Analysis of wood energy Russian market

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Abstract. The paper presents an analysis of the wood-based energy market in Russian Federation. There are highlighted a number of problems with the types of Wood Energy Sources identification in Russian classification for production and consumption. According to statistics, domestic consumption of WES in Russia does not develop as rapidly as its exports. The paper considers studies of the WES market development examples in some European countries. It is formulated a set of problems including in the area of domestic consumption of Wood Energy Sources Russian market development. Analyses based on dynamics of the production volumes, trading and prices of the Russian wood pellets and briquettes as the main species of Wood Energy Sources. The export prices and trading on wood pellets were analyzed according incoterms. The export volume of wood pellets by destination countries in 2016-2018 is compared. The supply volume of wood pellets by various types of transport is analyzed. The main problems and premises for the Wood Energy Sources market development in the Russian Federation, based on the study results, are formulated, and facility development actions are proposed.

1. Introduction

Forests are playing a greater role as a source for renewable energy. Intensive management of wood fuel raw materials is closely related to regional forest, industrial and infrastructure conditions. The challenges of sustainable development is largely determined by the transition to renewable energy sources. Obtaining the greater economic, social and environmental benefits can be aimed at increasing the use of wood energy sources (WES).

Wood processing for energy production not only provides additional opportunities for employment in the supply chain of wood biomass, but also involves investment in the development of manufacturing technologies.

There is a continual grow of the gasification level with natural gas in the regions of Russia, which reached 68.6% by 2019 (71.9% in cities and 59.4% in countryside), according to the RF Ministry of Energy. However, the potential of using renewable energy sources (RES) based on wood biomass remains to be quite high. First of all, it is related to the availability of necessary resources in most regions of the Russian Federation. According to the Rosstat data, the volume of waste from wood processing makes it possible to ensure the need in raw materials for the WES production (Table 1).

One of the main prerequisites for the WES market development is the regulation with the efforts of interagency cooperation. In that case it is advisable to pay extra attention to the development and implementation of standards on the best available techniques (BAT), presuming waste-free production according the concept of RRR (Reduce Reuse Recycle).
Table 1. Volume of waste from wood processing.

| Economic activity          | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|----------------------------|------|------|------|------|------|------|------|------|------|------|------|
| Wood processing and production | 4.8  | 5.0  | 9.6  | 3.9  | 3.7  | 5.3  | 5.0  | 4.5  | 3.7  | 3.9  | 3.9  |

The choice of a particular type of energy source depends on the factors: the intended usage volume, the resources availability and their distance from the consumer, the transport and energy infrastructure and its condition, as well as requirements for greenhouse gas emissions reduction.

The Arctic area regions are potentially significant for the use of RES based on wood biomass. Despite this, analysis of state energy development programs in these regions showed orientation towards the fossil-fuels usage. Russian Northwestern Federal District regions also have a most high capacity of wood processing waste usage. However capacity-building events as is a biofuel facility development actions in energy strategies of that regions occur rarely. Therefore, there is an obvious need for a phased development plan for the biomass market, which should take into account supply chains and the stakeholders’ benefits.

Currently, the domestic consumption of WES in the Russian Federation is difficult to assess. This is due particularly haven’t a code of some types of WES in Russian Classification of Products by Economic Activities, and therefore official statistics are not traceable. It is also doesn’t show data on small enterprises with a production capacity of less than 10 thousand tons/year. Officially, the domestic consumption volumes are not properly revealed, and studies in this area are not reflected enough in Russian periodics.

In this case, the need of adaptation of existing methods for collecting statistical data on the similarity of forms Joint Wood Energy Enquiry (JWEE) и Joint Forest Sector Questionnaire (JFSQ) IEA ECE/FAO is obvious. In the article [1] on the WES usage, the presented approach based on JWEE in Germany. This methodological approach is based on residential wood energy consumption. Enterprises in the commercial sector are divides into small (less than 1 MWt) and large (more than or equal to 1 MWt of produced energy). The study made it possible to obtain all the necessary data through the mentioned questionnaires. This approach to the study of wood-based energy consumption covers most of the enterprises and households. JWEE form represents a unified methodology for collecting data of the WES usage for various levels of consumers and different types of WES. It also seems appropriate to formulate a development strategy of the WES usage in Russian forest sector. Using these techniques in research will provide the most accurate picture of the situation in the wood bioenergy field for the development of effective actions of statutory regulation.

Unfortunately, according to most regional State programmes for the energy development, WES are not a priority. Despite the low production cost and low logistics costs as compared to fossil-fuels, the main volume of produced WES is realized on the foreign market [2].

