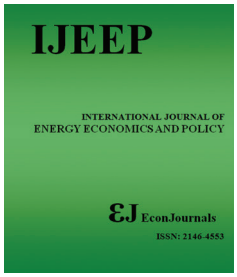

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A Critical Review of Russia's Energy Efficiency Policies in Agriculture

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ABSTRACT

The article presents a critical review of Russia's energy efficiency policies in agriculture since 2008 till 2016. First, we focus on the general background of energy efficiency policies in Russia, clearly indicating the place of agriculture in such policies. Second, the article reviews all the documents adopted on the federal level in Russia with respect to energy efficiency in agriculture. Third, the indicators used by the Ministry of Energy of the Russian Federation to evaluate energy efficiency performance in agriculture are analyzed. Finally, we critically review the existing energy efficiency policies in agriculture on the basis of the following criteria: (a) Overall goals and priorities, (b) a government management system, (c) a technological regulation in agriculture, and (d) financial incentives and funding. The review clearly shows that Russia has weak energy efficiency policies in agriculture and does not employ its full potential.

Keywords: Energy Efficiency, Agriculture, Russia
JEL Classifications: Q16, Q18, Q38, Q48.

1. INTRODUCTION

Russia's energy efficiency policies started in 2008, when Dmitry Medvedev, President of Russia, signed the Executive Order No 889, setting up an ambitious goal of reducing energy intensity of Russia's gross domestic product (GDP) by 2020 by no <40% of the 2007 level. In 2009, the Federal Law on Energy Saving and Energy Efficiency was passed, and the State Program on Energy Saving and Energy Efficiency Improvement for the Period till 2020 was adopted in 2010, which become part of the State Program on Energy Efficiency and Energy Sector Development in 2014. As a result, Russia's energy efficiency policies are comprehensive enough, relying on numerous legislative acts and state subprograms, which all together cover almost every sector of the Russian economy.

At the same time, Russia's energy efficiency policies primarily focus on the most energy intensive sectors, such as electricity, construction housing and communal services, manufacturing, and transport (UNDP Russia, 2013), not paying much attention to country's agriculture. However, current research (Rau et al., 2013; Woods et al., 2010; Pelletier, 2011; Schneider and Smith, 2009) clearly shows that agriculture and food systems have a high energy efficiency potential.

This paper critically reviews the existing energy efficiency policies in agriculture in Russia on the federal level. We argue that these policies are weak and do not employ a full potential Russia's agriculture has in terms of increasing energy efficiency. First of all, we explore the key features of Russia's energy efficiency policies in agriculture by creating a list of all federal legislation devoted to energy efficiency in agriculture and then carefully review all their provisions. Second, we analyze the methodology used by the Russian Ministry of Energy to evaluate energy efficiency performance in agriculture. In particular, we collect data on all four indicators used by the Ministry of Energy and analyze how

well these indicators capture energy efficiency performance in agriculture. Third, we discuss limitations that exist within the current energy efficiency policies in agriculture and provide a number of recommendations that could bring substantial improvements.

To the best of our knowledge, our research is the first one that critically and comprehensively investigates energy efficiency policies in Russia's agriculture on the federal level. One group of scholars (Martinot, 1998; Bashmakov, 2009; Ushakov, 2009; Letyagina and Salmin, 2012; Kobets, 2012; Makeykina and Leshin, 2013; Tatuev and Kerefov, 2014; Skrylnikova et al., 2014; Ishmametov and Menyalov, 2017; Pakhomova et al., 2017) focuses on overall trends and challenges in the field of Russia's energy intensity and energy efficiency almost without addressing the issue of improving energy efficiency in agriculture or giving the most general characteristics of the energy efficiency policies pursued in agriculture. Another group of scholars devote their attention to (a) energy efficiency and energy saving technologies in agriculture (Parkhomenko and Shukina, n.d.; Alekseev et al., 2015; Eloeva and Esenov, 2015; Kondratyeva, 2016), (b) energy consumption in agriculture (Vodyannikov, 2012; Tikhomirov, 2016), and (c) case studies on energy efficiency policies and energy saving technologies in agriculture in individual regions of Russia or at local enterprises (Zavodchikov and Voronkova, 2010; Erk and Sudachenko, 2015; Erk et al., 2016a; Erk et al., 2016b; Sudachenko et al., 2017; Fiklistova et al., 2017). Thus, our research significantly contributes to the body of scholarly literature and fills the existing gap by critically reviewing Russia's energy efficiency policies in agriculture.

The paper is structured as follows. In the next part, we describe the data and methodology used in our research. Then, we review the existing energy efficiency policies in agriculture and apply the methodology used by the Ministry of Energy of the Russian Federation to monitor the energy efficiency performance in agriculture. After that, we identify drawbacks in both Russia's energy efficiency policies in agriculture and the methodology used by the Ministry of Energy, as well as provide policy recommendations. Lastly, we conclude with final remarks.

