ENHANCING RESOURCE EFFICIENCY AND RECYCLING SECONDARY RESOURCES TO ACHIEVE SUSTAINABLE DEVELOPMENT GOALS: A VIEW FROM RUSSIA

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ABSTRACT

The article focuses on the development of an industrial policy towards modernization of the resource-intensive sectors of Russian economy based on the principles of Best Available Techniques (BATs) and secondary resource recycling (recovery). BATs are regarded as benchmarks for the regulators as they draw up mandatory requirements for the industry. This way industries would be motivated to introduce innovations and implement modernization programs, while the regulators should set targets for such a transformation. The methodological framework of the study includes the theories of economic growth, system efficiency, techno-economic paradigms and the concept of sustainable development.

The content of the environmental industrial policy (EIP) of Russia has been developed where the EIP fulfils the role of a "horizontal" industrial policy instrument designed to enhance the resource efficiency and to reduce the negative environmental impacts at the micro- and macroeconomic levels. At the macroeconomic level, BATs form a basis for forming industrial symbioses, in which secondary resources (often addressed as waste or waste heat) of one installation are used as raw materials (or energy resources) of the other ones. Industrial symbioses play the role of nuclei of the circular economy which is being formed in Russia. To promote circular economy approaches, a research project entitles "Green Cases" is being implemented by Russian researchers and their European colleagues. Two cases are presented in this paper.

Environmental Industrial Policy meets the Sustainable Development Goals (SDGs) by promoting economic development, industrialization and innovations, and transition to responsible production and consumption patterns. In order to assess the EIP effectiveness, the authors proposed to consider the resource efficiency as a value to be measured in physical rather than financial units. The results of a case study demonstrating the practical application of the EIP instruments for achieving the Sustainable Development Goals are presented.

Keywords: sustainable development; resource efficiency; recycling environmental industrial policy; Best Available Techniques; circular economy

INTRODUCTION

The concept of sustainable development proposed over 30 years ago is what the international community views now not only as a moral imperative but also as socio-economically and environmentally sound practice. The adoption of the Sustainable Development Goals and the development of their respective objectives and quantitative

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targets [1] are an evidence that the requirements and commitments of sustainable development at the regional, national or global levels are no longer mere declarations but transition into practice, with shaping the external conditions which the states, economic sectors, companies, and organizations have to take into account as they draw up and implement their development strategies and policies [2]. The social and environmental boundary conditions and the resource boundary conditions are conditions par excellence; there is no fundamental contradiction between economic development and efficient use of natural resources and reduction of adverse impacts on the environment and humans. However, there should be clearly described, evidence-based and quantified conditions in place; furthermore, they should only be modified in a consistent manner as previously specified conditions will have been met [3]. In Russia, resource and environmental conditions can and should be specified by the environmental industrial policy, a part of the industrial policy whose elaboration and implementation are driven by the adoption of the National Development Goals of the Russian Federation (RF) in 2018 and 2020 [4].

The purpose of this paper is to establish the content of the RF environmental industrial policy as an instrument for achieving the SDGs related to the resource efficiency improvement and developing responsible production patterns as well as to the industrialization, innovations and economic modernization. The paper aims at (1) identifying the key goals and instruments of the environmental industrial policy; (2) analyzing the specific features of the concept of Best Available Techniques as a driving force of industrial resource efficiency; and (3) analyzing some case studies (modernization of industrial processes and development of sustainable industrial and environmental systems performed by several Russian industrial enterprises).

RESEARCH METHODS

The problem of improving the efficiency of use of limited resources is the subject matter of R. Solow's theory of economic growth [5], the theory of global techno-economic paradigms of N. D. Kondratiev [6], J. Stiglitz's resource management theory [7], and the concept of sustainable development, which laid the foundation for contemporary research in economics, ecology, sociology, etc.

Global environmental problems have become the key motive for developing and implementing a set of measures towards coordination of the economic priorities and the resource and environmental priorities of industrial development. The resource-related and environmental group of priorities took shape in the late 1960s and early 1970s, when the environmental pollution appeared to be a permanent feature of the industrial production activities. Industrial ecology, a field of study focused on the stages of the production processes of goods and services from a point of view of nature, trying to mimic a natural system by conserving and recycling resources [8], gained traction in 1970s–1980s. Notwithstanding that the initial conditions were equal, the practical results as published by researchers from most diverse economies were primarily implemented in the industrial policies of those nations who had experienced severe resource and social and environmental constraints [9].