In the new Directive (EU) of the European Parliament 2018/2001 and the Council of 11 December 2018 [3] on the promotion of the use of energy from renewable sources, one of the goals is achieving the use of at least 32% of RES by 2030. This document is closely related to a number of other documents delivered by the EU, including special attention to climate change issues. Thus, for example, the greenhouse gas emission factors and the WES consumption related to the distance length from the consumer are reflected in the directive, which will likely affect on the demand growth of Russian WES. The positive factor is the proximity to the EU countries to Russian boarder (especially for the Northwestern Federal District (NWFD) compared to the North America.

In addition to the EU Directive, it is reasonable to note a growing trend in the WES consumption in the residential sector of European countries. Thus, in the article [4], the residential sector counts about half of the annual energy consumption from wood in Germany. Households’ energy consumption of
wood has shown a positive correlation with living space and an elastic responses to year of building construction. The widespread usage of central wood energy heaters, the price competitiveness of wood energy compared to alternative energy sources, and improving access to wood energy sources, according to the study, can lead to greater residential wood energy consumption in Germany.

In the article [5] presents the structure analysis of the wood pellet market model in Austria. It was noted that the EU bioenergy policies and oil prices hikes have resulted in a significant increase the number of installed pellet boilers for residential sector. Reports that European demand for wood pellets has been growing faster and more steadily than supply. However, this also leads to a price increase. Austria, one of the most dynamic markets for residential pellets, according of an econometric analysis of the demand and supply of wood pellets in the residential heating sector.

The work [6] also confirms the relevance of WES demand. It is noted that the EU policy is aimed at a wider use of RES, and wood biomass plays a key role in the implementation of this policy. According to the EU specification, [7] forecasts wood deficit by 2020, which may increase to 250 million m³ per year or more by 2030. In addition to the political goals of using biomass as an alternative energy source, there has been a significant jump caused by an increase in the WES consumption in residential sector.

Russian WES market studies are mentioned in the works [8,9]. There are identifies weaknesses of biomass market, which include poor willingness of the WES supply chain facility to meet the energy needs in the NWFD. The article also notes that the northwestern regions of Russia are in a great position due to the presence of abundant forest resources and relative proximity to the main European markets and ports. The article concludes that international trade has become a key aspect in the wood pellet business, and Russian pellets have significant part in the global market. Research in this area plays an important role in assessing the strengths and weaknesses of the Russian WES market development and should also apply to further regions (e.g. Arctic area regions).

Regarding mentioned above it's fair to indicate the WES of Russian market relevance of the study and reflect a number of problems. The solution to these problems can contribute not only to the development of domestic consumption, but also to ensure the economic security of this area.

The Russian Biomass Market Association highlighted a number of problems which are associated with regulation of the industry, and it includes:

- lack of a stable large-scale domestic market;
- limited access to funding for ongoing projects;
- high price for railway transportation;
- complexity ang high price of international product certification;
- absence of specialized infrastructure and facilities for storage and transshipment of products in the export directions (ports);
- lack of professionals in this area.

The aim of this study is to consider and analyze data about the market participants in the sphere of internal consumption, production, foreign trade and price formation across different types of WES. In order to accomplish this aim, the following tasks need to be completed:

- Analyze the international experience of state support of the WES market;
- Gather and analyze data regarding WES production volumes in the Russian Federation, taking into account the main types of WES, the stock of raw materials for their production, production infrastructure facilities;
- Gather and analyze data regarding domestic consumption of wood fiber for production of heat and electric energy;
- Evaluate the cost of WES, export volumes, the primary delivery destinations and terms across different WES types;
- Evaluate the potential of the WES market development in the Russian Federation.
- To formulate proposals on Russian WES market development.
The novelty of the study is gathering and analyzing data on the WES market and elaborating proposals for the development of this field in the Russian Federation. The results of the study can contribute to the creation of favorable conditions for the WES market development.

2. Methods
The object of study is the WES market in the Russian Federation.

Study methods include monitoring of export supplies, gathering and integration of data, processing of statistical data. This study takes into account the use of methods of system theory and system analysis, process-based approach and operational research. The study is based on the concept of supply chain planning.

Methods of system theory and system analysis, process-based approach and operational research were used to process the gathered information.

This study includes the following stages:

• Gathering and analysis of data regarding wood fiber consumption for production of heat and electric energy;
• Gathering and analysis of data regarding wood fiber consumption for industrial purposes;
• Gathering and analysis of data regarding the volumes of WES production, import, export, as well as the prices;
• Gathering of statistical data regarding the share of raw materials in domestic production of WES-based fuel.