2. DATA AND METHODOLOGY

In order to review current energy efficiency policies in agriculture, we collect all relevant federal legislation and government programs from open sources. The data comes from official websites and electronic databases of the Government of Russia and the Federal Assembly of Russia for the period of 2008-2017. We focus on the federal legislation and programs instead of the regional ones because the former affects all regions of the country by creating a general framework that should be followed in all regions of Russia and providing funding for further implementation. In particular, we focus on the following aspects while reviewing Russia's energy efficiency policies in agriculture: (a) Overall goals and priorities outlined; (b) a management system provided in order to implement certain policies; (c) a technological regulation in agriculture for increasing energy efficiency; and, finally, (d) financial incentives and funding.

To review the methodology used by the Ministry of Energy for evaluating energy efficiency performance in agriculture, we use the indicators obtained from the Russian Federal State Statistics Service (RFSSS, 2016). In particular, we use the indicators the Ministry of Energy relies on (MERF, 2016): (a) Energy consumption for greenhouse heating (kg of conditional fuel/cbm); (b) energy consumption by agricultural tractors and combines (kg of conditional fuel/ha.); (c) energy consumption for producing cattle for slaughter (in live weight, kg of conditional fuel/cwt); (d) energy consumption for producing poultry for slaughter (in live weight, kg of conditional fuel/cwt). The analysis is focused on the period of 2012-2016 because of the availability of data. We apply the methodological framework used by the Ministry of Energy to monitor energy efficiency in agriculture, point out its limitations, and then we discuss how energy efficiency policies in agriculture might be further developed.

3. RESULTS

3.1. Russia's Energy Efficiency Policies in Agriculture

The key documents on energy efficiency policies in agriculture are presented in Table 1. First, we review the two key documents adopted by the President of Russia in 2008, 2009 and by the Government of Russia in 2010. These documents are strategic and comprehensive, because they set the key goals in energy efficiency for all sectors of Russia's economy, including in agriculture. Then we review all other documents that are focused solely on energy efficiency in agriculture. By applying the analytical framework outlined above, we are able to comprehensively evaluate various dimensions of Russia's energy efficiency policies in agriculture, including the overall goals, management, technological regulation, and financial incentives and funding.

3.1.1. Overall goals of Russia's energy efficiency policies in agriculture

In 2008, the President of Russia issued the Executive Order No 889 and set a strategic goal to reduce energy intensity of Russia's GDP by 2020 by no <40% from the 2007 level (OPLI, 2008). In order to achieve the goal, the executive order outlined the following steps: (i) To take measures on technical regulation of the economic sectors aimed at increasing energy and environmental efficiency; (ii) to build a regulatory framework within the federal law that would establish certain economic mechanisms to encourage the use of energy-saving technologies and to require accountability for non-compliance with such regulations; and (iii) to provide budgetary allocations for the implementation of energy-saving projects (OPLI, 2008).

In order to implement the president's executive order, the Federal Law No 261 was adopted on November 23, 2009 (OPLI, 2009). Its purpose was to create legal, economic, and organizational bases for stimulating energy conservation and improving energy efficiency in Russia. For the first time, the Federal Law defined the timeframe for the mandatory installation of metering devices, commissioning them, and switching to paying for energy resources according to actual consumption. A separate task was set for the budgetary institutions, which should ensure a reduction in the amount of energy consumed within five years by no <15% of

Table 1: Energy efficiency policies in agriculture in Russia

Type	Document	Energy efficiency policies in agriculture
2008	Executive Order No 889 of July 4, 2008 On Some Measures to Increase the Energy and Environmental Efficiency of Russia's Economy. (OPLI, 2008)	The first official document on energy efficiency that sets a goal to reduce energy intensity of Russia's GDP by 2020 by no<40% from 2007 level
2009	The Federal Law No 261 of November 23, 2009 On Energy Saving and On Improving Energy Efficiency and on Amending Certain Legislative Acts of the Russian Federation. (OPLI, 2009)	Creates legal, economic, and organizational bases for stimulating energy conservation and improving energy efficiency in Russia's economy
2012	The State Program for the Development of Agriculture and Regulation of the Markets of Agricultural Products, Raw Products, and Food for 2013-2020. (GRF, 2012a). Approved by the Government Resolution No 717 of July 14, 2012	Improvement of rural infrastructure (especially energy-saving and resource-saving housing and public infrastructure). Rational placement and specialization of agricultural production and food industry in the regions of the country, taking into account climatic conditions and logistics costs. Introduces an indicator "The share of costs for purchasing energy resources in the structure of costs for the basic production of agricultural products."
2012	Government Resolution No 1432 of December 27, 2012 On Approving Regulations for the Allocation of Subsidies to Farming Equipment Manufacturers (GRF, 2012b)	Technological modernization of agriculture, renewal of machinery
2014	The State Program on Energy Efficiency and Energy Development (MERF, 2014). Approved by the Government Resolution No 321 of April 15, 2014	General data on energy-saving potential in economic sectors, including agriculture. Gasification and use of peat are mentioned
2016	Government Resolution No 759 of August 9, 2016 On specifying the Procedure for the Implementation of Technological Connection to the Electric Grid Facilities Owned by an Organization for Managing the Unified National (All-Russian) Electric Grid (GRF, 2016)	Optimization of costs for electricity supply to greenhouse enterprises
2017	Order of the Ministry of Agriculture of the Russian Federation No 24 of January 24, 2017 On Approving the Lists of Directions for the Targeted Use of Preferential Short-term Loans and Preferential Investment Loans (MARF, 2017)	Transfer of trucks, tractors and agricultural machinery to gas motor fuel. Those machines that use natural gas as fuel are subjects to concessional lending

