

# Condition and trends of energy construction in the Russian Federation for 2023 based on the results of the implementation of energy supply contract programmes

*Ivan Voronkov, and Kseniya Burlutskaya\**

Moscow State University of Civil Engineering, Moscow, Russian Federation

**Abstract.** The article discusses the state and development trends of the energy construction of the Russian Federation. The experience of implementing energy modernization programs in the Russian Federation was analyzed. The exit of the domestic economy and the electric power industry from the protracted crisis of the late 20<sup>th</sup> - early 21<sup>st</sup> century required the development of systemic policy documents aimed at building new and modernizing existing generating capacities. We can talk about the complete and partial completion of these programs, which allows us to talk about their structural features, practical results achieved, as well as prospective development trends. The first program turned out to be extremely effective only in the first years. When significant discrepancies and other difficulties began to appear, including financial ones, the system began to require certain improvements. They touched on almost all projects. However, the adopted course cannot be called promising and having an exhaustive potential for long-term development. It is necessary to develop and implement a new program that considers both previously unpredictable socio-political and economic changes, as well as modern trends in the development of industrial and civil construction.

## 1 Introduction

For decades, the Russian Federation has been pursuing a policy of modernization in all areas, including the thermal power industry. The fuel and energy complex (FEC) is currently considered as one of the promising areas of the state's innovative economy, linking all its key instruments. In the total volume of industrial goods in the economy of the Russian Federation, the share of the fuel and energy complex is at least 30%.

The energy sector of our country is one of the priority sectors for the economy. This is explained by the fact that the energy sector is endowed with enormous resource potential that can ensure the successful operation of all areas of the economy as a whole. Despite the growth of certain characteristics of the functioning of the fuel and energy complex, the situation in the energy sector in our country remains extremely vague. At the beginning of 2023, most of

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\* Corresponding author: [ksunazarova@yandex.ru](mailto:ksunazarova@yandex.ru)

the facilities of the energy complex did not introduce new, more powerful equipment, and the old one was already very worn out and does not meet the new requirements, which gives rise to a large number of problems with the development and unresolved investment problem.

Based on the decision of the Government of the Russian Federation, DPM-2 was specially created - a program of contracts for the provision of capacity. The main goal of this program is the modernization of the country's fuel and energy complex by the end of 2024. Among the main areas of this program are the following:

- modernization of thermal power plants, hydropower complex, nuclear power plants, electric grid complex [1];
- improvement of renewable energy sources;
- development and implementation of advanced technologies and devices for the modernization of the electric power complex.

Also, this program provides for the systematic renewal of the entire technological and production base of the electric power industry based on modern energy technologies developed by domestic scientists, with the growth of fixed assets in the field of generating capacities.

Based on all of the above, it can be stated that the energy sector of our country today is in strong need for additional investment in the industry and the introduction of advanced domestic technologies, which is a priority problem today for the industry and the entire state as a whole. [2, 12]

## **2 Materials and methods**

Even before the development and implementation of DPM-1, certain problems with the energy sector were observed on the territory of the Russian Federation, the negative impact of which led to the emergence of a desire to introduce innovations. It was impossible to do without the latter, because they who served as the engine of progress and made it possible to get rid of the following problems: worn-out capacities and low investment in the country's economy.

The first stage of the reform falls on the period 1992–2002. It was accompanied by the formation of the federal holding RAO "ES of Russia" and regional vertically integrated organizations. Together, these business entities are characterized as vertically integrated monopoly enterprises. In addition, the Federal Electricity Market was created during the period under review. The key purpose of government decisions at the first stage of reforming the energy sector in the Russian Federation was, first, to introduce various management mechanisms in the industry, to form and stimulate intra-industry competition. However, it should be noted that the results of reforming the energy sector of our country did not show the rationalization and increase in productivity not only of the entire industry, but even of its individual elements.

