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Russia's Energy Efficiency Policies in the Industry Sector: Critical Perspectives

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ABSTRACT

The paper critically reviews the existing energy efficiency policies in the Russian industry sector with the purpose of analyzing their current state, processes of implementation, and main limitations and drawbacks. In particular, we focus on the most energy intensive industries: (a) Ferrous metallurgy, (b) building materials production, (c) pulp and paper industry, and (d) fertilizer production. The paper carefully reviews the existing energy efficiency policies in Russia's industry since 2008, focusing on the following dimensions: (a) Government management system, (b) technological regulation, (c) financial incentives and funding, (d) supporting mechanisms. Then, on the basis of the data collected according to the methodology used by the Ministry of Energy of Russia, an analysis of energy efficiency performance in industry is conducted. Last, we critically discuss the results obtained, emphasize overall directions of the energy efficiency policies, and outline main limitations the methodology used by the Ministry of Energy of Russia to evaluate energy efficiency performance in the industry sector has.

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1. INTRODUCTION

Many countries, the European Union, China, and Japan in particular, heavily depend on the foreign supply of energy resources. As a response to the increasing demand for energy and high energy prices, such countries had to adopt and implement ambitious energy saving and energy efficiency policies aimed at reducing the energy intensity of their GDP and CO_2 emissions (Pardo and Moya, 2013).

In contrast, Russia has abundant energy resources and is one of the main suppliers of energy resources to the world markets (Kryukov and Moe, 2018). At the same time, the Government of Russia has adopted energy efficiency policies and set high goals in reducing its GDP energy intensity (Camioto, 2018). The main issue behind these policies is not the growing demand and scarcity of energy resources in Russia, but the fact that the economy of Russia is very wasteful when it relates to energy consumption (Mimouni and Temimi, 2018). According to the International Energy Agency, Russia has the largest energy saving potential in the five most energy intensive industry: (a) Iron and steel, (b) cement, (c) chemicals and petrochemicals, (d) aluminum, and (e) pulp and paper (IEA, 2011). Being one of the four largest energy consumers in the world (after China, the United States, and India), Russia has the highest energy intensity level of primary energy (Table 1).

Therefore, the importance of increasing energy efficiency and reducing energy intensity of Russia's GDP in general and in the industry sector in particular is hard to overestimate. According

Table 1: Energy intensity level of primary energy, ML/$2011 PPP GDP

Country	Energy intensity			
	1990	2000	2010	2015
Russia	12.027	12.687	8.731	8.413
China	21.179	10.233	8.679	7.341
United States	8.667	7.335	6.072	6.690
India	8.292	6.950	5.353	5.408
Canada	10.170	9.219	8.012	4.731
Brazil	3.810	3.948	3.891	4.130
France	5.448	4.978	4.577	4.102
Germany	5.882	4.635	4.115	3.603
United Kingdom	5.658	4.818	3.740	3.017

Source: World Bank (2015)

to numerous studies (Camioto, 2018), Russia has a very large potential for improving the energy efficiency of its economy. At present, the energy saving potential is estimated to be around 35–40% of the total current energy consumption in Russia, which is about 350-400 million tons of equivalent fuel (IFC and World Bank, 2014).

Following the importance of the topic under consideration, several studies have addressed energy efficiency issues of Russia's economy in general (Bashmakov, 2009; Malmendier, 2011; Strakhova and Lebedinsky, 2012; Orlov et al., 2013; Camioto et al., 2016; Kreydenko et al., 2018),) or its particular sectors (Overland, 2013; IFC and World Bank, 2014; Tyutikov et al., 2016; Lezier et al., 2017; Orlov, 2017). Some studies addressed the issue of reducing energy efficiency in Russia's industry (IEA, 2011; Bashmakov and Myshak, 2014; Guseva et al., 2016; Koroleva, 2016). Nevertheless, none of these papers comprehensively analyzed goals and priorities of energy efficiency policies in the industry sector, critically reviewed the methodology used by the Ministry of Energy of the Russian Federation (MERF) to evaluate energy efficiency performance in industry, or exclusively focused on drawbacks and limitations of such policies and methodological approaches in the industry sector of Russia, relying on the latest quantitative and qualitative data available.