GDP: Gross domestic product

the volume actually consumed in 2009. In addition, the annual reduction of this volume, according to the Federal Law, should be no <3% (OPLI, 2009).

To achieve these goals, the "State Program on Energy Saving and Improving Energy Efficiency for the Period until 2020" was adopted by the Government of Russia in December 2010. At present, this is a subprogram titled "Energy Saving and Energy Efficiency Improvement" and is part of the larger "State Program Energy Efficiency and Energy Development," which was approved by the Government of Russia in 2014. The key objective of the 2014 state program was to reduce the energy intensity of Russia's GDP by 13.5% through the implementation of program activities, which should ensure the achievement of the goal set by the Presidential Executive Order No 889, with the factor of structural shift (MERF, 2014). In addition to the main goal of reducing the energy intensity of GDP, a number of indicators and target values by sector were also introduced, such as the depth of oil refining, losses of electric power in electric grids from the total volume of electricity supply, and the consumption of fuel and energy resources in the production of oil, coal, and gas (MERF, 2014).

With respect to agriculture, a strategic goal was outlined in the 2010 "State Program on Energy Saving and Improving Energy Efficiency for the Period until 2020." The document clearly states that the Russian agriculture should accelerate to the use of new high-performance and resource-saving technologies. At the same time, technical and technological modernization should be carried out on the basis of the agricultural machinery renewal. In addition, the main organizational action to improve energy efficiency in agriculture is to conduct voluntary and mandatory energy audits of agricultural consumers of energy resources. As expected, the implementation of such policies in agriculture should lead to annual savings of primary energy in the amount of 9.94 million tons of equivalent fuel for the period 2011-2020 (MERF, 2014).

In particular, the program focuses on the implementation of two projects in the field of energy efficiency in agriculture. The first project is titled "Improving Tractors' Fuel Efficiency" and includes the following: (a) Establishing an average fuel standard for new agricultural diesel-fueled tractors, 229.5 g/kWh in 2020; (b) increasing the coefficient of agricultural tractors renewal up to 10.3% in 2012 and its maintenance at this level until 2020 (MERF, 2014).

Thus, the fist project focuses on technical re-equipment of agriculture that would lead to more efficient use of energy resources. The use of energy-saturated, high-performance machinery and introduction of resource-saving technologies allows to reduce specific costs of material and energy resources

and to reduce losses of agricultural products during its processing. The Government of the Russian Federation provides subsidies to producers of agricultural machinery, who then sell it to agricultural producers at a discount. The Government Resolution No 1432 of December 27, 2012 was adopted with the aim of providing state support for agriculture and renovating the machinery within the framework of the state program for the development of agriculture (GRF, 2012b).

The second project, "Improving Energy Efficiency of Greenhouse Facilities," focuses on greenhouse production, one of the most intensive industries in agriculture (MERF, 2014), and sets the following tasks: (a) Improving the insulation of greenhouses and introducing automatic control systems for heat and microclimate; (b) introducing effective water heating systems for irrigation; (c) recycling the heat from end gases, using variable frequency drive; and (d) introducing new technologies.

Effective operation of greenhouse complexes is impossible without the use of modern energy-saving technologies. At present, the construction of new greenhouse complexes, including ones supported by the "State Program of Support for Agriculture and Regulation of Markets for Agricultural Products, Raw Materials, and Food for 2013-2020" (GRF, 2012a), uses technologies that reduce the specific energy consumption: Automation of microclimate control systems; multi-circuit heating system; waste heat recovery; energy saving lighting; and improved insulation of greenhouses, etc. In order to optimize the cost of electricity supply to greenhouse enterprises, the Government of the Russian Federation adopted Resolution No 759 of August 9, 2016 entitled "On Specifying the Procedure for the Implementation of Technological Connection to the Electric Grid Facilities Owned by an Organization for Managing the Unified National (All-Russian) Electric Grid" (GRF, 2016).