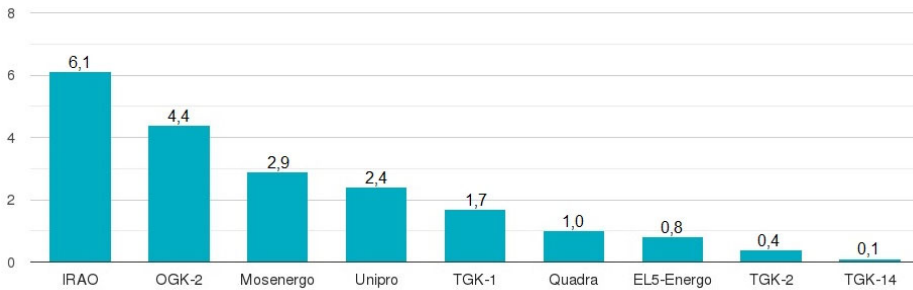
The second stage of reforming the energy sector fell on the period 2003–2007. It was accompanied by the restructuring of monopoly activities in the electric power industry, the formation of horizontally integrated special-purpose enterprises. At this stage, the system of regulation in the field of thermal energy was significantly changed.

The third stage of reform began in 2008 and continues to this day. It involves the final construction of a competitive market in the production and sale of electricity. At this stage, regulation is carried out in the form of normalization, tariffing, and standardization (regulated agreements between the seller and buyer of electricity).

All three stages of the reform marked the beginning of the adoption of DPM-1, which became a kind of benchmark for the development of the energy sector. DPM-1 became a long-term program, the implementation of which made it possible to build new capacities. Launched in 2010, the program was focused on 10 years, until 2020. As part of its

implementation, about 30 GW of new capacities were commissioned, which made it possible to cover most of the needs of the entire sector. One of the results of the program was the launch of the first coal-fired power unit at the Krasnodar CHPP in 2012. As a result of its introduction, it was possible to significantly reduce the risk of a shortage of communal resources, as well as provide the necessary reserve for new microdistricts of the city (Sloboda Vesny, Pokrovsky and others) [3, 4].

Almost all domestic companies received the greatest profit from the integration of the program, including the following: IRAO (6.1 GW), OGK-2 (4.4 GW), Mosenergo (2.9 GW), Unipro (2.4 GW) etc. For the period 2010-2020. 136 power units of thermal power plants with a total capacity of 30 GW were put into operation on the territory of the Russian Federation (see Figure 1).

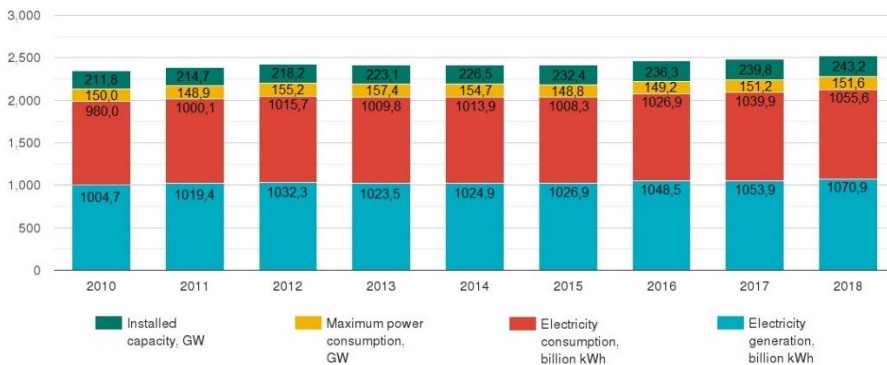


**Fig. 1.** Commissioning of the main capacities for DPM, GW.

Figure 1 shows that such companies as Inter RAO and OGK-2 received the greatest benefit from the implementation of the CSA program.

Starting from 2013, the CSA RES program was also launched. It is aimed at modernizing generating capacities using renewable energy sources - solar power plants, wind farms and small hydropower plants. Within the framework of this program, in the period from 2014 to 2024, 228 facilities with a total capacity of 5.5 GW are planned to be put into operation on the territory of our state.