This paper addresses the gap exiting in the literature and critically evaluates energy efficiency policies in the Russian industry sector, focusing on (a) ferrous metallurgy, (b) building materials production, (c) paper industry, and (d) fertilizer production. Power generation, refineries, and the distribution of electricity, gas, and water are excluded from the industry sector and, consequently, from our analysis (IEA, 2011). First of all, we carefully review the existing energy efficiency policies in Russia's industry since 2008. Second, on the basis of the data collect according to the methodology used by the Ministry of Energy of Russia to evaluate energy efficiency performance in the aforementioned industries, we review the existing state energy efficiency in the following dimensions: (a) Government management system, (b) technological regulation, (c) financial incentives and funding, (d) supporting mechanisms. Third, we critically discuss the results obtained, emphasizing overall directions of the energy efficiency policies and analyzing the the methodology used by the Ministry of Energy of Russia to evaluate energy efficiency performance in the industry sector. Lastly, we conclude with some final remarks.

The research presented in the paper is actually part of our series on energy efficiency of the Russian economy. The paper that critically analyzes Russia's energy efficiency policies in agriculture has been already published (Bogoviz et al., 2018). The research focusing on energy efficiency policies in Russia's (a) fuel and energy complex and (b) construction and housing, as well as (c) discussing the role of energy efficiency policies with respect to climate change is to be published in the upcoming year.

2. DATA AND METHODOLOGY

Since the goal of the paper is to critically review Russia's energy efficiency policies in the industry sector (namely, ferrous metallurgy, building materials production, paper industry, and fertilizer production), we build our research on the official documents being adopted on the federal level for the last 10 years (2008–18), aimed at increasing energy efficiency of the Russian economy in general and of the industry sector in particular. While reviewing Russia's energy efficiency policies in the industry sector, we explore the following aspects: (a) Overall goals and priorities set up by Russia's federal authorities, (b) a government management system existing to regulate the policies in place, (c) technological regulations existing in the industry sector, (d) financial incentives and funding available to the industry, and (d) supporting mechanisms existing to back up these policies.

We also review the methodological framework that has been used by the Ministry of Energy of Russia to evaluate energy efficiency performance in the industry sector. We collect data for the total of 14 different indicators (available in the Appendix) and carefully analyze them. All the data came from the Russian Federal State Statistics Service (RFSSS, 2018), which is also known as Rosstat.

Our analysis is focused on the main drawbacks existing in the current energy efficiency policies in the industry sector, including those limitations that the Ministry of Energy's methodology has. The next section provides all the data and presents our policy analysis. Then we proceed with our critical discussion and policy recommendations.

3. RESULTS

3.1. Russia's Energy Efficiency Policies in Industry

This section summarizes the key federal policies on energy efficiency in Russia's industry, starting with a general review and then going specifically into the policies exclusively addressing the industry sector. The methodological framework briefly outlined above is used to analyze the documents and policies being adopted and implemented by the federal Government of Russia. In particular, we overview such dimensions of energy efficiency policies in industry as (a) overall goals and priorities, (b) issues of government management, (c) technological regulation, (d) financial incentives and funding, and (d) supporting mechanisms.

3.1.1. Overall goals and priorities in Russia's energy efficiency policies in industry

Following the industrialized countries in their energy efficiency policies, the President of Russia, the Legislative Assembly, and the Government of Russia in the period of 2008–2010 issued and adopted a number of key documents on increasing energy efficiency in the country, setting up ambitious goals and planning an array of actions in many sectors of the economy. The president of Russia, in our opinion, established a general framework for stimulating further activities aimed at reducing energy intensity of Russia's GDP by no <40% of the 2007 level (OPLI, 2008).

The General Assembly of the Russian Federation adopted the Federal Law No 261 of November 23, 2009 with the purpose of achieving the goal set up by the President of Russia (OPLI, 2009). The Federal Law defined the concepts of "energy efficiency" and "energy saving," indicated the annual reduction of 3% in energy intensity of Russia's GDP, and created a legal framework for increasing Russia's energy efficiency. Finally, the Government of Russia adopted the State Program on Energy Saving and Improving Energy Efficiency for the period of 2020 in 2010 (Rossiyskaya, 2011; Government of the Russian Federation, 2010), which later, in 2014, was included as a subprogram into a larger State Program on Energy Efficiency and Energy Development (Government of the Russian Federation, 2014a).