3.1.2. Government management system

The presence of a government management system to improve energy efficiency includes the formation of a multi-level structure of public administration with zones of responsibility in each sector of the economy and the presence of coordinating bodies. Unfortunately, there is no unified system of government management of energy efficiency policies in agriculture. The Ministry of Energy of the Russian Federation is the single coordinating body of a large program to improve energy efficiency (and is responsible for general indicators), but the Ministry of Agriculture of the Russian Federation does not have a separate program and indicators for improving energy efficiency in agriculture in particular.

3.1.3. Technological regulation

Technological regulation is a very important part of successful policies aimed at improving energy efficiency in agriculture. In our perspective, the government should regulate and stimulate the implementation of (a) energy-efficient standards for the construction of agricultural infrastructure facilities and equipment requirements, (b) the best available technologies, and (c) implementation of energy accounting systems. Unfortunately, there is no technological regulation in agriculture with the aim of increasing energy efficiency in Russia.

3.1.4. Financial incentives and finding

There are only two branch institutions, the "Russian Agricultural Bank" (RAB) and "Rosagrolizing," that are responsible to attract extra-budgetary funding to modernize agriculture. The order of the Ministry of Agriculture of Russia No 24 of January 24, 2017 approves the areas of targeted short-term loans and off-exchange investment loans, including investments aimed at transferring agricultural machinery to gas engine fuel (MARF, 2017). However, energy efficiency requirements are not applied when making decisions on providing such loans.

3.2. Monitoring Energy Efficiency Performance in Agriculture

In order to conduct a general analysis of improving energy efficiency in agriculture, the Ministry of Energy of the Russian Federation recommends to use the following indicators (MERF, 2016): (a) Energy consumption for greenhouse heating (kg of conditional fuel/cbm); (b) energy consumption by agricultural tractors and combines (kg of conditional fuel/ha.); (c) energy consumption for producing cattle for slaughter (in live weight, kg of conditional fuel/cwt); (d) energy consumption for producing poultry for slaughter (in live weight, kg of conditional fuel/cwt). We collect all the data from the Russian Federal State Statistics Service (RFSSS, 2016) and present these data in Appendix (Table A1 and Figures A1-A4). We analyze how well the indicators used by the Ministry of Energy capture energy efficiency performance in agriculture, because the policy-makers evaluate the energy efficiency programs in agriculture on the basis of these indicators.

The first indicator is the level of energy consumption for greenhouse heating. According to Figure A1, energy consumption for greenhouse heating has been systematically reduced by 50% over the period of 2012-2016. However, this is unclear what factors cause such dynamics. For instance, this can be caused by high rates of the new greenhouses being built, which are more energy efficient. The second indicator is the level of energy consumption by agricultural tractors and combines. This indicator, as shown in Figure A2, fell in 2016 by 8% and amounted to 16.4 kg of conditional fuel/ha. In our perspective, this is really hard to explain why the indicator lost 8%. The same applies to other two indicators, energy consumption for producing (a) cattle for slaughter and (b) poultry for slaughter. For example, the consumption of energy for the production of poultry for slaughter fell by 15% in 2016 and amounted to 23.7 kg of conditional fuel/cwt. The decrease of this indicator was observed in all Federal Districts of, with the exception of the Far Eastern Federal District. And once again, there is no possibility to provide any valid explanation for the changes observed in this indicator. In our opinion, this may be largely due to the natural and climatic conditions of the aforementioned federal district, as well as a relatively small amount of production in livestock.

We discuss the indicators used by the Ministry of Energy and the overall limitations of Russia's energy efficiency policies in agriculture in the next section.

4. DISCUSSION

On the basis of the review conducted, we conclude that Russia's energy efficiency policies in agriculture are too limited, do not address the energy related issues existing in agriculture, as well as do not cover the whole potential of energy efficiency in this sector of the economy. The current policies do not address such important areas as renewable energy sources in agriculture and the development of organic agriculture. With regard to the indicators used by the Ministry of Energy to evaluate energy efficiency performance, we believe that since the overall policies are weak and fragmented, we have the indicators that actually do not make any sense, because they capture energy consumption in only a few areas of agriculture and do not focus on many direct and indirect aspects of energy consumption. In other words, there is no effective mechanism of increasing energy efficiency in Russia in the field of agriculture and no effective evaluation mechanism in place. The current measures are very fragmented, and the indicators are not suitable for measuring real progress in energy efficiency performance in agriculture. However, the use of proper indicators is crucial for any comprehensive analysis since they serve as a basis for decision-making process. As a result, the full potential of increasing energy efficiency in agriculture is not addressed by the Russian policy-makers.

