A Concept of Transition to a Technological Regulation System for the Power Industry

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1 Introduction

In accordance with the Federal Law № 219-FZ "On Amendments to the Federal Law 'On Environmental Protection' and Certain Legislative Acts of the Russian Federation," a gradual transition to the technological regulation system, based on the best available technologies (BAT), using the European Union experience and specifics of the domestic economy began in Russia since January 1, 2015 [1]. The goal of this research is the use of a systematic approach to the problem solution and the development of a mechanism to select the best options for the introduction of new technologies based on BAT.

2 Transition to Technological Regulation System

Power industry of the Russian Federation is among the three leaders in terms of the exerted influence volume. Major energy sector companies are classified as units with significant impact on the environment. As a part of the energy strategy of Russia for the period until 2030 (approved by the Government Decree № 17–15-r of November 13, 2009), the target figures to reduce the volume of the industry's negative impact on the environment were developed [2].

To reach the set figures, radical changes in the monitoring approaches to the companies' impact on the environment and stimulation of this impact reduction are needed. According to the authors, the transition to a regulation system, based on

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Table 1 Stages of transition to the technological regulation system

Period	Work-stage contents
2015–2017	The division of the companies into four categories according to the degree of their negative impact on the environment State registration of working companies and category conferment The development of BREF reference documents
Since January 2015	State regulation measures in the field of environmental protection will apply only to the pollutants included in the list established by the government of the Russian Federation
2019–2022	The owners of category I companies, with the contribution to the total pollutant emissions not less than 60%, are required to apply for an integrated environmental permit (IEP)
Since January 2019	The coming into force of the legal requirements for the inclusion into IEP of the mandatory program of eco-efficiency increase and environmental protection action plans for the facilities of category II
Until January 2025	The rest of the economic entities will have to get IEP

BAT, can make a significant contribution to the achievement of these goals. The foundation of these changes relies on the principles and provisions of environmental regulation, approved by the European Union Directive on Industrial Emissions 2010/75/UE (IED) (integrated pollution prevention and control, IPPC) [3], instead of the previously used EU Council Directive № 96/61/EU of 24.09.1996 "On Integrated Pollution Prevention and Control (IPPC)" [4]. According to the current IED, only big thermal stations with the thermal energy exceeding 50 MW are taken into account, thus excluding the other types of stations such as nuclear or hydroelectric power stations.

Certainly, the Russian Federation, in spite of certain achievements, stands at the beginning of transition to technological regulation; that is why the experience of the EU is carefully studied and adaptation of the EU regulatory framework to the legal field and the economic and technological characteristics of the Russian Federation is carried out. The planned stages of the transition to technological regulation system are shown in Table 1.

As mentioned above, the direct use of European BREFs [5, 6] by the Russian companies is hardly possible due to the existing differences in characteristics of all types of resources, peculiarities of raw materials, the availability of different energy types, natural conditions, environmental characteristics of the areas, and production technologies. That is why a science-based methodological support should be developed for transition of the Russian energy sector to BAT. An algorithm, consisting of several stages, is proposed. The algorithm is original and rather subjective, but it helps to choose the best technologies in accordance with a systematic approach, taking into account economic and environmental components of this process.

3 Application of BAT Selection Algorithm by Energy-Producing Companies

To determine BAT, the most effective technology (technical measures, administrative decisions) in terms of achieving a high general level of environmental protection at the energy-producing companies should be chosen.

Stage 1. Current situation of the companies' analysis. It is necessary to estimate the current situation of the companies in terms of their impact on the environment. First of all, environmental pollution at the power companies depends on the technology used at the power station and fuel type that was used to generate energy. On the basis of the company impact volume on the environmental components, its risk category should be determined from an environmental point of view. The volume of the impact on the environmental components also should be defined, so it would be possible to determine whether the impact of the given company is subject to the BAT regulation [5].

Stage 2. Determine the sphere of application for alternative technologies. At this stage it is necessary to consider all technologies that can be used to reduce the impact on the environment [5, 6]: (1) technological solutions, (2) raw material selection, (3) production processes control, (4) organizational arrangements, (5) "nontechnical" events, and (6) end-of-pipe technology. It is likely that at this stage the level of impact on the environment and the possible effects of the technologies introduction will become evident. It will be possible to choose the most appropriate technology [7, 8].

Stage 3. Alternative technologies analysis. At this stage, data on pollutant emissions (discharges, wastes production, and consumption) as a result of considered technologies application should be analyzed and summarized, as well as the data on used resources. During this stage of realization, relevant input and output parameters should be submitted in the form of a list (with quantitative indicators) of the considered technologies. This list should include produced discharges, emissions, wastes, other impacts, and consumed materials (water, coal, gas) [8].

Stage 4. Evaluation of all types of environmental impacts. Comparison of the different pollutants is conducted for each of the considered alternative technologies according to seven priority environmental problems: (1) toxicity for people, (2) the toxicity of water bodies, (3) global warming, (4) acid rain formation, (5) eutrophication, (6) ozone layer depletion, and (7) probability of tropospheric ozone formation. A reference publication [6] describes the integrated assessment methodology of the technological impact on the environment, which can be used to compare alternatives considered as BAT.