The 2010 State Program is aimed at (a) creating an energy efficiency society in Russia, (b) reducing the energy intensity of Russia's GDP by 13.5%, which (together with other factors) would solve the problem of reducing the energy intensity of GDP by 40% by 2020, (c) ensuring annual primary energy savings of 100 million tons of equivalent fuel by 2016 and 195 million tons of equivalent fuel by 2020 (Government of the Russian Federation, 2010). Within the 2010 State Program, there was a subprogram focused solely on increasing energy efficiency and energy saving in industry. The subprogram's goals include (a) achieving an annual savings of primary energy of 34.33 million tons of equivalent fuel by the end of 2016 and 50.57 million tons of equivalent fuel by 2021. In the period of 2011–2015, the total primary energy should amount to 110.35 million tons conditional fuel, as well as 333.25 million tons of equivalent fuel should make savings for the entire duration of the program by the end of 2021 (Rossiyskaya, 2011).

According to the 2010 State Program, the main organizational measures to improve energy efficiency in the industry sector include: (a) Conducting voluntary and mandatory energy audits of industrial consumers; (b) training and professional development of managers and specialists in the field of energy conservation and energy efficiency; (c) developing and implementing an energy management system. According to the subprogramme, the main instrument of state support for the implementation of energy saving projects and increasing energy efficiency in energy-intensive industrial production is the provision of government guarantees of the Russian Federation on loans for further implementation of projects on energy conservation and energy efficiency, which are attracted by the organizations being elected in the manner established by the Government of the Russian Federation (Government of the Russian Federation, 2010; Rossiyskaya, 2011).

In turn, the larger 2014 State Program on Energy Efficiency and Energy Development sets the following goals: (a) Providing the country with reliable fuel and energy resources; (b) increasing energy efficiency of the use of energy and fuel resources; and (d) reducing the anthropogenic impact of the fuel and energy complex on the environment (Government of the Russian Federation, 2014a).

The 2014 State Program aims to achieve the following results: (a) Reducing the energy intensity of the GDP by 2020 through the implementation of activities within the Program by 9.41% compared to the level of 2007; (b) increasing the depth of crude oil processing to 85% by 2020; (c) stabilizing the annual oil and gas condensate production at 553 million tons in the period up to 2020; (d) bringing the volume of gas production to 687.8 billion cubic meters per year by 2020; (e) bringing the volume of coal mining to 425 million tons per year by 2020; (f) completing the regulatory and legal framework for the creation of a heat market model in 2015; (g) increasing the labor productivity in the fuel and energy complex by 1.3 times relative to the level of 2013 by 2018 (Government of the Russian Federation, 2014a).

Since the 2014 State Program includes the previous 2010 State Program as a subprogram, all priorities, goals, and objectives for the industry sector being adopted previously are still in place. The rest of the section reviews the main provisions of Russia's energy efficiency policies in industry according to our framework, focusing on (a) a government management system, (b) technological regulations, (c) financial incentives and funding, and (d) supporting mechanisms.

3.1.2. Government management system in the industry sector

An analysis of the 2010/2014 State Programs shows that there is no effective system for managing the policies aimed at increasing energy efficiency in the Russian industry. Probably, it is possible to single out only one control element that deserves attention with respect to our research objectives. The State Program on Industry Development and Enhancing Competitiveness (approved by the Decree of the Government of the Russian Federation, 2014) has an integrated specific indicator of the energy intensity of the ferrous metallurgy. More precisely, it is titled "energy intensity of manufacturing industries for the base year 2011" (Government of the Russian Federation, 2014b).

3.1.3. Technological regulation in industry

The Ministry of Industry and Trade of the Russian Federation (Minpromtorg) is the key governmental body dealing with issues of technological regulation in industry in Russia. In particular, it is possible to distinguish three main directions: (a) Creating directories of the best available technologies, (b) regulating the requirements for determining the energy efficiency class of goods in technical documentation, (c) monitoring the list of facilities and technologies that relate to facilities and technologies of high energy efficiency.

The Minpromtorg coordinates the development of directories of the best available technologies for the purposes of implementing environmental regulation and issuing integrated environmental permits. Requirements in the field of energy efficiency are included in the technical regulations, and also requirements for the energy efficiency of household appliances are updated. Within the framework of the National Standards Development Program, work is under way to develop a set of energy efficiency standards (Minpromtorg, n.d.).

The Minpromtorg is authorized to approve rules for (a) determining the classes of energy efficiency of goods; (b) including information on the energy efficiency class of the goods in the technical documentation attached to them; (d) collection of other information on the energy efficiency of goods, which is included in the technical documentation attached to the goods. However, it is worth mentioning that these regulatory acts were not updated in the period from 2012 to 2016 (Minpromtorg, n.d.).