With regard to the government management system, we can argue, due to the review conducted, that there is very little coordination of the policies in the field of increasing energy efficiency of the Russian agro-industrial complex. For example, the Ministry of Agriculture does not analyze and plan the energy efficiency of agriculture and, as a result, does not set the corresponding objectives for its activities. In our opinion, this is necessary, first of all, to consolidate the powers for the implementation of energy efficiency policies in the field in agriculture in the jurisdiction of government bodies at different levels, including federal, regional, and municipal. Second, the Government of the Russian Federation should create and implement systems of objective key indicators of energy efficiency in agricultural development plans and implement management incentives to improve energy efficiency. In our view, the Ministry of Agriculture, as a profile ministry, should have a direct responsibility for improving energy efficiency in agriculture.

Another important aspect of successful policies is the technological regulation of agriculture aimed at increasing its energy efficiency. The Government of Russia, in our perspective, pays too little attention to this aspect of energy efficiency policy. One of the main directions to develop technical and technological regulation in foreign countries is the introduction of the principle of the best available technologies. For example, with a view to implementing and harmonizing policies on best available technologies and techniques, the European Union has developed reference books that contain their detailed description for various industries, including agriculture (European Commission, 2009).

In addition, technological regulation can be manifested in the implementation of construction standards and requirements for equipment. For example, documents on the energy characteristics of agricultural infrastructure facilities can be adopted. The main goal is to improve the energy efficiency of buildings, ensure long-term safety in relation to energy supplies, and improve the microclimate of the premises. In addition, plans to reduce energy consumption of agricultural infrastructure facilities can also be adopted, and the energy performance of new buildings should correspond to the values of nearly-zero energy.

With regard to financial incentives and funding, there are too few profile financial institutions, working for such purposes in agriculture. At the same time, the formation of financial incentives and the provision of financing implies the introduction of incentive pricing and taxation of energy resources, stimulation of investments in energy efficiency of agriculture. The Government of the Russian Federation, in our perspective, should much more actively participate in the development of investment schemes to finance energy efficiency in agriculture. As a rule, tax support is one of the most common forms of stimulating energy efficiency (Tanaka, 2011; Zhou et al., 2010). Such forms may imply the establishment of taxes on the consumption of energy resources or can be expressed in various tax incentives and other indulgences related to the implementation of measures for energy conservation and energy efficiency, including in agriculture.

5. CONCLUSION

Russia's energy efficiency policies in agriculture can be considered as part of the overall energy saving and energy efficiency policies, conducted by the Government of Russia on the federal level. However, this critical review clearly shows that there are actually no comprehensive energy efficiency policies in agriculture, and the potential of increasing energy efficiency in agriculture is simply neglected. The policies are too narrow, because they capture only some parts of Russia's agriculture, such as energy consumption by greenhouses, agricultural machinery, and producing poultry/cattle for slaughter, leaving behind all other issues that account for direct and indirect energy consumption in agriculture. The existing legislation should be substantially improved in order to address (a) drawbacks in government management system, (b) lack of technological regulation, and (c) limitations of financial incentives and funding in current Russia's energy efficiency policies in agriculture.

REFERENCES

Alekseev, V.A., Artemev, V.S., Vasilyev, A.A. (2015), Problems of introducing energy-saving technologies in the agro-industrial complex. Strategy of Sustainable Development of Russian Regions, 28, 7-12.

Bashmakov, I. (2009), Resource of energy efficiency in Russia: Scale, costs, and benefits. Energy Efficiency, 2, 369-386.

Eloeva, R.K., Esenov, I.K. (2014), Prospects for the use of alternative energy sources in agriculture. Proceedings of Gorsky State Agrarian University, 51(3), 193-196.

Erk, A.F., Sudachenko, V.N. (2015), Methods of energy conservation and power efficiency improvement in agricultural production. Technologies and Technical Means of Mechanized Production of Crop and Livestock Products, 87, 233-239.

Erk, A.F., Sudachenko, V.N., Butrimova, E.I. (2016b), Creation of demonstration zones of high energy performance of agricultural