The concept of Best Available Techniques (BAT) underlies the effort towards coordination between the economic priorities and the resource and environmental priorities for industrial development. The BAT are a set of economically viable technological, technical and managerial solutions which, with due account of the specific features of a particular industrial installation, would ensure a high production resource efficiency while simultaneously preventing (or significantly reducing) the adverse environmental impact [10]. The quantitative consumption and emission indicators when using the BAT, allow considering the Best Available Techniques as the benchmarks for drawing up requirements which are mandatory for the industry.

Since 1996 requirements to ensure compliance with BAT have been extended to all major industrial installations in the European Union (EU) Member States. According to the 2019 Report of the Organization for Economic Cooperation and Development (OECD) [10], the effectiveness of the BAT-related policy should first of all be assessed by studying the decoupling characteristics by comparing environmental emissions reduction and the industrial growth indicators. However, it is a special feature of the BAT that in shaping the conditions for industrial development, priority is given to methods which help prevent resource inefficiency, replace non-renewable natural resources with renewable or secondary ones, and avoid using highly hazardous substances in industrial processes. These principles are a direct link between the BAT concept and the environmentally focused industrial policy [11], which is effectively close to the so-called Green Industrial Policy, [12]. Let us consider the priorities of the European Green Deal, published in 2019 [13]:

– building a circular economy;

– ensuring a significant improvement in resource efficiency;

– providing support for the innovations-based industrial development;

– improving the efficiency and environmental properties of buildings, structures, and transport;

– investing in environmentally-friendly techniques;

– reducing environmental pollution;

– decarbonizing the energy sector;

– working with international partners to improve global environmental standards.

As it can be seen, the resource efficiency and environmental performance are becoming the indicators to measure the industrial policy effectiveness at the level of an installation, company, industrial sector, region, nation, and community.

RESULTS AND DISCUSSION

Key Objectives and Major Instruments of Russia's Environmental Industrial Policy

The environmental industrial policy (EIP) should be defined as a horizontal instrument of industrial policy aimed at modernizing resource-intensive industries based on the Best Available Techniques and recycling of secondary resources [3].

Achievement of SDG 8 "Decent Work and Economic Growth", SDG 9 "Industry, Innovation and Infrastructure" and SDG 12 "Responsible Consumption and Production" is not possible to attain unless fundamentally novel products, services and techniques have been developed and implemented along with changing the attitudes towards resource availability and efficiency of resource use. Thus, an environmental industrial policy is an instrument for addressing the key targets essential for achieving the SDGs (Table 1), representing a set of measures and an action program enabling the transition from the current to the intended or desired state of the economic and social system (industry), which ensures the improvement in citizens' well-being and national security.

The EIP aims at the modernization of industrial processes in the key sectors (which, as emphasized before, does not prevent from the introduction of innovations or development of fundamentally novel types of production) and recycling of secondary resources (primarily, production waste). This is in line with the National Goals, Objectives and Targets of the Russian Federation.

Table 1. Correlation Between the Targets of Environmental Industrial Policy of the Russian Federation and the Internationally Approved Sustainable Development Targets

Targets under the Sustainable Development Goals	Targets of the Environmental Industrial Policy of the Russian Federation
8.4. Improve progressively, through 2030, global resource efficiency in consumption and production and endeavor to decouple economic growth from environmental degradation	Promote responsible production and consumption patterns and reduce the adverse environmental impact of industry
9.4. Upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes	Support for technological re-equipment and modernization of industry Introduction of resource-efficient and environmentally safe technologies
12.2. Sustainable management and efficient use of natural resources	Providing incentives for the industry to use all resource types in a rational and efficient manner
12.4. Environmentally sound management of chemicals throughout their life cycle... and significantly reduce their release to air, water, and soil to minimize their adverse impacts on human health and the environment	Chemical management in accordance with international commitments
12.5. Substantially reduce waste generation through prevention, reduction, recycling, and reuse	Prevention of production waste generation and recovery of secondary resources

To assess the effectiveness of the Environmental Industrial Policy, a set of indicators should be set and used, reflecting both the government's efforts to implement the EIP and the outcomes of the upgrade of industries, first of all, an increased resource use efficiency, reduced adverse environmental impact and increased share of secondary resources recovered (see Table 2). Since the 1990s, "polluter pays" principle has been implemented in Russia in the form of pollution charges (adverse environmental impact (AEI) charges) paid by all companies, including law abiding ones.