In addition, the Minpromtorg is working to maintain the List of facilities and technologies that are relevant to the objects and technologies of high energy efficiency, which is approved by the Decree of the Government of the Russian Federation No. 600 of June 17, 2015 (Government of the Russian Federation, 2015). The work is also being done to update the requirements for internal and external coverage of budget sector organizations.

3.1.4. Financial incentives and funding

The Minpromtorg implemented car recycling programs aimed at both attracting private investment in the automotive industry and increasing the ecological classes of motor vehicles being operated in Russia. There are also some mechanisms in place to attract extra-budgetary investments in the modernization of key assets in air transport, but the efforts are insufficient (Niels, 2018).

Decree of the Government of the Russian Federation No 600 of June 17, 2015 approved a list of facilities and technologies that relate to objects and technologies of high energy efficiency. In accordance with this list, benefits are provided within the framework of tax legislation. Measures are being implemented to stimulate the introduction of the best available technologies in the construction materials industry (Government of the Russian Federation, 2015).

3.1.5. Supporting mechanisms for the industry sector

In order to popularize the introduction of "lean manufacturing" at the enterprises, the "lean manufacturing" standards were developed, and a voluntary certification system was created. At all enterprises controlled by the Minpromtorg, "lean manufacturing" practices are being introduced in a directive manner (Minpromtorg, 2017).

3.2. Monitoring Energy Efficiency Performance in Industry

To evaluate energy efficiency performance in industry, the Government of Russia uses a number of indicators and reviews the performance of the Ministry of Energy, the main government body responsible for increasing energy efficiency of the Russian economy, in a given year. Since there are many industries to be analyzed, the Government of Russia collects and reviews separate sets of indicators for (a) ferrous metallurgy, (b) building materials production, (c) paper industry, and (d) fertilizer production. We provide these indicators below for every industry being analyzed under energy efficiency policies of the Government of Russia.

3.2.1. Ferrous metallurgy

The following indicators are used by the Government of Russia to monitor the implementation of federal energy efficiency policies and evaluate energy efficiency performance in a given period of time: (a) Specific consumption of fuel and energy resources for the production of iron ore (including enrichment and production of concentrates), kg of conventional fuel/ton; (b) specific consumption of fuel and energy resources for the production of cast iron, tons of conventional fuel/ton; (c) specific consumption of fuel and energy resources for the production of steel pipes, kg of conventional fuel/ton. All the data collected on these indicators is available in Appendix, Table A1 and Graph A1 (RFSSS, 2018).

Specific consumption of fuel and energy resources for the production of commodity iron ore (including concentrates enrichment and production) in the Russian Federation tends to decrease for the period from 2012 to 2016. In particular, this indicator decreased by around 40%. Specific consumption of fuel and energy resources for the production of steel pipes for the period from 2012 to 2016 decreased as a whole, and the cumulative decline of the indicator was 14.7% for the indicated period. In 2015 and 2016 years, the growth of this indicator was observed to the level of the previous year.

More than that, we observe a stable decline of 3% per year in the Central Federal District. In our opinion, this may be due to the modernization of the facilities at the ore mining and processing enterprises that are part of the Metalloinvest Corporation (Metalloinvest, 2016). This indicator is the best in Russia, since this federal district has rich iron ore deposits of the Kursk magnetic anomaly.

In general, we can observe a steady decline in almost all indicators in the field of ferrous metallurgy in Russia. Most likely, the reasons for such a decline include a broad modernization of the industry, introduction of energy efficient technological solutions, and introduction of new production capacities with optimized energy costs (for example, steel rolling capacities).

Unfortunately, the data collected do not allow us to make any causal inferences that could explain how the ferrous metallurgy was affected by the energy efficiency policies in the industry sector, which were adopted and implemented by the Government of Russia and its agencies.

3.2.2. Building materials production

In order to analyze energy efficiency performance in the industry of building materials production, the Government of Russia relies on the following indicators: (a) Specific consumption of fuel and energy resources for the production of aluminous cement, slag cement, and similar hydraulic cements, kg. con. f./t.; (b) specific consumption of fuel and energy resources for the production of cement clinkers, t. con. f./t.; (c) specific consumption of fuel and energy resources for the production of wall blocks (small, made of cellular concrete), k. cond. f./t.; (d) specific consumption of fuel and energy resources for the production of large wall blocks (including blocks of cellar walls) made of concrete, t. cond. f./t. We present the collected data on these indicators in Table A2 (RFSSS, 2018).