enterprises in Leningrad region. Technologies and Technical Means of Mechanized Production of Crop and Livestock Products, 88, 46-53.
Erk, A.F., Sudachenko, V.N., Butrimova, E.I. (2016a), Efficiency of energy use in dairy cattle Husbandary. Technologies and Technical Means of Mechanized Production of Crop and Livestock Products, 89, 12-18.
European Commission. (2009), Reference document on best available techniques for energy efficiency. Available from: http://www.eippcb.jrc.ec.europa.eu/reference/BREF/ENE_Adopted_02-2009.pdf.
Fiklistova, L.I., Lisakonova, N.V., Barykina, E.N., Yudaev, I.V. (2017), Energy saving technologies in agriculture and their implementation on the example of poultry farm. Innovations in Agriculture, 2(23), 116-122.
GRF. (2016), Government Resolution No 759 of December 9, 2016. Available from: http://www.publication.pravo.gov.ru/Document/View/0001201608120016.
GRF, Government of the Russian Federation. (2012a), The State Program for the Development of Agriculture and Regulation of the Markets of Agricultural Products, Raw Products, and Food for 2013-2020. Available from: http://www.government.ru/programs/208/events.
GRF. (2012b), Government Resolution No 1432 of December 27, 2012. Available from: http://www.government.ru/docs/7101.
Ishmametov, R.H., Menyailov, V.S. (2017), Modern aspects of energy efficiency in housing fascilities in Russia. Vestnik Volgogradskogo Gosudarstvennogo Arhitekturno-Stroitelnogo Universiteta-Seriya: Stroitelstvo i Arhitektura, 47(66), 347-358.
Kobets, E.A. (2012), Energy saving in the Russian economy: Problems, solutions, first results. National Interests, 32(173), 25-28. Available from: https://www.cyberleninka.ru/article/n/energosberezhenie-v-ekonomike-rossii-problemy-puti-resheniya-pervye-rezultaty.
Kondratyeva, N.P., Vladykin, I.R., Baranova, I.A. (2016), Energy-saving electro technologies and electrical equipment in agriculture. Innovations in Agriculture, 19(4), 11-16.
Letyagina, E.N., Salmin, S.P. (2012), Improving energy efficiency of the Russian economy by reducing energy consumprion. Vestnik of Lobachevsky University of Nizhni Novgorod, 2(1), 248-250.
Makeykina S.M., Leshin, S.S. (2013), Need for improvement of economic energy efficiency in Russia under the conditions of modernization and innovative development. Society: Politics, Economics, 1, 1-4. Available from: http://www.dom-hors.ru/rus/files/arhiv_zhurnala/pep/2013-1/makeykina-leshin.pdf.
MARF, Ministry of Agriculture of the Russian Federation. (2017), Order of the Ministry of Agriculture of the Russian Federation on Approving the Lists of Directions for the Targeted Use of Preferential Short-term Loans and Preferential Investment Loans. Available from: http://www.docs.cntd.ru/document/436706648.
Martinot, E. (1998), Energy efficiency and renewable energy in Russia: Transaction barriers, market intermediation, and capacity building. Energy Policy, 26(11), 905-915.
MERF, Ministry of Energy of the Russian Federation. (2014), The State Program on Energy Efficiency and Energy Development. Available from: https://www.minenergo.gov.ru/system/download/444/516.
MERF. (2016), Order of the Ministry of Energy of the Russian Federation No 67 of February 4, 2016. Available from: https://www.minenergo.gov.ru/system/download/444/60649.
OPLI, Official Portal of Legal Information. (2009), The Federal Law No 261 of November 23, 2009. Available at: http://www.pravo.gov.ru/proxy/ips/?docbody=&nd=102133970.
OPLI. (2008), Executive Order No 889 of July 4, 2008 on Some Measures to Increase the Energy and Environmental Efficiency of Russia's Economy. Available from: http://www.pravo.gov.ru/proxy/ips/?docbody=&nd=102122361.
Pakhomova, N.V., Richter, K.K., Zhigalov, V.M., Malkva, A.S. (2017), Managament of energy-efficiency in the context of new climate policy. Ekonomika Regiona [Economy of Region], 13(1), 183-195.
Parkhomenko, N.V., Shukina, L.V. (n.d.), Energy-efficient technologies and sustainable development of the region's agriculture. Available from: https://www.goo.gl/tCqut4.
Pelletier, N., Audsley, E., Brodt, S., Garnett, T., Henriksson, P., Kendall, A., Kramer, K.J., Murphy, D., Nemecek, T., Troell, M. (2011), Energy intensity f agriculture and food systems. Annual Review of Environment and Resources, 36, 223-46.
Rau, V.V., Skul'skayam, L.V., Shirokova T.K. (2013), Recent trends and factors of resource intensity in the agricultural sector. Studies on Russian Economic Development, 24(4), 336-343.
RFSSS, Russian Federal State Statistics Service. (2016), Actual Consumption of Electricity, Heat, and Fuel Per Unit of Certain Types of Products and Services Produced (by Types of Products, Works, Services). Available from: http://www.gks.ru/free_doc/new_site/technol/5-10.xls.
Schneider, U.A., Smith, P. (2009), Energy intensities and greenhouse gas emission mitigation in global agriculture. Energy Efficiency, 2, 195-206.
Skrylnikova, N., Shchetinin, P.P., Ponomaryov, K.A. (2014), Problems of Predicting and Providing Energy Efficiency and Effective Environmental Management in Russia. Proceedings of the International Multidisciplinary Scientific Geo Conference SGEM, 3, 331-338. Available from: https://www.sgemworld.at/sgemlib/spip.php?article4966.
Sudachenko, V.N., Erk, A.F., Timofeev, E.V. (2017), Methods of energy saving and energy efficiency improvement for livestock farms in the North-West of Russia. Technologies and Technical Means of Mechanized Production of Crop and Livestock Products, 81, 5-14.
Tanaka, K. (2011), Review of policies and measures for energy efficiency in industry sector. Energy Policy, 39(10), 6532-6550.
Tatuev, A.A., Kerefov, M.A. (2014), Factors of increasing energy efficiency of the Russian undustry. Vestnik of North Ossetian State University after K.L. Khetagurov-Social Sciences, 4, 649-655.
Tikhomirov, A.V. (2016), The concept of power supply systems development and energy increase of fuel use and energy resources in agriculture. Bulletin of the All-Russian Scientific Research Institute of Agriculture Electrification, 1(22), 11-16.
UNDP Russia. (2013), Report on the development of human capital in Russia-2013. Available from: http://www.undp.ru/documents/NHDR-2013.pdf.
Ushakov, V.Y. (2009), Improving the energy efficiency of the Russian economy: Plans and actions. Bulletin of the Tomsk Polytechnic University, 314(4), 52-56.
Vodyannikov, V.T. (2012), Methods for assessing the level of energy efficiency in agriculture. Bulletin of the Moscow State Agro Engineering University, 1, 85-89.
Woods, J., Williams, A., Hughes, J.K., Black, M., Murphy, R. (2010), Energy and the food system. Philosophical Transactions of the Royal Society B, 365, 2991-3006.
Zavodchikov, N.D., Voronkova, E.A. (2010), Energy budget of the Orenburg region in the light of developing agricultural production. Strategy of Region's Development, 2(137), 12-16.
Zhou, N., Levine, M.D., Price, L. (2010), Overview of current energy-efficiency policies in China. Energy Policy, 38(11), 6439-6452.