The conventional approach to assessing the environmental and economic efficiency and evaluating the effectiveness of the supervisory functions of the state is the calculation of the revenues going to the state budget through AEI charges. At the same time, the significance of the investments in new resource efficient (and pollution preventing) techniques is not fully recognized by environmental authorities. Such indicators as compliance rates among major polluters and their trend, share of operators demonstrating responsible behavior, improvements in resource and energy efficiency are not assessed or assessed very seldom.

Thus, most EIP effectiveness indicators should be assessed in physical terms (units) (see Table 2), which is in line with the UN approach to developing the indicators pertaining to the objectives of sustainable development. For instance, the SDG indicators include such items as total resource consumption, resource consumption per capita, recycling rate, and the amount of recycled, processed, and reused waste (secondary resources). These indicators are needed to understand if circular economy business models lead to the intended environmental improvements.

Table 2. Effectiveness Indicators of the Environmental Industrial Policy

Description (changes in the state of industry as a social and economic system)	Indicators
Improving the resource efficiency of industry	Energy consumption per production unit, GJ/t (reduction in consumption vs. the baseline value, %) Consumption of natural resources (raw materials) and water per production unit, t/t or m3/t (reduction in consumption vs. the baseline value, %)
Emission reduction	Reduction of emissions vs. the baseline value, %
Secondary resource recycling (recovery)	Ratio of recycled (secondary) and natural raw materials processed in the industrial process, % Share of products manufactured using recycled resources in the total output, %
Reduction of the number of contaminated sites (so called accumulated damage objects)	Number of sites of historic pollution (illegal dumps, oil spills, etc.) vs. the baseline value, %
Improved level of responsible behavior (compliance) of the regulated community (industry)	Ratio of industrial enterprises' production development (modernization) expenditures and their pollution charges or penalties for infringements, % Share of industrial installations meeting the BAT requirements (those exempt from AEI charges)
Proper and efficient handling of public funds	Government expenditure on efforts to improve the indicators in the above Paras 1–4, Russian Rubles per unit of variation (Δ) of the indicator

The Concept of Best Available Techniques as the Driving Force of Russia's Resource Efficiency

The concept of Best Available Techniques has had a broader meaning in Russia than in most other countries where regulators focus on issuing the BAT-based integrated environmental permits. The Russian approach is special; the new system of technological regulation is primarily designed to stimulate industry to upgrade and introduce modern techniques which would be highly resource-efficient, environmentally sound and economically efficient. This approach is consistent with the international BAT principles. Moreover, according to OECD experts, the emphasis on providing support to industry has allowed Russia to quickly identify (as well as quantify) the Best Available Techniques in dozens of industrial sectors, draw up BAT reference documents (BREFs) and form the necessary regulatory framework and infrastructure for the transition to technological regulation in the field of environmental protection (BAT-based regulation) [10].

The degree of compliance of a particular industrial installation is linked to the BAT requirements and the achievement of established industry-specific technological indicators (BAT-associated environmental performance levels, BAT-AEPLs) depend on the resource efficiency and environmental performance of the technological processes, applied techniques and management systems in place. In Russia, organizations meeting the BAT requirements gain goodwill (which is in line with Objective 12.6.1 “Application of sustainable production methods and disclosure of information on the sound use of resources in public reporting”) and are exempt from pollution charges. Operators of the installations failing to comply with the BAT requirements are obliged to draw up and implement modernization programs, officially referred to as Environmental Efficiency Enhancement Programs (spanning, as a rule, seven years) [58]. The “polluter pays” principle takes on its originally intended meaning: businesses invest in modernization and resource efficiency improvements, thus ensuring the internalization of externalities. The respective requirements will be getting increasingly more specific and restrictive, and businesses should consider this fact for their strategic planning. The regulator sets targets while businesses receive signals allowing them to identify areas of modernization and select technological solutions that would be viable in the long run (Figure 1).