Stage 5. Description of the environmental problems assessment approach. Three possible approaches are proposed to evaluate options and get the results on the basis of the fulfilled assessments. Each of the approaches can be used independently or together. The first approach is the most simplified; it compares the previously considered and calculated impacts for each of the seven environmental problems.

The second approach is more complex and allows one to compare contributions made by the considered technology for each of the seven environmental issues, with all-European indexes. The third approach allows one to compare considered pollutants separately with the data of the European Pollutant Release and Transfer Register [5, 6].

Stage 6. Analysis of the additional information for alternative technologies description. At this stage all available additional information to clarify the description of the technology is gathered: technical and economic service time of the equipment and service data. Detailed characteristics will be used to collect and analyze data on costs. Together with the level of impact on the environment, it is necessary to assess the degree of exploitation reliability of considered production systems for the local area [8].

After reviewing and ranking of the possible options in terms of environmental performance, the variant with the least impact on the environment is considered to be the best, but only if this option is available from the economic point of view. Therefore, after the integrated assessment of impacts on the environment, it is necessary to evaluate and compare the costs of the considered alternative technologies implementation [7].

Stage 7. Data collection on the costs of the technologies introduction. All factors that may affect the data accuracy should be taken into account. Certainly, this may affect the evaluation results and the final decision on BAT selection. The main sources of the cost data are technology or equipment producers (suppliers), consultants and research groups, energy sector development plans, authorities, published information (papers, reports of engineers, sites of the power complex companies, data from conferences), and costs assessment of the comparable projects in other industries [8].

Stage 8. Determination of the cost structure of technologies implementation. The main task of this stage is to determine which elements of the costs should be included or excluded from the assessment. This stage helps to understand the cost structure and items to which costs are allocated. It is possible to distinguish the following groups of expenses: (1) investment, (2) annual expenditures for operation and maintenance (operating costs), and (3) costs to be considered separately.

All costs are to be assessed relatively to the basic version (the existing situation). The basic version is to be set according to the BAT assessment methodology, while the alternative versions are considered relatively to the basic version. Expenditures for all versions are to be shown for construction of new power plants.

Stage 9. Revenue assessment. It is necessary to collect information on additional income that may arise with the BAT implementation: (1) sales revenues, (2) avoided costs, and (3) following benefits.

Stage 10. Processing and presentation of information on costs and revenues. The collected information on costs and revenues should be processed in such a way that it would be possible to objectively compare alternatives. It is possible to formulate the most significant moments of information processing and presentation: (1) data calculation and presentation in the form of annual costs and revenues, (2) stating cash flows in a single currency (rubles for the Russian Federation), (3) adjustments for inflation effects, (4) use of the discounted cash flow method, and (5) valid approach to the discounting rate determination [8].

Stage 11. Evaluation and comparison of alternative technologies. After the benefit for the environment and the economic costs on the implementation have been established for the alternative technologies, it is necessary to fulfill a comparative analysis and to determine which technology meets the BAT criteria [6, 7]. There are several major ways to determine the cost-effectiveness with reference to the Russian energy sector companies.

Economic effectiveness analysis. In the context of ecological policy, this method means the achievement of the highest ecological results for every ruble invested into the environmental measures.

The most obvious way to compare the costs of the activity realization and the gained benefits consists in presenting them in the pecuniary form and comparing them by the analysis of costs and gains. If the comparison shows that the benefits exceed the costs, then the activity is worth investing into. Though such an analysis requires the large amount of data, and some benefits are difficult to present in the pecuniary form.

The cost efficiency analysis is simpler than costs and gains analysis as in this case the ecological benefits are assessed quantitatively and not in money terms. The economical effectiveness is defined by the following: economical effectiveness = annual costs/emissions (discharges) decrease.

The allocation of the costs between the polluting emissions (discharges). This brings the additional information regarding the methods of the cost allocation between the polluting substances, the ingress of which into the environment should be prevented or decreased. If the costs related to the environmental technologies were allocated between the polluting substances, then the method of their proportional distribution should be described. There are two possible approaches to the cost allocation:

1. The costs of the technology (equipment) may be fully allocated to the same problem of the environment pollution, for which this activity was initially intended. Then the decrease of the other pollutant discharges will be considered the additional benefit for the environment as it did not require the additional costs.
2. The scheme of the cost apportionment may be created to allocate the costs between the pollutants, the impact of which on the environment provokes the concerns.

The comparison of the technologies introduction costs and environmental benefits. The technology will be considered effective if the environmental benefits will exceed its implementation costs.

The cost-effectiveness of the technology introduction equals the sum of the discounted income over the sum of the discounted costs. But in this case there are certain difficulties with the justification of the discount rate and the amounts of revenues and expenses for an extended period of time. But even considering these difficulties, according to the authors, the method is the most preferable and reflects reality most accurately.

