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Economics of Russian Coal Industry

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1 Introduction

The development of fuel and energy industry should cover internal demand for fuel and energy in any and provide their export to external markets. There are some countries abundant in coal but experiencing various economic difficulties related to the development and modernization of that industry (Wilde 2009; Yue 2012; or Kalyugina et al. 2015). One of the typical examples is the Russian coal industry (Lisin et al. 2017).

Russia has significant balanced coal reserves, which is over 200 billion tonnes (12% of world reserves) with 105 billion tonnes of those being explored at the moment. However, coal reserves are allocated extremely unevenly: over 80% of all of those are in Siberia, whereas the share of the European part of Russia is 10% only (Ministry of Energy of the Russian Federation 2010; Russian Federal State Statistics Service 2016).

According to the Russian Energy Strategy for the period up to 2030 (Ministry of Energy of the Russian Federation 2011), the consumption of power-generating coal in the power industry will grow, which will increase its production. Thus, the coal production in 2015 was 360 million tonnes, including the coal stock of 115 million tonnes for thermal power plants. The coal production in 2020 should rise up to 415 million tonnes, including 138 million. tonnes as fuel for thermal power plants.

Meanwhile, there is a number of problems that hinder the development of coal power production industry. Increased ash content of coal from many deposits with poorly developed enrichment technologies decrease their competitiveness when compared to natural gas production and give rise to some problems when used as fuel. Also, significant number of coal deposits are characterised with unfavourable mining and exploration conditions. At

some particular deposits, significant impairment of coal-mining capacities is expected, which requires commissioning of new facilities considering their technical re-equipment and intensification of production. It is worth to mention the fact that the enhancement of coal production would stimulate the increase in the volume of the interregional solid fuel traffic related to additional coal supply for thermal power plants (Bugge et al. 2006; Strielkowski et al. 2013; Lisin and Strielkowski 2014; Lisin et al. 2015a, 2015b, 2015c, 2015d; or Gorbacheva and Sovacool 2015).

2 Social and economic aspects of Russian coal industry

Thermal power plants as enterprises performing their industrial and economic activities for heat and electric power production influence the social sphere through creation of new employments and via pricing for energy products.

The cost of energy products, which has to lay within the range of socially affordable prices, is also limited by the development of coal-fired technologies (Balitskiy et al. 2016). The energy product prices for the population of Russia are regulated by the government by using tariff restrictions. Tariff restrictions are figured up by the Russian Federal Tariff Service (FTS), which assigns the price limits (upper and lower) in accordance with the social policy of the government (Strielkowski and Bilan 2017).

Considering that the cost of the natural gas is growing more rapidly than tariffs for energy products (Lisin et al. 2016a, 2016b, 2016c; Streimikiene et al. 2016; Strielkowski and Lisin 2016; Russian Federal State Statistics Service 2016), a threatening situation for power plants arises since fuel cost is the principal cost item for thermal power plants. In this case, switching to the prior use of coal as fuel in the future will allow to avoid the decline in profits of power generating companies. This means the reduction of investment programmes for technical re-equipment in the industry, which is one of important criteria of provision of the energy safety to the country. Also, the implementation of effective coal-fired technologies will allow to rein in energy product tariffs growth and to fulfil obligations of the government with regard to social programmes.

Another important aspect of development of coal power production industry is the impact of energy products on environment. Production activities of thermal power plants related to pollutant emissions such as sulphur oxides SOX and nitrogen oxides NOX. Non-exceeding of threshold limits of allowable pollutant concentrations in emissions is the criteria of environmental cleanness of a power generation facility.

In the absence of the emissions quota system no economic incentive for implementation of additional environmental measures as well as for switching to more advanced coal-fired technologies is provided. Therefore, targeting the construction of thermal power plants with elevated steam conditions as the way of development of power production industry will provide saving non-renewable resources (power-generating coal) and will decrease pollutant emission rate, which is extremely important within the context of permanently growing demand for electric power

3 Russian coal power: renewal and development

Coal-fired power production sufficiently contributes into the diversification of production structure of Russian electric power industry. However, within the last 10 years its share diminished from 29% to 24% over the country and from 19% to 16% in the European part of Russia (Russian Federal State Statistics Service 2016; Ministry of Energy of the Russian Federation 2011).

Active power plants are characterised by wide spread of semi-fixed costs and fuel costs, which requires calculations based on variant models for substantiation of various standard solutions for renewal and optimisation of the structure of power generating facilities. Due to the ratio of the natural gas and oil prices (despite the intensive rate of increase of the natural gas price, the average cost of 1 TOE of the natural gas was less than the same of the coal), the improvement of coal-combusting technologies and solving of economic problems if coal is used at thermal power plants have fallen out of interest.

However, Russia is one of the leading countries in the world in coal usage at conventional steam units of power plants, which is cost-effective today and will be profitable in the foreseeable future. Nowadays, there are 116 coal-fired thermal power plants in operation. Their basic facilities are units with 150–800 MW output capacity.

There is a severe need in improvement of technical performance of coal-fired units. The prerequisites are achievements in development of new materials and aspiration to reduce the negative impact on environment, including the CO2 emission.

The efficiency of coal-combusting power unit may be increased from 37% to 42% by enhancement of turbine and boiler units, optimisation of thermal circuit, and reduction of auxiliary power consumption. Further raising of unit efficiency up to 43–46% (depending on the quality of fuel) is achievable by the increase in steam parameters (Dykas et al. 2011).