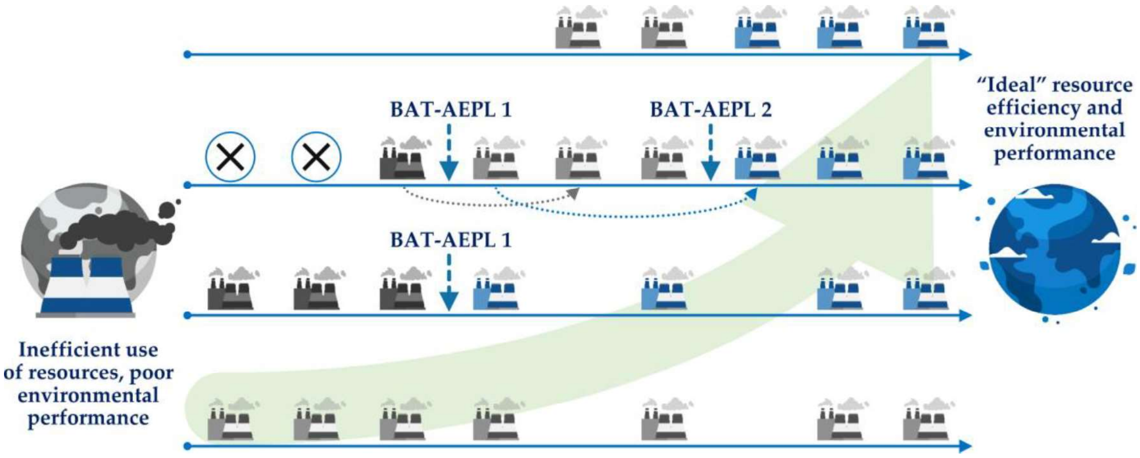

Figure 1. Best Available Techniques as a driver for the technological modernization of industry

This way, the Environmental Efficiency Enhancement Program can be viewed as a modernization roadmap. As the programs are being implemented, the share of compliant businesses will increase, while on the other hand, the resource efficiency of production will improve and the adverse environmental impact will decrease. At the next cycle (with stricter BAT requirements), further transformation of industry (approximation to the desired, or 'ideal' state) will take place.

In order to ensure non-biased approach during the decision-making, the regulators should specify the conditions in such a way that modern (efficient) techniques could be distinguished from the not-so-efficient practices in each industry. To select such a criterion, a concept of the reference technique (or a set of reference or desired properties of the technique) should be conceived. It is logical to imply by reference technique such a technique that features a high productivity and resource efficiency and low adverse emissions in to the environment. If a reference technique is perceived as an ideal (with an energy efficiency at the thermodynamic limit, zero emissions, etc.), then achieving compliance with it would require a drastic change on the scale typical for innovative solutions, which necessitates a quantum leap in research and technology advancement [59]. Examples of such idealization include the complete elimination of mercury emissions by means of the membrane technology in production of chlorine and alkali, widely used since the beginning of the 21st century; a sharp reduction in organochlorine compounds generation by dropping the use of molecular chlorine for cellulose bleaching (this is presently the BAT for pulp-and-paper or textile manufacturing); or carbon-free production of sponge iron by using hydrogen as a reducing agent (the testing of which is under way at a pilot steel plant in Sweden since 2019).

In real life, the BAT compliance may be viewed as an indicator for determining the 'up-to-dateness' of a technique. The expert assessment is the basic approach to identifying the Best Available Techniques both in Russia and abroad due to the complexity of industrial processes, their numerous parameters and ambiguity of technique benchmarking procedures. The development and updating from time to time of the BAT themselves and BAT requirements are the responsibility of special technical working groups (TWGs), and the BAT Bureau was established to manage and supervise those activities. A Best Available Technique reference document is the deliverable for each TWG. In Russia, BREFs are a new document type of the national standardization system, there being no such experience in the Russian law enforcement practice until 2019. In Russia, a BREF has a standard structure which differs a little from the structure of most European BREFs (Figure 2).