The data show an increase in the specific consumption of fuel and energy resources by 48.9% on the production of aluminous cement, slag cement, and similar hydraulic cements. All other indicators show a steady decline in the level of energy costs, despite low values. In our opinion, high energy consumption in the production of building materials is associated with the historical features of the industry. The main production facilities for the production of building materials were put into operation in Russia in the period 1950–88.

It is noteworthy that there was practically no commissioning of new capacities during the period of 1991–2003, as the country suffered from a protracted economic crisis and did not need additional construction capacities. Because of the reduced demand for building materials, obsolete and physically worn out technological lines were taken out of service. Equipment that has been in operation now since the late 1980s needs modernization, because it has high material and energy consumption values. Unfortunately, current volumes of modernization of the construction industry in Russia are insufficient (Lvov and Obukhova, 2010; Alekseeva, 2014).

3.2.3. Pulp and paper industry

The total of five indicators are used by the Government of Russia to evaluate energy efficiency performance in the paper industry of the country. These indicators include the following: (a) Specific consumption of fuel and energy resources for the production of plywood, t. cond. f./m^3; (b) specific consumption of fuel and energy resources for the production of cellulose, t. cond. f./t.; (c) specific consumption of fuel and energy resources for paper production, t. cond. f/t.; (d) specific consumption of fuel and energy resources for the production of cardboard, t. cond. f./t. The data on these indicators were also collected by us from (RFSSS, 2018). Full information on the indicators is available in Table A3.

As the data show, specific consumption of fuel and energy resources for the production of pulp and paper products is steadily declining in all sub-sectors. For the period from 2012 to 2016, the decrease in the specific consumption of fuel and energy resources for the production of plywood was 12.6%, pulp production - 2.4%, paper production - 6.8%, cardboard - 15.2%.

Our analysis of the industry shows that the largest energy costs fall on the largest timber industry enterprises, which is due to the peculiarities of technological processes. There are certainly differences in data with respect to Russia's regions. In our opinion, four factors determine the existing differences in the indicators between the federal districts of Russia: (a) The level of technology used (equipment wear, the full use of raw materials, the regeneration of chemicals, etc.); (b) a different raw material base for the production of fibrous semi-finished products; (c) a range of products; (d) climatic conditions. For example, enterprises in the European part of Russia use gas, and enterprises in Siberia and the Far East mainly use fuel oil and coal, which can also explain differences in energy consumption between federal districts (Filimonova et al., 2014).

3.2.4. Fertilizer production

The Government of Russia relies on the three indicators in the evaluation of energy efficiency performance in the production of fertilizers, including: (a) Specific consumption of fuel and energy resources for the production of chemical or mineral potassium fertilizers (in terms of 100% potassium oxide), t. cond. f./t.; (b) specific consumption of fuel and energy resources for the production of chemical or mineral phosphate fertilizers (in terms of 100% phosphoric anhydride), t. cond. f./t.; (c) specific consumption of fuel and energy resources for the production of chemical or mineral nitrogen fertilizers (in terms of 100% nitrogen), t. cond. f./t. The data on the aforementioned indicators is available in Table A4 (RFSSS, 2018).

Specific consumption of fuel and energy resources for the production of phosphate fertilizers tends to decrease for the period from 2012 to 2016. The decrease in specific consumption was 32.9%. At the same time, the specific consumption of fuel and energy resources for the production of potash fertilizers is growing for the period from 2012 to 2016. The growth was 5.8%.

It is worth noting that the enterprises producing mineral fertilizers are the most energy-intensive ones in the production of chemical products. That is why, such enterprises should have energy saving and energy efficiency programs that include a set of organizational and technical measures, so that they can reduce energy, fuel, and water consumption.

4. DISCUSSION

Despite some noticeable success in adopting energy efficiency policies with a focus on industry by the Government of Russia, our analysis clearly shows that these policies are still too narrow and fragmented. In our perspective, the policies being adopted and implemented do not address the whole potential the Russian industry has with respect to increasing its energy efficiency.

First of all, it is necessary to provide an appropriate assessment of potential energy efficiency sources in industry. The state programs do not provide such an in-depth assessment. They focus on surface trends and indicators, without having a clear picture of the structure of energy consumption in industry. Formulating and developing the program was conducted without any prior comprehensive assessment of energy consumption and energy efficiency issues in the Russian industry (Niels, 2018). As a result, the policies being adopted are fragmented and not well coordinated.