The results of the DPMs are clearly presented in Figure 2.



**Fig. 2.** Results of DPM.

During the implementation of the DPM program, the total installed capacity of power plants of the UES of Russia increased by 16%. At the same time, the production and consumption of electrical energy over the past 10 years have increased by only 7%, which is due to the slow pace of development of the domestic economy. At the same time, the maximum load remained practically unchanged. As a result, generating capacity has become too much. For example, in 2010, the maximum power consumption reached 71% of the total

installed capacity, and in 2018 this figure dropped to 62%. On the other hand, an excess of capacity allows generating entities to use old and poorly efficient equipment without any problems.

The problem of obsolete equipment remains relevant today, since instead of modernizing old facilities, new facilities in the energy industry were built. Today our country ranks fourth in terms of electricity generation in the world. However, the average level of technical condition of generating capacities leaves much to be desired, since more than half of all generating capacities are older than 35-40 years, and 25% are older than 50 years.

Thanks to the implementation of the DPM program, the domestic energy system was able to make the transition to advanced and more efficient equipment. In addition, green generation facilities have been actively erected. The DPM also made a significant contribution to the growth of shares of energy companies. In this regard, the termination of this program may have a negative impact on quotations due to a decrease in the amount of cash received from payments for capacity at increased tariffs.

In 2017, the period of implementation of the DPM program was completed. This program was focused on the reconstruction of advanced generating capacities in the domestic electric power industry. During the period (2008-2017) of the DPM, more than 4 trillion rubles were allocated from the state budget. rub., which were directed to the construction and repair of more than 21 GW of new capacities, and the modernization of about 7 GW. But, with the implementation of the transformations of RAO UES, the demand for electricity has not increased. In the period 2015-2018. The economy of our country was recovering extremely slowly. As a result, it was not possible to achieve the projected average annual increase in demand for electricity use. This led to an overabundance of capacity in the market, so it was decided to develop a new DPM-2 program.

The DPM-1 program, while being quite effective during the period from 2010 to 2020, still cannot be called ideal. Having served as an excellent tool for optimizing most of the processes in the energy sector, it showed all the weaknesses and required improvement, but in a new interpretation. They were able to find it in the DPM-2, which involves the signing of investment agreements for 16 years. For 15 years, organizations will receive payments for renewed capacity at a certain rate of return. In accordance with DPM-1, all investment agreements were signed for 10 years. The last modification of the program assumes that the rate of return reaches 12% and includes a 7.5% yield on public debt bonds with appropriate elasticity. This indicates that in the event of an increase in the profitability of 10–15-year securities, payments under the DPM will be revised upwards. With a decrease in profitability, the reverse procedure will be carried out. The noted tool is designed to ensure an appropriate level of efficiency of the invested capital [4, 12],

Upon completion of the DPM-1 and the implementation of the DPM-2 project, serious changes took place in the energy sector of the Russian Federation. They touched not only the principles of achieving the set goals, but also the selection of new modernization projects through an auction. As statistics have shown, the key criterion for such auctions is the low cost of electricity supplies, thanks to which the state receives a budgetary source that can have a better impact on the state of development of the entire economic and energy sectors. The first number of applications for the improvement of 11 GW was completed before the end of November 2018. Project execution timeframe is until 2022-2024. In the future, projects for generating capacities of 3-4 GW will be selected annually. The first cash flow under the new program was directed in 2019.