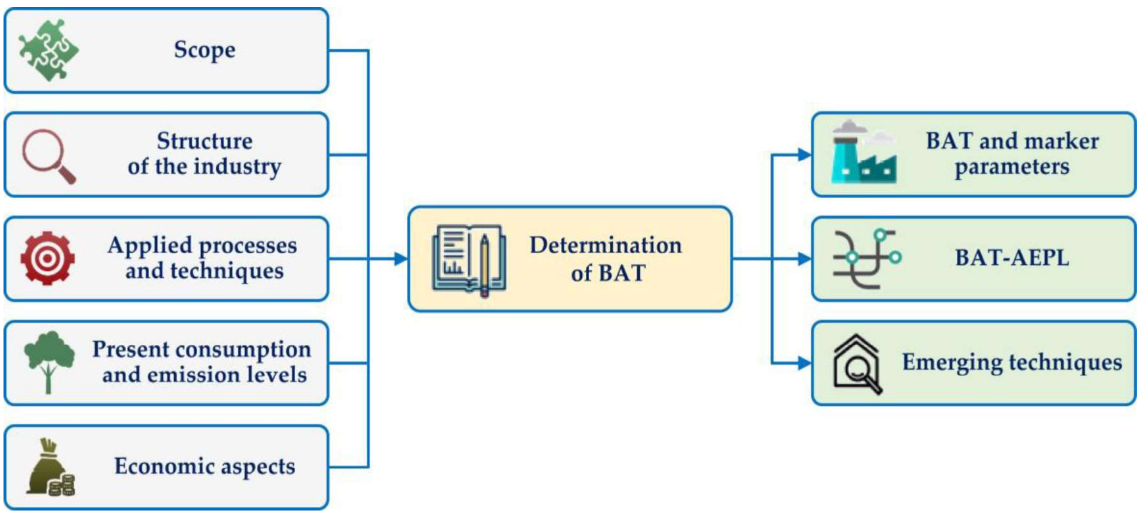

Figure 2. Structure of the Russian Reference Documents on Best Available Techniques

Each sectoral BREF describes specific industry sector and its industrial processes, introduces characteristics for their benchmarking (BAT-AEPLs, technological indicators), as well as defines, he solutions to be identified as the Best Available Techniques along with their characteristics of resource environmental efficiency and environmental performance based on the current level of development and capabilities for modernization of the respective enterprises.

The BREF sections with a description and benchmarking of techniques (the respective product life cycle, specific features of material and energy balance, equipment) and the role of a particular industry in the economy have already been used in practice by the TWGs as the latter update the BREFs, by experts when assessing enterprise modernization programs, and by university teachers and students in their classes and when working on their qualifying papers.

Experience in Modernizing Industrial Processes and Forming Sustainable Industrial Symbioses

“The Green Case Studies” research project aims at the systematization of the evidence on improved resource efficiency and reduced adverse environmental impact through the BAT-based modernization of resource-intensive enterprises and secondary resource recycling. The project addresses the decision-makers, as in most cases communication is required between business entities and government agencies (at the level of region or higher) to ensure effectiveness of the environmental industrial policy. To date, over twenty operational or still designed case studies located in the Urals, Siberia, North-Western Russia have been identified as Green Cases of industrial symbioses.

One of industrial symbioses was developed in the city of Novotroitsk (Orenburg Region, Russia). The Orsko-Khalilovsky metallurgical plant was launched in Novotroitsk in 1955. Ural Steel JSC, a full-cycle enterprise including sinter, blast-furnace, coke-oven, steelmaking and rolling practices, continued as its successor in 1992. The typical large-tonnage manufacturing slag produced by the metallurgical plant and later by Ural Steel JSC has been disposed into slag dumps at the north-eastern border of the city for decades. In 2002, the Akkerman Cement plant was established to process slags and recover metal concentrates. The special-purpose innovative facilities of Akkerman Cement process annually around 6 mln tons of slag, including all the slags currently produced by Ural Steel JSC, and 5 mln tons of the stock accumulated during the previous years (see Figure 3).

The use of the metallurgical slags as a secondary resource has made possible the replacement of the limestone mined in the Akkermann quarry located 1.5 km from the city. Natural limestone consumption has been almost halved, and the adverse environmental impact of the slag dumps has also been reduced. The technique in question meets the BAT requirements and features a high resource and energy efficiency: specific energy consumption of the plant is almost 1.5 times lower than at other cement-producing enterprises [14]. Greenhouse gas emissions have also been significantly reduced, which is especially important as carbon regulation is expected to be adopted in the Russian Federation, and also in the context of efforts to achieve the SDG 13 “Take urgent action to combat climate change and its impacts”.

Therefore, the environmental and economic system under consideration has two industrial enterprises interconnected with their respective material flows, the material and energy efficiency of cement production have been significantly improved by replacing natural resources with secondary ones. The degree of secondary resource recycling could be further improved by using slag-processing leftovers (mainly, chemically neutral stones) in road construction and landscaping as a gravel (crushed stone). This will require developing a strategy for secondary resource recovery in place, which could draw, among other things, on the experience of the European Union's Raw Materials Initiative.