Our review demonstrates that there is no effective mechanism of stimulating the introduction of best available technologies that would increase energy efficiency policies in industry. For instance, there is a list of energy-efficient technologies for the iron and steel industry in He and Wang (2017). If to compare this list with the best available technologies approved by Rosstandard (2017a), one could find that the Rosstandard's guide actually cover 36% of the list published in He and Wang (2017). The Ministry of Energy and Rosstandars focus primarily on the areas of oil, gas, oil refining, natural and associated gas, and coal production and enrichment (MERF, 2018), not actually fully covering ferrous metallurgy, paper industry, building materials production, and fertilizer production in its interbranch guide to energy efficiency (Rosstandard, 2017b). More than that, there is still no mechanisms in place that would effectively stimulate diffusion of such technologies in the Russian industry. The Ministry of Energy itself states that the process of introducing the best available technologies is to start in 2019, but no actual plan or any mechanism has not been yet issued. And it is worth mentioning that the Ministry of Energy has been working on the introduction of best available technologies since early 2015 (MERF, 2018).

Second, another important issue is how the Ministry of Energy evaluates energy efficiency performance in industry. In our perspective, it relies on weak indicators that tell almost nothing about actual developments in industry with respect to energy efficiency. Our review of the data being collected and analyzed according to the methodology applied by the Ministry of Energy demonstrates how hard it is to make any solid observations on energy efficiency performance in industry.

In our perspective, there are also no clear casual mechanisms between the policies being adopted and the actual energy efficiency trends; therefore, the data and methodology that the Ministry of Energy relies on is so weak and, honestly, almost useless for conducting a reliable analysis. In other words, the methodology is not sensitive to actual energy efficiency trends in the industries under analysis. On the one hand, the use of indicators that focus solely on energy consumption by industry sector and by energy source (which the Ministry of Energy fully relies on) allows to explain the role a particular energy source played on the trends in energy consumption. On the other hand, such indicators are very weak in analyzing the impact of energy efficiency policies.

We also think that the Ministry of Energy and analytical subdivisions of the Government of Russia should employ prospective methodological approaches to study the actual energy efficiency performance, such as a total-factor and non-parametric data envelopment analysis framework (Charnes et al., 1978; Zhou et al., 2008, Ramanathan, 2005; Zhou and Ang, 2008) in order to capture both radial and non-radial measures of efficiency. Also, they could take advantage of the energy efficiency accounting system developed by (Bashmakov and Myshak, 2014).

Third, many limitations of energy efficiency policies in the industry sector are connected to the drawbacks existing within the general energy efficiency policies of Russia. Additional efforts are to be taken in order not only to implement the already adopted policies, but also to improve them (IEA, 2014). It applies to (a) revising energy efficiency legislature with the purpose of closing loopholes and improving the regulatory framework, (b) effectively regulating energy prices in all sectors of the national economy, (c) improving data collection and analysis, (d) unleashing the hidden energy efficiency potential, especially in the residential, public service, manufacturing industry, and the power and heat sectors, etc.

In sum, in order to achieve effective implementation of the existing energy efficiency policies and significantly improve them, the Government of Russia should (a) provide an appropriate assessment of energy efficiency potential in the industry sector, (b) significantly improve data collection and analysis in industry, (c) focus on the regulatory framework and implementation mechanisms of the energy efficiency policies in the industry sector.

5. CONSLUSION

With the aim of unleashing the high potential of increasing energy efficiency of the Russian economy, the Government of Russia has adopted a number of key policy measures since 2018, with some of them being devoted solely to the industry sector. The analysis conducted in this paper clearly shows that these policies cannot be considered comprehensive and effective for a number of reasons. First of all, there has been no appropriate assessment of the potential the industry sector has with respect to increasing energy efficiency. Second, there is a lack of the implementation of the existing policies, which the process of introducing best available technologies in industry clearly demonstrates. Third, the Ministry of Energy is not capable of effectively collecting and analyzing data on energy efficiency in the industry sector because of the very weak analytical framework and methodology being developed and used in recent years. Given the largest potential Russia has in increasing energy efficiency in all five most energy intensive industrial sectors, the development of detailed and industry-specific indicators that would capture the development trends and the impact of energy efficiency measures is of high demand. Such indicators should be able to explain the changes in energy consumption over a period of time, give relevant insights about the impact of energy efficiency policies on the industry sector in general and on a specific industry. It is very important because energy consumption and influence of energy efficiency policies differ from industry to industry.