It cannot be emphasized that the conditions for the implementation of the first DPM program to attract cash flow to the industry were identical. According to experts, these conditions are assessed as positive for companies from a long-term point of view. At present, the project's return could be around 13%, given 4-5% inflation - which is a significant support

for companies in the generating sector investing in the modernization of obsolete generating equipment. [7, 8]

Domestic generating capacities are among the outdated in the world. Objects older than 45 years make up almost 1/3 of the total volume of all capacities. The diagnosed capacity for 2020, over 45 years old, reached more than 64 GW, some of which was used during the implementation of the DPM-1 program. The resource of the remaining part, by decision of the current government of the Russian Federation, will be extended by increasing the tariff on the CTO market (competitive power take-off), and 41 GW requires modernization. [7, 5]

The DPM-2 regulation provides that suppliers – participants of the wholesale market that supply (purchase) electricity and capacity to the WECM can take part in the selection of modernization projects. Generating equipment operating before the implementation of modernization measures, which is planned to be included in the modernization project of the generating facility, must meet the criteria for confirming the production of industrial products on the territory of the Russian Federation.

In DPM-2, projects are selected by the direct system operator for a period of 6 years prior to the year of equipment delivery. The first selection under the program for the period 2022-2024. was carried out back in April 2019. At this time, 30 of the most promising projects with a total capacity of 8.6 GW were selected: 2.2 GW in 2022, 3.6 GW in 2023 and 2.8 GW in 2024. For the period of 2025, it is planned to implement 25 projects with a total capacity of 4 GW, and for the period of 2026 - 15 facilities with a total capacity of 3.8 GW. At least 4 GW of power is also planned for the next years. In total, over the given period of time, it is planned to improve more than 40 GW, which in turn is almost 17% of the total capacity of all equipment. It is envisaged that the implementation of the DPM-2 program will continue presumably until 2031-2032 [6].

**Table 1.** Competitive selection capacity modernization program for 2022-2026.

<b>Organization</b>	<b>2022</b>	<b>2023</b>	<b>2024</b>	<b>2025</b>	<b>2026</b>	<b>Total</b>
Inter RAO, MW	1064	1840	210	660	1180	4954
Unipro, MW	830	-	830	830	830	3320
Irkutskenergo, MW	-	325	410	260	-	995
OGK-2, MW	65	-	60	470	-	595
Mosenergo, MW	-	-	360	80	-	440
Enel Russia, MW	-	-	-	320	-	320
TGC-2, MW	-	-	-	120	-	120
TGC-1, MW	-	-	-	100	-	100
TGC-14, MW	-	-	-	80	-	80
Quadra, MW	-	-	-	30	-	30

### 3 Results and discussion

The DPM-1 program had a positive impact on the general state of the domestic energy industry, but failed to fully achieve all the goals set for it. The problem of obsolete capacities still remains relevant and one of the priorities [9]. According to experts from the Ministry of Energy, in the Russian Federation in the coming years it is advisable to modernize or completely decommission about 50% of all generating equipment. In this regard, at the beginning of 2019, the current government of the Russian Federation decided to launch a new program for selecting projects for re-equipment - DPM-2.

According to experts, the DPM-2 program will enable generating companies to receive the largest increase in investments not only from the state budget, but also from private companies. According to various estimates, DPM-2 will attract more than 2 trillion rubles of investment.

It is assumed that in the long term this program will be effective for generating business entities, as it will help to obtain a high profitability of capital investments in the re-equipment of generating capacities, which in turn will have a positive result in the form of lower fuel costs and increase production performance [8, 10].

## 4 Conclusions

The situation in the thermal power industry of our country at the moment is developing in such a way that absolutely everyone will be able to benefit from the modernization of generating capacities in the thermal power industry: the energy system, investors, local authorities, the environment in the form of a reduction in the carbon footprint and directly the consumer himself, in whose interests the conservation and modernization of the CSO.

Ситуация в тепловой энергетике нашей страны на данный момент складывается так, что от модернизации генерирующих мощностей в тепловой энергетике смогут выиграть абсолютно все: энергосистема, инвесторы, местная власть, экология в виде снижения углеродного следа и непосредственно сам потребитель, в интересах которого будет обеспечено сохранение и модернизация ЦСО.