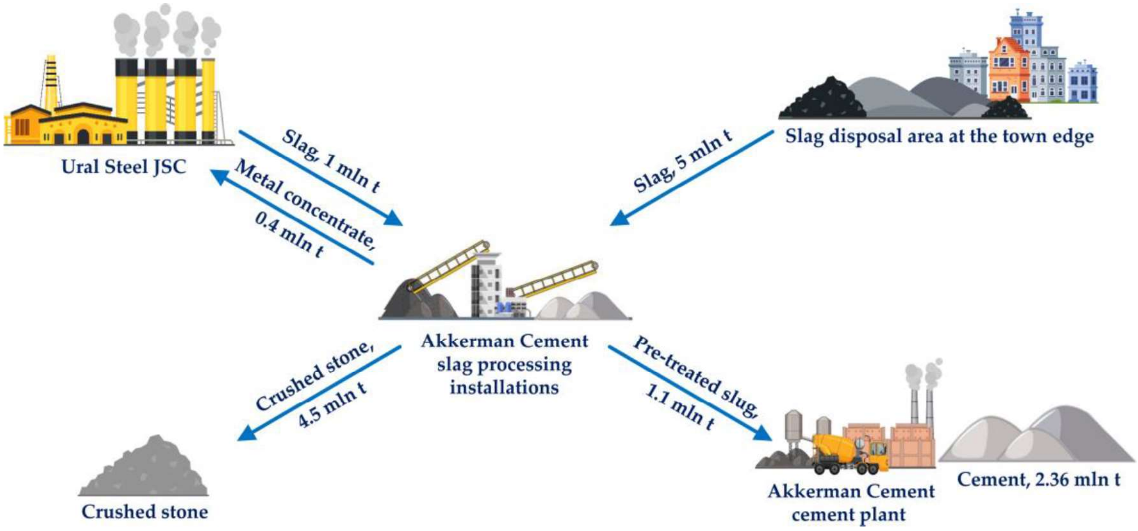

Figure 3. Green case study: closing loops in the eco-economic system of town of Novotroitsk (figures reflect annual values)

Another example (or a Green Case) is Mondi Syktyvkar Pulp and Paper Mill, one of the leaders in the Russian pulp and paper industry and the largest domestic paper producer. The enterprise was established in the Republic of Komi in 1969. In 2003, the mill was included into the Barents Environmental Hot Spot List as an installation contributing to the pollution of atmospheric air and local rivers [15].

Currently, the mill is fully integrated across the entire production cycle – from harvesting wood to shipping cardboard, paper and other goods to the customers. The company also operates a wood yard, a power plant, and a wastewater treatment plant.

A series of modernization projects implemented in 2003–2019 allowed to significantly increase production (by 83 %) and enhance the resource efficiency. For 1 ton of bleached sulphate cellulose Mondi Syktyvlar consumes 3.45 cubic meters of dense timber. Modern digestion and bleaching (Elemental Chlorine Free, ECF) techniques provide for both for the production of better-quality cellulose and for the minimization of Adsorbable Organic Halides (AOX) effluents. AOX emissions reach 0.115 kg/t of cellulose which complies with the requirements of the sectoral BREF. Older soda recovery boilers are replaced by the new and bigger one. A special system for collecting and burning non-condensable gases installed at the mill helps eliminate bad odor at the site and in its vicinities. In 2019, Mondi Syktyvlar completed implementation of two strategic investment projects – modernization of power plant and wastewater treatment plant [15].

Nowadays, the wastewater treatment plant of Mondi Syktyvkar processes over 80 mln cubic meters of water annually, including 100 % of municipal wastewater from the city of Syktyvkar and neighboring industrial enterprises. Bark boilers of the power plant burn 100 % of bark and wood residues, the share of green energy in the overall energy balance exceeds 40 %. Power plant covers around 20 % of the municipal demand in electric energy, and it is the only source of heat and hot water for Ezhva district of Syktyvkar with a population of around 60,000 thousand people [15]. As it is shown in Figure 4, being a highly resource efficient and environmentally sound industrial installation, Mondi implements also social functions in accordance with SDG 8 "Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all", SDG 9 "Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation", SDG 11 "Make cities and human settlements inclusive, safe, resilient and sustainable" and SDG 12 "Ensure sustainable consumption and production patterns" [1].