3. Results and discussion
Biofuel plays different roles in the energy sectors of various countries and regions, depending on the type of state structure and abundance of forest resources. As a consequence, state and legal instruments regulating the national programs and bioenergy sector development plans are also very diverse. They may influence demand and the sale markets through tax incentives or an obligation to sell biofuel along with hydrocarbon fuel; stimulate the use of wood biofuel by end consumers, for example through subsidies.

State regulation is not limited only by adoption of normative acts and additional taxation of fossil fuels. It also includes support for scientific-technical research, investments into creation and installation of the necessary equipment or full-scale modernization. Thus, the accumulation of practical experience significantly influences the decrease of manufacturing costs (which comprise a significant part of biofuel production costs), while the technologies of raw wood procurement and processing are developing faster than the existing methods of wood biomass cultivation.

Taking into account the specific features of the normative framework in the EU and the USA, as well as the growing development level of the biofuel market, technical and normative limitations may be introduced instead of statutory requirements and target indicators. This is what happened to fuel mixture ratio and general limits in the US, where the statutory norms became a serious impediment for the further development, for example, of the ethanol market.

All EU strategies in the sphere of bioenergy are within the joint competence of its member states. Activities within the framework of national programs are based on directives and normative acts. EU countries are obliged to follow the directives, and the European Commission is entitled to oversee their performance and enforce corresponding non-compliance procedures where necessary.

In 2017, the volume of wood pellet production in Russia skyrocketed by 20 %, despite a lower volume of timber procurement than in 2016 (a decrease of 1.4 mln m3) (figure 1). In particular, this is explained by development of the production infrastructure in a number of regions.
Despite positive production dynamics, 2018 began with a 24% drop and only reached the previous year’s production numbers in April, with a slight surplus at the end of the year. In part, this may be explained by a deficit of raw materials, as well as suspension of activity by the largest player on the pellet market in March of the previous year.

There are over 100 enterprises producing briquettes around Russia, with a total annual production capacity of 663,000 t. Compared by the total production capacity in Russia, the share of briquette production comprises one fifth of the production volume of fuel pellets. However, this type of product is gaining popularity as a household and industrial fuel, which stimulates the growth of domestic consumption.

Biofuel infrastructure is best developed in the NWFD. Over 60 enterprises with a total production capacity of 2.5 mln tons per year are located there (Figure 2).

Regions showing the fastest development in this sphere include Komi Republic, Republic of Karelia and Arkhangelsk Region. Siberian Federal Circuit is also among the sector’s leaders, housing more than...
30 factories with a total production capacity of 1.5 mln tons per year. Compared to 2015, production has risen by 36% here, and export volumes gained 43%. The third place is shared by the Central and Far East federal circuits – each has a production capacity of 0.5 mln tons per year. The total production capacity of all Russian enterprises is 5.5 mln tons of pellets per year, which forms a considerable potential on the wood energy sources market.

Currently, 63 priority investment projects are being realized across the country in the sphere of timber by-products processing for production of biofuel. An investment project in the Far East is now on the preparatory stage; it will include plantation cultivation of wood for energetic purposes. Among the investment projects in the sphere of renewable energy currently implemented in Murmansk Region, the following are of particular interest:

- Kandalaksha – “An investment project to organize extraction of shredded and sod peat and to organize production of peat and peat-and-wood pellets and briquettes to supply boiler houses and thermal power plants in Murmansk Region”;
- Monchegorsk – “Reconstruction of Boiler House No. 1 in the city of Kandalaksha with switching to local fuel types (shredded peat, wood by-products (woodchips))”.

Despite the annual growth of WES production, Russia’s domestic market has not formed so far, although Russian-made fuel pellets and briquettes have been successfully exported to Europe and Asia for several years now [11-13]. In Russia, support measures of export-oriented small and medium enterprises, including those producing fuel pellets, are aimed at dealing with export barriers, enhancing the activity and competition capacity of exporting enterprises. The most effective support mechanisms of export-oriented enterprises are subsidizing of promotional costs incurred on the global market and compensation of interest rates on export contracts [14,15].

The EU climate policy, especially the aim to reduce greenhouse gas emissions, contributed to the increasing demand for fuel pellets and briquettes in Europe. Around 85% of the world’s pellet consumption takes place in Europe. According to Hawkins Wright, a UK-based consulting firm, the annual demand for wood pellets will grow both in industrial and private consumption, reaching 20.1 mln tons and 13.51 mln tons in 2021 accordingly (figure 3).

