MW. [2]

In the current conditions of planning for the near future, the share of HPPs in the structure of electricity generation, as much and taking into account the ongoing modernization program, will remain at the achieved level of 19% of its capacity.

At the same time, hydropower is a powerful complex-forming center in its regions. On the basis of cheap electricity, modern industrial and social infrastructure is formed, contributing to sustainable regional development, raising the standard of living of the population. After commissioning the HPP, the cost of electricity does not depend on the level of fuel prices and the situation on the world market. Hydroelectric power plants perform a number of system and other functions to ensure the reliability of the functioning of the power systems. Many of Russia's hydroelectric power plants are objects of integrated importance: they regulate river runoff, ensure the requirements of navigation, irrigation, water supply or flood protection, among others. [12]

The main disadvantage of HPPs, in comparison with other generation facilities, is the high unit cost of capital investments per 1 kW of installed capacity. In part, this is a constructive feature of this source of electricity. But this gap can and should be shortened. [13] It can be stated that there is an unrealized potential in the hydropower industry to increase the investment attractiveness of hydropower facilities due to the introduction of modern technical and technological solutions, the use of modern materials, and a new, more effective approach in organizing interaction between scientific and design organizations.

The positive contribution of hydropower stations to the development of energy was assessed by the international community. For example, the hydropower potential in the US and Canada was used by about 58-75%, in Brazil by 53%, in Western Europe by 80%, and in Norway by 96%. China today is actively building hydroelectric facilities, outstripping the rest of the world in commissioning capacities. For comparison, the indicators of the use of hydropotential in Russia: about 40% - in the European part of the country, 23% - in Siberia and less than 6% - in the Far East.

However, it should be noted that the indicators of Russia are from 1967. Currently, due to the socio-economic changes in the country, the economic hydropower potential needs to be adjusted (due to the strengthening of environmental restrictions, the emergence of alternative opportunities for the use of natural resources aligned in the construction of hydropower, changes in the economic situation and the system of market assessments used in the analysis of efficiency implementation of hydropower projects). Therefore, the definition of the current economic hydropower potential today is the most important and one of the priority tasks. [14]

4. Conclusions

1. The maximum effect for the development of our economy, the development of industrial production can be obtained with the rational use of local resources, primarily renewable. Hydropower should play an important role in this process in the long-term planning of its development.

2. In the face of great uncertainty and disproportions in the development of energy systems, there is a need for long-term planning. Based on the definition of energy management, any actions within the framework of general managerial functions that contribute to the realization of the goal and objectives of the state energy policy, it is important to understand the target parameters. It is the long-term hydropower planning that acts as an element of energy management that meets the target task of minimizing the costs of fossil fuels, by developing renewable energy sources.

3. A new approach to long-term planning is necessary, first of all, in connection with the need to take into account the limitations of the initial resource base.

References

[1] Kamenik L L 2016 Innovatsionnaya model' resursnoy bazy vosproizvodstva ekonomiki - strategicheskoe napravljenie obnovleniya ekonomicheskoy politiki Rossii / Kamenik L L.
Forsyt "Rossiya": dizayn novoy promyshlennoy politiki / sbornik materialov Sankt-Peterburgskogo mezhdunarodnogo ekonomicheskogo kongressa (SPEK-2016) / pod obsheh. red. Bodrunova S D. — M.: INIR, Kul'turnaya revolyutsiya, pp 375-380

[2] Prognoz nauchno-tekhnicheskogo razvitiya otрасley toplivno - energeticheskogo kompleksa Rossii na period do 2035 goda. Moskva, 2016

[3] Kamenik L L 2017 Proshloe i budushchee Rossii na global'nom rynke syr'ya: novaya "sverkhreal'nost'" Competitiveness in a global world: economics, science, technology, №5, pp 69-73

[4] Erastov A E, Novikova O V 2015 Federal'noe subsidirovanie kak drayver innovatsionnogo razvitiya regionov v oblasti energosberezheniya i energoeffektivnosti. Restrukturizatsiya ekonomiki Rossii i promyshlennaya politika / Trudy nauchno-prakticheskoy konferentsii s zarubezhnym uchastiem / pod red. Babkina A V, pp 102-106

[5] Kamenik L L 2017 Povyshenie resursobespechennosti - novye vozmozhnosti evraziyskoy integratsii / analiticheskie materialy / Analiticheskie materialy I s'ezda assamblei narodov mira. Moskva, [Electronic resource] – www.rosprodunion.ru

[6] Danilov-Danil'yan V I Ustoichivoe razvitie: Novye vyzovy. Uchebnik dlya VUZov / pod obsheh. red. Danilova-Danil'yana V I, Piskulovoy V I. — Aspekt-Press Moskva, p 336 (2015)

[7] Erastov A E, Novikova O V 2017 Innovative energy saving: the integrated method of estimating motivational environment Vestnik of Ivanovo State Power Engineering University, №2, pp 75-86

[8] Kamenik L L Resursosberegayushchaya politika i mekanizm ee realizatsii v formate evolyutsionnogo razvitiya. Monografii / Kamenik L L. Sankt-Petersburg. (Izd. 2-e, dop.) pp 476 (2012)

[9] Kamenik L L 2018 Ecological and economic balance - a strategy for managing innovative development of the society of the XXI century Innovative Economy Issues Vol. 8, №1, pp 25-38

[10] Glazev S Yu, Chistilin D K 2017 Where goes Russia? (Analysis of the proposed programs for socio-economic development of the country) Russian Economic Journal, №4, pp 36-48

[11] The Sustainable Development Goals Report. United Nations, New York, 2017, pp 32-33

[12] Furtatova A S, Kamenik L L 2017 Contemporary problems of modernization of a water supply system in the reality of innovative development (by the example of the city of St. Petersburg) Journal of Economy and enterepreneurship, № 4-2 (81-2) Vol.11, Nom. 4-2, pp 868-873

[13] Erastov A E, Novikova O V 2016 The rating of the regions attractiveness for implementation of energy-efficiency projects / Innovation economy and industrial policy of region (ECOPROM – 2016) / Works with the research-to-practice conf. with foreign participation 22-24 September 2016 / pod red. Babkina A V, pp 103-111

[14] Makarov V M, Novikova O V, Tabakova A S 2017 Energy efficiency in “green construction”: experience, issues, trends / Reliability. Infocom Technologies and Optimization (Trends and Future Directions) 6th International Conf. ICRIPTO, pp 732-737