Initially, during the implementation of DPM-1, during the construction of new facilities, there was an opportunity to approach projects creatively. At the same time, the current vector of development, according to DPM-2, is aimed at modernization based on specific requirements, restrictions and conditions, as well as against the backdrop of limited funds. Considering the cyclical nature of changes in the technological order, as well as the fact that the current development vector of DPM-2, being focused on a strict framework, is a dead end, it can be assumed that in the next stage of energy development in Russia, work will be carried out to demolish stations and build them in the same place fundamentally new and technological energy facilities, or the modernization of capacities will continue, but with the creation of an attractive appearance of the buildings of the stations and their adjacent territories [11, 12].

As a new step in the development of the energy sector in the country, many comprehensive programs from young professionals [13] can also be proposed, a fresh look of which will allow Russia to pave its own way in the development and optimization of both a separate sector and the entire industry. In the future, such scientists can be awarded grants that will not only optimize most of the processes, but also motivate specialists to start working on the development of their country.

In the future, when approving a new project, great importance can be given to rethinking the architectural appearance, renovation of industrial zones in cities, creation of cultural spaces, etc. Cultural spaces may become relevant again, and then the renewal of production areas and the modernization of generating capacities, not just with the replacement of equipment, but with giving the buildings and structures of thermal power plants an aesthetic appearance, will become extremely important. Their new appearance will allow the stations to become centers of attraction. They will not only become attractive externally, but the radius of the sanitary protection zone can also be reduced due to the use of innovative gas purification systems from impurities, which will allow the development of the territory nearby. Thanks to this, it will be possible to use the area around them: to create a noteworthy urban infrastructure, to effectively use the territories, thereby increasing the profitability and attractiveness of nearby facilities and the station area as a whole.

Proof of this can be found in the fact that over the past ten to fifteen years the architectural appearance of residential buildings has changed. Typical new buildings of fifteen years ago were quite restrained and unremarkable in their facade solutions; they were echoes of the Soviet era, as were the makings for the DPM-1 program. But literally in fifteen years the design of these houses has changed significantly, that is, the window openings, the colors of

the panels, the shape of the entrance groups. Absolutely everything has changed its appearance, which was predictable and expected for a period of modernization. Perhaps in the coming years it will be possible to predict an identical regularity, but in the thermal power industry. Cultural spaces can become relevant again, and then the renovation of production areas and the modernization of generating capacities will take place, not just with the replacement of equipment, but with giving the buildings and structures of thermal power plants an aesthetic appearance [14, 15].

As an example that attracts attention and allows you to draw inspiration, consider the Copenhill thermal station in Copenhagen (Denmark), which was able to gain recognition from tourists from all over the world with its extraordinary appearance. The uniqueness of this project lies in the fact that this large power plant is not only an industrial facility, but also a multidisciplinary public space. Its roof, on the one hand, is a year-round artificial ski slope, and on the other, a vast park with walking paths, planted with greenery and coniferous trees. The guests of the complex go up on the cable and tape lifts, as well as on the panoramic elevator, which provides an overview of the station from the inside. Such a decision, even a hundred years ago, could seem completely unrealistic to be implemented, and clearly did not allow predicting such a great popularity. In the case of DPM-3, this solution could be an interesting option to consider, able to attract tourists and attract additional investment. [16]

Therefore, it can be said that the next stage after the implementation of the DPM-2 program may well be modernization with the replacement of equipment with an emphasis on the creation of cultural spaces in the nearby territories. The last option is the most promising, because it is with its help that the energy sector will be able to implement ideas and goals of any complexity. Thus, by developing a new DPM-3 plan, which includes not just reconstruction, but a total renovation of all power plants, Russia can gain access to new opportunities in which it will be able to ensure its own energy security and minimize the risks of implementing large investment and construction projects in the field of thermal, renewable and nuclear energy construction [17]. In the future, this may prove to be a promising solution for other countries that want to see such a strong partner in the energy market.

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