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APPENDIX

Table A1: Specific energy consumption indicators in the ferrous metallurgy (iron ore, steel pipes)

Region	Year	Specific consumption of fuel and energy resources	
		Iron ore (including enrichment and production of concentrates), kg of equivalent fuel/ton	Steel pipes, kg of conventional fuel/ton
Russian Federation	2012	12.45	116.8
	2013	12.65	106.1
	2014	12.22	80.2
	2015	12.15	88.0
	2016	7.8	99.6
Central Federal District	2012	9.97	31.3
	2013	10.17	28.7
	2014	9.91	39.3
	2015	9.71	25.5
	2016	10.0	35.5
Northwestern Federal District	2012	13.05	12.7
	2013	13.17	13.1
	2014	12.98	11.6
	2015	13.48	11.5
	2016	12.96	14.8
Southern Federal District	2012	-	171.9
	2013	-	160.6
	2014	-	-
	2015	-	138.1
	2016	-	143.9
North Caucasian	2012	-	-
	2013	-	-
	2014	-	-
	2015	-	-
	2016	-	-
Volga Federal District	2012	-	24.5
	2013	-	35.5
	2014	-	64.2
	2015	-	23.6
	2016	-	25.2
Ural Federal District	2012	15.74	171.2
	2013	16.182	160.6
	2014	15.50	122.4
	2015	16.16	142.6
	2016	3.6	165.6
Siberian federal district	2012	18.23	14.3
	2013	18.01	-
	2014	17.09	10.2
	2015	18.41	7.8
	2016	18.65	8.2
Far eastern federal district	2012	16.22	-
	2013	-	-
	2014	-	-
	2015	10.82	-
	2016	-	-

Table A2: Specific energy consumption indicators in building materials production

Region	Year	Specific consumption of fuel and energy resources			
		Aluminous cement, slag cement, and similar hydraulic cements, kg. con. f./t.	Cement clinkers, t. con. f./t.	Wall blocks (small, made of cellular concrete), k. cond. f./t.	Large wall blocks (including blocks of cellar walls) made of concrete, t. cond. f./t.
Russian federation	2012	28.0	0.19	-	-
	2013	29.7	0.19	-	-
	2014	32.9	0.17	32.5	0.118

(Contd...)

Table A2: (Continued)

	2015	36.8	0.17	25.1	0.129
	2016	41.7	0.16	25.4	0.117
Central federal district	2012	27.9	0.22	-	-
	2013	28.6	0.21	-	-
	2014	27.6	0.19	30.0	0.072
	2015	41.3	0.19	23.6	0.071
	2016	58.3	0.18	23.7	0.089
Northwestern federal district	2012	33.0	0.15	-	-
	2013	30.8	0.16	-	-
	2014	39.6	0.14	134.6	0.358
	2015	41.6	0.12	127.0	0.310
	2016	43.5	0.11	-	0.123
Southern federal district	2012	12.9	0.19	-	-
	2013	12.0	0.18	-	-
	2014	12.0	0.16	44.1	0.239
	2015	10.8	0.15	28.2	0.200
	2016	10.8	0.15	23.9	0.096
North Caucasian	2012	9.9	0.21	-	-
	2013	-	-	-	-
	2014	-	-	-	0.040
	2015	-	-	-	0.078
	2016	-	-	-	0.117
Volga federal district	2012	37.6	0.20	-	-
	2013	39.5	0.19	-	-
	2014	41.2	0.18	30.4	0.097
	2015	37.1	0.17	23.7	0.113
	2016	42.2	0.15	24.7	0.114
Ural federal district	2012	18.1	0.17	-	-
	2013	23.9	0.17	-	-
	2014	25.8	0.17	19.2	0.053
	2015	28.8	0.16	17.0	-
	2016	29.7	0.16	18.2	717.1
Siberian federal district	2012	27.1	0.19	-	-
	2013	26.4	0.18	-	-
	2014	25.6	0.18	19.9	0.138
	2015	27.3	0.18	18.4	0.256
	2016	30.7	0.18	37.2	0.214
Far eastern federal district	2012	16.2	0.21	-	-
	2013	-	0.22	-	-
	2014	-	0.09	-	0.166
	2015	10.8	0.08	-	0.104
	2016	7.8	0.07	44.2	0.107