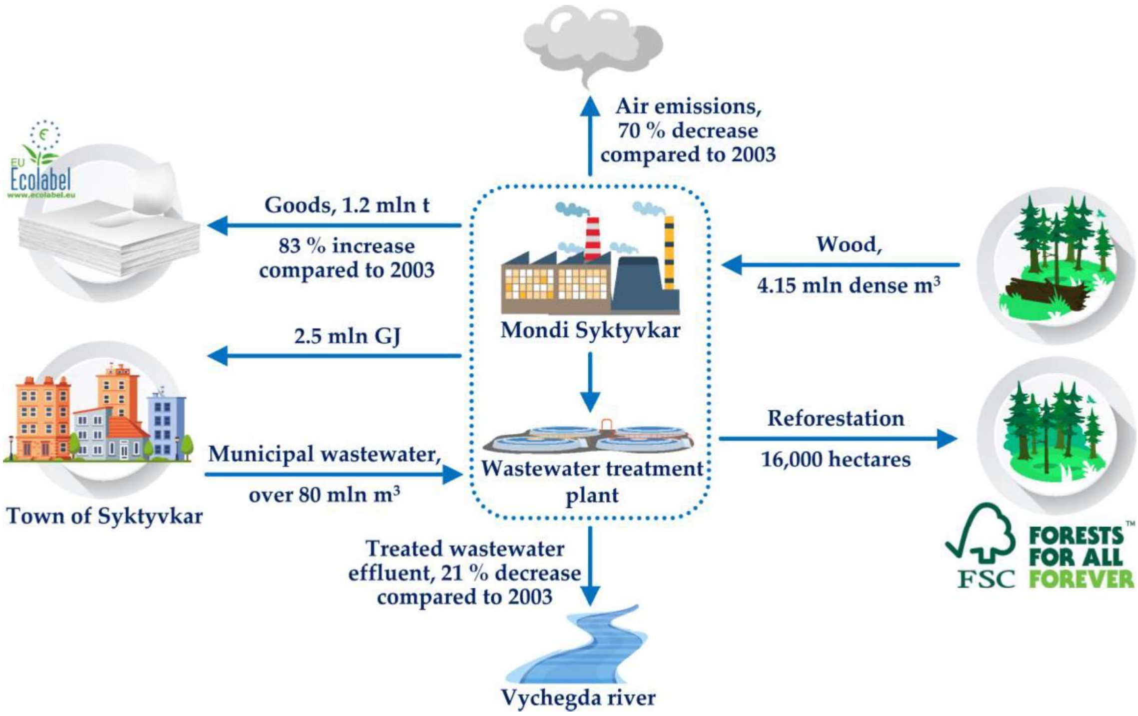

Figure 4. Green case study: the role of the pulp and paper mill in the eco-economic system of town of Syktyvkar (figures reflect annual values)

In 2019–2020, Mondi Syktyvkar Pulp and Paper Mill proved its full compliance with applicable BAT requirements and was successfully excluded from Barents Environmental Hot Spots List 2020 [15].

Therefore, in order to increase the resource efficiency at the regional level, the principles of industrial symbiosis should be followed, with establishing interaction between the business entities in such a way that by-products or objectionable products of one facility (production waste, according to the current terminology) are used as inputs (raw materials) by other facilities.

In general, the results of the case study suggest that the implementation of the EIP would contribute to the achievement of the Sustainable Development Goals related to economic growth and innovation, building of a circular economy (establishing responsible production patterns and improving the efficiency of natural resource use) and reduction of adverse environmental and climate impacts.

CONCLUSION

The paper makes a case for regarding the Environmental Industrial Policy of the Russian Federation as a horizontal instrument of the industrial policy, designed to contribute to the achievement of the national development goals and internationally accepted Sustainable Development Goals.

It has been shown that the implementation of the EIP will contribute to the transformation of the economy, coordination of the economic, resource-related and environmental priorities for industrial development and development of up-to-date technologies.