The technology identified as BAT should be developed on such a scale which allows its implementation in the relevant industrial sector, under economically and technically valid conditions. The assessment of the economic efficiency is only necessary with BAT determination at the industry level, when the proposed technologies lead to the fundamental changes in the energy sector.

4 Evaluation of the Technologies Economic Viability in the Energy Sector

A reference publication [6] and the national standard of the Russian Federation [9] provide general recommendations on the assessment of the technologies economic cost-effectiveness in various industry sectors. In this chapter the authors focus on the peculiarity of such assessment in the energy sector. In the authors' opinion, this approach will allow a better understanding of the existing differences in the types of resources, peculiarities of raw materials, the availability of different energy types, natural conditions, environmental and production characteristics of the areas, and a better disclosure of the BAT transition concept.

It is assumed that for the consideration of the economic cost-effective assessment at the industry level, the most significant problems are: (1) industry structure, (2) market structure, (3) the ability of quick recovery ("elasticity"), and (4) implementation rate [6, 9] (Fig. 1).

The structure of the (energy) industry describes the socioeconomic characteristics of the considered industry and the technical characteristics of the industry

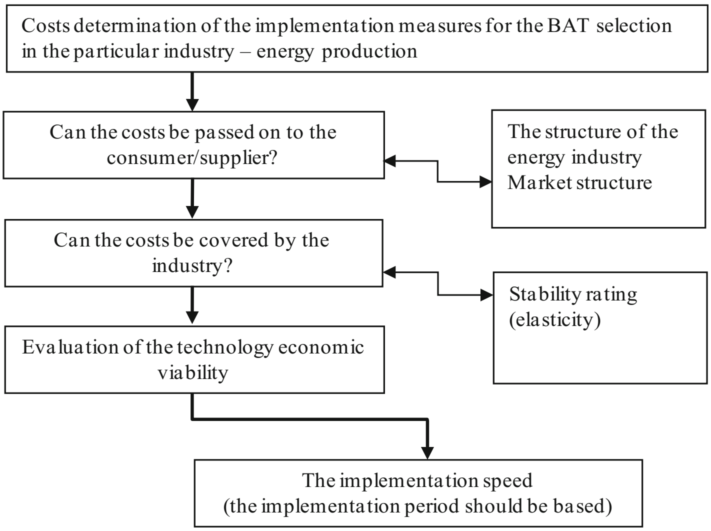

Fig. 1 The evaluation of the BAT implementation economic cost-effectiveness in the energy sector

companies. These characteristics allow a better understanding of the industry structure and how easily can the BAT implementation pass. While describing the structure of the industry, it is logical to consider the following questions: (1) the size and number of the companies in the industry (large companies are common for the energy industry). (2) Companies' (units) specifications. The existing infrastructure of the company will have some impact on the BAT type and can also affect the implementation costs of this technology. (3) Equipment service life. The equipment with long service life is usually used in the energy sector. It is a determining factor in the investment cycle. (4) Barriers for market entry or exit. In cases when there are barriers for the new players' entry into the market (e.g., high prices for equipment or licenses), the problem of technical barriers should be considered separately.

The market structure can affect the ability of the company in terms of the transfer and assignment of the "environmental" costs of the BAT implementation on to the consumers or suppliers. There is a range of factors characterizing the market structure for the energy sector. Many of these factors are associated with a qualitative assessment, which makes it difficult to determine their effect on BAT; but among them the most important factors can be marked: the market size, the price elasticity, and the competition between the products. The analysis of the market structure facilitates the significant risk identification and allows industry to consider the impact of these risks (if any) for the BAT definition.

The industry stability (elasticity). The elasticity reflects the ability of the industry to cover the increasing costs of the BAT implementation, while maintaining its profitability in the short, medium, and long term. Any increase in costs associated with the BAT implementation should be covered by the industry or passed onto the consumer. The elasticity describes the ability of the industry to cover these costs. To describe the elasticity of the industry, it is useful to consider the long-term trends (5–10 years) to ensure that short-term fluctuations do not affect the BAT determination.

The implementation speed. If after assessing the industry structure, market structure, and stability of the industry certain doubts about the idea of BAT remain, the technology implementation speed can be estimated as the implementation time can be critical for the energy sector. The implementation speed normally is not an issue for the new facilities (as opposed to active) because it is expected that new companies are ready to use environmentally safe technologies and pollution control equipment. Therefore, the evaluation process should distinguish new and existing enterprises. To determine the BAT implementation speed, it is useful to consider the following time scales: short term (several weeks or months), medium term (from a few months to a year), and long term (several years).

5 Conclusions

The economic cost-effectiveness is an integral part of the best available technologies concept. But its in-depth assessment should be carried out only in cases when there are clear differences regarding which BAT can be implemented cost-effectively in the energy sector. The approaches considered by the authors are quite reliable and form a structure for the decision-making process. The concept of the transition to BAT presented in this chapter should help to clearly state the existing aspects, to justify the costs and benefits of the technologies implementation and ensure the further energy companies development.

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