Table A3: Specific energy consumption indicators in paper industry

Region	Year	Specific consumption of fuel and energy resources			
		Plywood, t. cond. f./m^3	Cellulose, t. cond. f./t.	Paper, t. cond. f./t.	Cardboard, t. cond. f./t.
Russian federation	2012	0.137	0.543	0.335	0.332
	2013	0.182	0.539	0.347	0.316
	2014	0.173	0.518	0.342	0.313
	2015	0.169	0.510	0.336	0.308
	2016	0.153	0.531	0.331	0.281
Central federal district	2012	0.180	-	0.334	0.331
	2013	0.150	-	0.295	0.197
	2014	0.131	-	0.264	0.194
	2015	0.130	-	0.266	0.174
	2016	0.113	-	0.224	0.135
Northwestern federal district	2012	0.156	0.475	0.335	0.315
	2013	0.171	0.465	0.325	0.310
	2014	0.171	0.468	0.328	0.313

(Contd...)

Table A3: (Continued)

	2015	0.168	0.430	0.327	0.322
	2016	0.178	0.432	0.329	0.294
Southern federal district	2012	-	0.171	0.364	0.264
	2013	-	-	-	0.232
	2014	-	-	0.307	-
	2015	-	-	0.342	0.256
	2016	-	0.158	0.312	0.250
North Caucasian	2012	-	-	-	-
	2013	-	-	-	-
	2014	-	-	-	-
	2015	-	-	-	-
	2016	-	-	-	-
Volga federal district	2012	0.212	0.146	0.331	0.353
	2013	0.208	0.162	0.387	0.330
	2014	0.200	0.133	0.381	0.303
	2015	0.199	0.130	0.366	0.265
	2016	0.184	0.125	0.361	0.256
Ural federal district	2012	0.202	0.438	0.526	0.173
	2013	0.206	-	0.497	-
	2014	0.192	-	0.504	-
	2015	0.189	-	0.452	-
	2016	0.180	0.689	0.528	0.757
Siberian federal district	2012	0.225	0.775	0.489	0.578
	2013	0.200	0.791	0.372	0.585
	2014	0.188	0.694	0.548	0.582
	2015	0.166	0.727	0.551	0.583
	2016	0.162	0.825	0.584	0.515
Far eastern federal district	2012	-	-	-	0.313
	2013	-	-	-	-
	2014	-	-	-	-
	2015	-	-	-	-
	2016	-	-	-	-

Table A4: Specific energy consumption indicators in paper industry, t. cond. f/t

Region	Year	Specific consumption of fuel and energy resources		
		Chemical or mineral potassium fertilizers (in terms of 100% potassium oxide)	Chemical or mineral phosphate fertilizers (in terms of 100% phosphoric anhydride)	Chemical or mineral nitrogen fertilizers (in terms of 100% nitrogen)
Russian federation	2012	0.127	0.462	-
	2013	0.136	0.415	-
	2014	0.116	0.318	0.139
	2015	0.125	0.279	0.102
	2016	0.134	0.310	0.178
Central federal district	2012	0.577	0.690	-
	2013	0.567	0.694	-
	2014	0.371	0.935	-
	2015	0.353	0.465	-
	2016	0.383	0.449	0.123
Northwestern federal district	2012	0.068	0.523	-
	2013	0.303	0.438	-
	2014	0.209	0.432	0.195
	2015	0.187	0.393	0.225
	2016	0.184	0.370	0.277
Southern federal district	2012	-	-	-
	2013	-	-	-
	2014	-	-	-
	2015	-	-	-
	2016	-	0.206	0.206
North Caucasian	2012	0.202	0.478	-
	2013	-	-	-

(Contd...)

Table A4: (Continued)

	2014	-	-	-
	2015	-	-	-
	2016	-	0.388	-
Volga federal district	2012	0.114	0.267	-
	2013	0.113	0.230	-
	2014	0104	0.111	0.054
	2015	-	-	0.069
	2016	0.117	0.156	0.191
Ural federal district	2012	-	-	-
	2013	-	-	-
	2014	-	-	-
	2015	-	-	-
	2016	-	-	-
Siberian federal district	2012	0.518	-	-
	2013	-	-	-
	2014	-	-	0.300
	2015	-	-	0.314
	2016	-	-	0.313
Far eastern federal district	2012	-	-	-
	2013	-	-	-
	2014	-	-	-
	2015	-	-	-
	2016	-	-	-

Graph A1: Specific energy consumption indicators in the production of cast iron, t. cond. f./t