Enhancement of reliability and cost-efficiency of actively operated equipment, modification of capital and auxiliary units, implementation of new technologies also contribute to the increase in the performance of coal-fired thermal power plants (Hasler et al. 2009).

Usage of them depends on the equipment conditions, competitiveness of coal-fired generating facilities on the energy market, availability of funds, and other parameters of both internal and external environments.

In order to improve reliable and cost-effective operation of active equipment, well-known and proven technical solutions are applied. These include organising of examination and monitoring of technical conditions of coal-fired units with maximum age-dating. Commissioning of up-to-date automated control systems at coal-fired units is another way of enhancement of efficiency of coal power plants. It sufficiently improves their reliability, possibilities of operational control, economic and operational parameters.

The need in technical modernisation of coal-fired CHPs became extremely crucial. These plants are economically unsound for their operation without heat load and thus they are operated during the heating season only, which is about 4,000–5,000 hours per year (Lisin et al., 2016a, 2016b). Heat and power plants work according to heat load schedule and have no flexibility necessary for power adjustment in energy systems. Equipment and systems of heat and power plants were designed and manufactured about 50 years ago, they are worn, insufficiently automated and require huge personnel for their operation and maintenance. The replacement of obsolete equipment of coal-fired heat and power plants with the new heating units with modern boiling and turbine equipment is a durable solution of the problem. Implementation of production technologies based on elevated steam parameters is necessary for improvement of economic efficiency of coal-fired power units

4 Modernization programmes

Economic mechanisms of thermal power plants modernisation under the implementation of the Programme of Modernisation of Electric Power Industry in Russia and within the approach used for management in electric power industry presume the following:

- economically viable ratio of yields and risks of long-term investments into modernisation and construction of new power generating facilities;
- leading role of the government in the investment process for the purpose of secure provision of energetic safety of the country and its regions under the limitation of direct budget expenditures for investments into electric power industry;
- containment of additional investment burden on electric power tariffs for end customers;
- reduction of costs of energy equipment and construction of power generating facilities due to reorganisation of credit portfolio with acquisition of “long-term” loans and refinancing, including resources of Russian banks with state participation.

Financing of commissioning of main generating facilities of electric power plants is provided within terms of concluded contracts for power provision (CPP). Commissioning of auxiliary capacities is managed through modified mechanism of the long-term power market, which presumes the following:

- separated competitive capacity take-off (CCT) for operating facilities of power plants with limitations on technical and economic access conditions (it stimulates modernisation of generating assets);
- competitive selection of projects of new capacities for auxiliary CCT with further conclusion of CPP;
- pricing limitation on the cost of standard projects and yields for CCT concerning new capacities;
- guaranteed investments into commissioning of new capacities dictated by balanced requirements of energy system;
- inclusion of new projects on modernisation and construction of facilities of power plants in the programme of public-private partnership in electric power industry.

The following methods are applied for selection of new projects on modernisation and construction of power plants:

- Assessment of comparative efficiency of standard solutions on technical modernisation and new construction of power plants (optimisation of technology varieties) on the basis of calculation of discounted expenditures and ranging according to efficiency of power generating technologies. Discounted unit costs per life cycle of applied technology of energy resources production are the criteria of assessment;
- Systematic assessment of balanced and economically viable ways of development of electric power industry (optimisation of the scope of development of technologies) on the basis of dynamic optimisation of electric power industry development model. The minimum discounted cost of energy supply to the economy per planning cycle is the criteria of assessment;

- Assessment of rational option of the generating capacities structure on the basis of balanced and circuit-operational calculations. The minimum deviations from the optimal capacity structure considering the cost of the single capacity of power generating units, operational factors and resource limitations are the criteria of assessment.

The adopted economic mechanisms of thermal power plants modernisation are primarily focused on commissioning of new capacities characterised by minimal operational costs. The prospects of development of coal-fired generating technologies will be defined by coal price forecast, the ratio of coal and natural gas prices and pollutant emission quotas.

5 Conclusions and implications

Overall, one can see that there are large coal deposits in Russia with favourable mining conditions. Regions where those deposits are located need electric power and heat for their development. In order to satisfy such demand in energy products, the stimulating technical policy of the government is needed, as well as economic conditions for implementation of projects for thermal power plants construction and modernisation.

The programme of technical modernisation of operated coal-fired units should provide the gradual transition to higher-level coal-fired power production technologies. Implementation of such technologies results to significant reduction of fuel consumption as well as to improvement of environmental performance of the enterprise; however, it requires a bigger share of expensive steels and alloys for the construction of power generating units. This leads to significant increase of capital costs per installed capacity unit. From the economic standpoint, implementation of high-level technologies is viable nowadays for the construction of high capacity power plants.

According to the Russian Energy Strategy for the period up to 2030, the maximum inclusion of coal into fuel balance of power plants is provided. Given this, despite the severe necessity of diversification of fuel and energy resources consumption and decrease of dependence of power industry upon the natural gas, the transition to the prior use of coal-fired technologies does not occur. Moreover, exclusion of coal-fired power production by the natural gas-based one is carrying on. The prospects for coal power industry development in Russia would be influenced by the coal price, conventional pollutant emission limits, stimulating policy of the government, as well as by the availability of high-performance technologies of coal-fired energy products generation.

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