The need to pursue two logically interconnected objectives of the environmental industrial policy has been substantiated: (1) modernization of resource-intensive industries based on the Best Available Technique principles, and (2) secondary resource recycling. A system of indicators to be used to assess the EIP effectiveness has been proposed. These indicators should be measured in physical terms (units), which will make it possible to assess the industry's response to the impact of EIP instruments. Information on the targets and actuals should be collected and systematized for its further use by the regulators as the latter develop mandatory requirements in their respective area of responsibility. The first step will be to include resource efficiency indicators in the Best Available Technique reference documents, the preparation of which is coordinated by the Ministry of Industry and Trade of the Russian Federation.

The BAT concept has been considered as a driving force in technological advancement; it has been shown that the consistent tightening of requirements for the resource and environmental efficiency of industrial processes will foster innovation and modernization in the resource-intensive industries while being no impediment to the introduction of innovative solutions.

The recent research project entitled “The Green Case Studies” and implemented both at the sectoral and regional levels has been considered. It has been shown that the implementation of the above will allow to (1) develop methodological approaches for providing the rationale for consistent improvement of the requirements for the resource and environmental efficiency of techniques, and (2) systematize the objective evidence of the effectiveness of the environmental industrial policy at the industry or regional levels.

REFERENCES

[1] Take Action for the Sustainable Development Goals – United Nations Sustainable Development. URL: https://www.un.org/sustainabledevelopment/sustainable-development-goals/ (accessed on 16.09.2021).

[2] Smol M., Marcinek P., Duda J., Szołdrowska D. Importance of Sustainable Mineral Resource Management in Implementing the Circular Economy (CE) Model and the European Green Deal Strategy. Resources 2020, 9, 55.

[3] Almgren R., Skobelev D. Evolution of Technology and Technology Governance. J. Open Innov. Technol. Mark. Complex. 2020, 6, 22.

[4] Bobylev S. N., Solovyeva S. V. Sustainable Development Goals for the Future of Russia. Studies on Russian Economic Development 2017, 28, 259.

[5] Solow R. N. A Contribution to the Theory of Economic Growth. The Quarterly Journal of Economics 1956, 70, 1, 65–94. DOI: https://doi.org/10.2307/1884513.

[6] Barnett V. Kondratiev and the Dynamics of Economic Development. Long Cycles and Industrial Growth in Historical Context. Studies in Russian and East European History and Society; Palgrave Macmillan: London, UK, 1998, pp. 105–142.

[7] Stiglitz J., Sen A., Fitoussi J. Report of the Commission on the Measurement of Economic Performance and Social Progress (CMEPSP). January, 2009. URL: https://www.researchgate.net/publication/258260767_Report_of_the_Commission_on_the_Measurement_of_Economic_Performance_and_Social_Progress_CMEPSP (accessed on 16.09.2021).

[8] Chertow M. R. Industrial Ecology in a Developing Context. In: Clini C., Musu I., Gullino M. L. (eds) Sustainable Development and Environmental Management. Springer, Dordrecht, 2008. DOI: https://doi.org/10.1007/978-1-4020-6598-9_24.

[9] Meadows D., Randers J., Meadows D. Limits to Growth: The 30-Year Update. Chelsea Green Publishing, 2004.

[10] Organisation for Economic Co-operation and Development (OECD) Best Available Techniques (BAT) for preventing and controlling industrial pollution. Activity 3: Measuring the effectiveness of BAT policies. Environment, health and safety, Environment directorate, OECD: Paris, France, 2019.

[11] Fogarassy C., Finger D. Theoretical and Practical Approaches of Circular Economy for Business Models and Technological Solutions. Resources 2020, 9, 76.

[12] Rodrik D. Green industrial policy. Oxford Review of Economic Policy 2014, 30, 3, 469–491.

[13] European Commission. Brussels, 11.12.2019. COM(2019) 640 final. Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of The Regions. The European Green Deal. URL: https://ec.europa.eu/info/sites/info/files/european-green-deal-communication_en.pdf (accessed on 16.09.2021).

[14] Guseva T., Shchelchkov K., Vartanyan M., Tikhonova I. Setting Energy Efficiency Enhancement Objectives for Russian Energy Intensive Industries. Procedia Env. Sci. Eng. Man. 2019, 6, 4, 619–628.

[15] Mikaelsson A., Guseva T., Tikhonova I., Shchelchkov K. Best Available Techniques as Criteria for Excluding Russian Industrial Installations from the Environmental Hot Spot List of The Barents Region. International Multidisciplinary Scientific GeoConference SGEM 2020, 20, 5.3, pp. 261–268.