APPENDIX

Table A1: Energy consumption indicators in Russia, 2012-2016

Indicator	Year	Heating of greenhouses	Agricultural tractors and combines	Cattle for slaughter	Poultry for slaughter
Russian Federation	2012	30.8	21.3	-	-
	2013	27.5	21.5	-	-
	2014	24.5	23.1	21.9	22.2
	2015	23	17.9	21.2	23.7
	2016	11.4	16.4	-	20.1
Central Federal District	2012	36.6	14.2	-	-
	2013	34.2	14.8	-	-
	2014	27.1	14.7	20.3	24.1
	2015	20.7	14.3	18.3	23.3
	2016	18.3	15.2	-	19.6
Northwestern Federal District	2012	38.1	35	-	-
	2013	37.1	38.8	-	-
	2014	29.6	41.5	27.4	27.6
	2015	28.3	17.3	26.7	27.1
	2016	34.5	14.5	-	25.4
Southern Federal District	2012	25.1	27.1	-	-
	2013	24.1	28.4	-	-
	2014	23.8	27.3	18.3	15.7
	2015	26.9	28	19.1	15.6
	2016	11.6	21.1	-	20.4
North Caucasian	2012	10.6	18.9	-	-
	2013	9.3	18.1	-	-
	2014	9.4	19.4	22.6	20
	2015	11.1	20	20.9	19.9
	2016	18.5	16.2	-	9.1
Volga Federal District	2012	35.5	29.5	-	-
	2013	33.1	28	-	-
	2014	32.9	32.5	7.6	28.9
	2015	29	19.1	11.4	27.2
	2016	5.4	16.2	-	20.3
Ural Federal District	2012	29.8	22.4	-	-
	2013	14.6	22.1	-	-
	2014	17.7	30.2	22	24.2
	2015	21.8	20.5	24.3	22.6
	2016	25.9	14.4	-	19.2
Siberian Federal District	2012	54.2	22.3	-	-
	2013	44	26	-	-
	2014	46.7	34.2	27.6	7.1
	2015	33.8	14.9	24.2	23.7
	2016	31.8	15.6	-	21.9
Far Eastern Federal District	2012	29.7	21.3	-	-
	2013	28.4	24.7	-	-
	2014	48	21.7	31.9	20
	2015	54.6	20.9	66.1	39.7
	2016	47.4	20.5	-	74.6

Figure A1: Energy consumption for greenhouse heating in Russia and its Federal Districts. 2012-2016 (kg of conditional fuel/cbm)

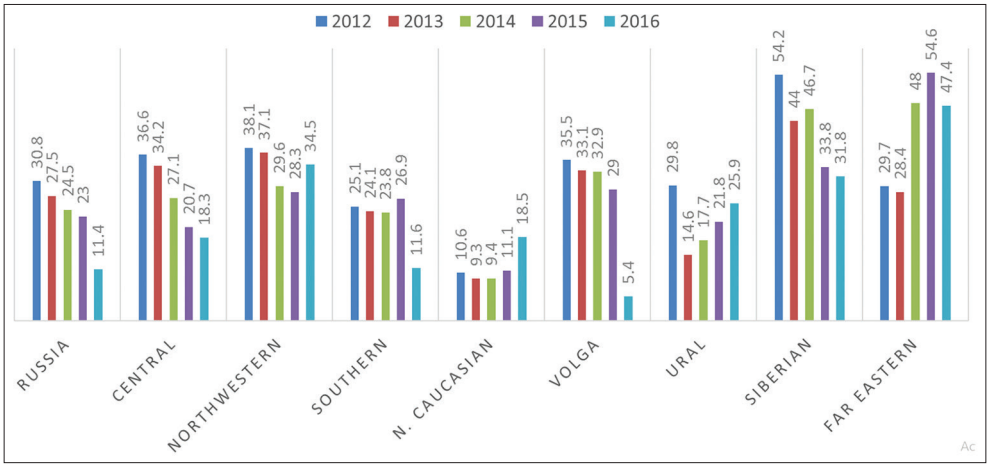

Figure A2: Energy consumption by agricultural tractors and combines in Russia and its Federal Districts, 2012-2016 (kg of conditional fuel/ha)

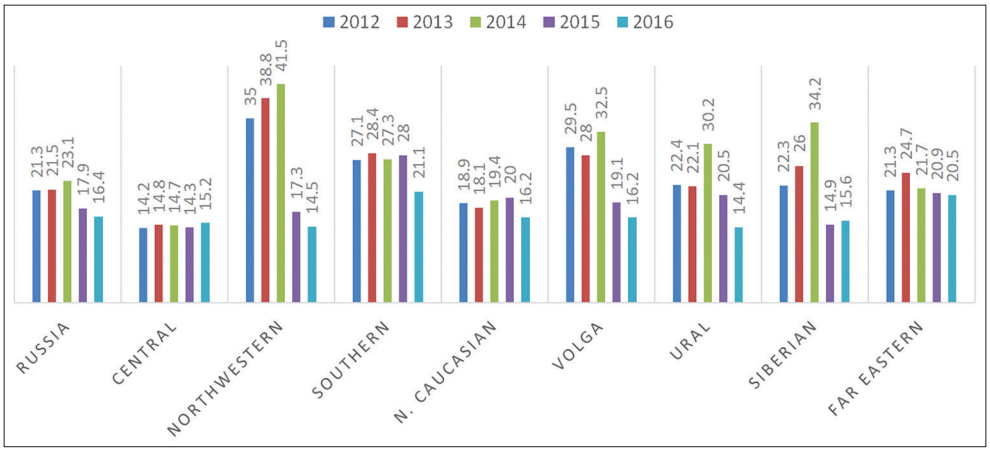

Figure A3: Energy consumption for producing cattle for slaughter in Russia and its Federal Districts, 2014-2015 (in live weight, kg of conditional fuel/cwt)

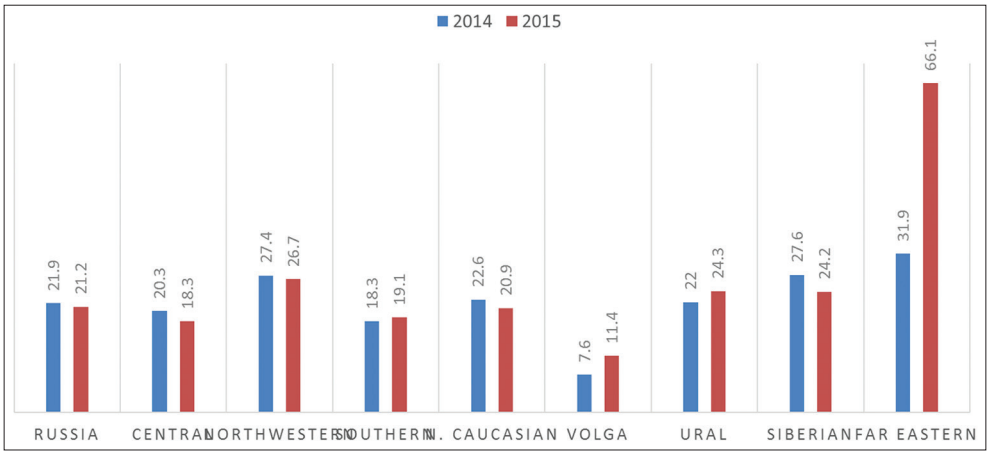

Figure A4: Energy consumption for producing poultry for slaughter in Russia and its Federal Districts, 2014-2016 (in live weight, kg of conditional fuel/cwt)