![Figure 3. Projected European demand for wood pellets by 2021.](image)

The most frequent terms of delivery of fuel pellets from Russia are delivery of goods to the carrier nominated by the buyer (FCA) or delivery to the buyer’s ship at the port (FOB). The end price of goods may differ significantly depending on these terms. In 2017, 685,300 tons of fuel pellets were shipped out of Russia on FCA terms, which is 155,400 tons more than in 2016. A slight decrease of the average price (3.7%) can be seen across all FCA contracts nominated in euro. In 2016, the price of a ton of
FCA-delivered fuel pellets was EUR 84.7; it dropped to EUR 81.6 at the end of 2017. CIF exports have increased, but by late 2017 the price has dropped by 18 % to EUR 110.5 per ton. Denmark still remains the primary destination of Russian fuel pellets. The volume of export of fuel pellets to this country has increased by 32 % since 2016, while the price decreased by 4.8 %. In 2017, the average price of a ton of fuel pellets, shipped to Denmark on FCA/FOB terms, was EUR 80.5/84 accordingly, changing to EUR 88/98 by early 2018.

According to Argus Media, the freight cost of fuel pellets (Spot, cargo) on Saint-Petersburg – Copenhagen route was EUR 17.5 per ton in January 2018 [16].

Belgium became the second major export destination in 2017. The volume of shipments showed a 79 % increase (up to 123 400 tons) as compared to 2016. The main share of exports to Belgium in 2017 was performed on CIF terms, comprising 62 % of the total volume. Carriage by sea helped increase the volume of exports to Belgium, while carriage by road stayed the same. For example, the price of FCA-delivered fuel pellets remained almost unchanged in 2017 (EUR 82), but rose to EUR 92 in Q1 2018. CIF price demonstrated a slight growth, rising from EUR 108 to 109.4 per ton.

The average price of a ton of fuel pellets, exported to Sweden on DAP terms decreased in 2017, followed the the exchange rate depreciation of euro against the ruble and went down as compared to the 2016 average price, reaching EUR 74 and rising to EUR 76 in early 2018. In January 2018, the freight cost of fuel pellets (Spot, cargo) on Saint-Petersburg – Stockholm route was EUR 15.75.

On the Eastern destination, the price of export of a ton of fuel pellets from Russia demonstrates a positive dynamic. In 2017, the dollar/ruble exchange rate fell by 12.7 %, however the price of a ton of fuel pellets shipped to the Republic of Korea rose by 23 %, from USD 66 to 86. According to Q1 2018 data, the price of a ton of FOB-delivered fuel pellets is USD 96.

Despite the general downward price trend, volumes of shipments of fuel pellets into certain countries have decreased significantly. For example, the price of a ton of fuel pellets, ensured and CIF-delivered to a port in the Netherlands, fell by 21 % (from EUR 137.7 to 109.3 per ton) [17].

The analysis of pellet export dynamics in recent years has shown a sharp increase in the number of exported goods since 2017, however a significant profit growth was observed only in 2018.

Since 2014, there has been a noticeable increase in demand for Russian wood pellets from 888,000 tons to 1,581,000 tons in 2018. Italy and Sweden included in the top five main export directions of Russian wood pellets in 2018. Their volumes were 148,300 and 158,100 tons, consequently. Denmark remains the largest importer of Russian wood pellets in 2018, the export volume was 720,200 tons. Korea, Sweden, the Netherlands, Italy, Finland, the UK and Belgium engage in this trade on a somewhat different scale. Italy, Sweden and the UK significantly increased imports of Russian wood pellets in 2018, while Belgium reduced imports to the figures of the year 2016 (Table 2, figure 4).

Table 2. Comparison of export volumes of wood pellets by destination countries, tons.

| Main countries-importers of Russian wood pellets | 2016          | 2017          | 2018          |
|------------------------------------------------|---------------|---------------|---------------|
| Denmark                                        | 399 942,60    | 670 218,00    | 720 212,00    |
| Sweden                                         | 130 991,74    | 120 142,27    | 158 146,00    |
| Korea                                          | 129 374,05    | 127 518,50    | 72 842,00     |
| Netherlands                                    | 93 391,10     | 57 147,93     | 81 269,00     |
| Italy                                          | 62 332,79     | 105 786,21    | 148 304,00    |
| Finland                                        | 51 271,62     | 53 909,02     | 59 677,00     |
| Belgium                                        | 25 993,81     | 123 388,50    | 26 837,00     |
| United Kingdom                                 | 55 050,22     | 61 858,86     | 94 086,00     |
Figure 4. Comparison of export volumes of wood pellets by destination countries in 2016-2018, tons.

14,500 tons of fuel pellets were carried by sea to Italy in 2017 (FOB delivery); around 81,000 tons were carried by road (FCA). Here, the 2017 export volume mainly occurred in Q3. Fuel pellets are FOB-delivered to Korea in the ports of the Far East. The main volume of exports to Sweden was on DAP terms; in Q2, it decreased to results of the same period in 2016.

Sea transportation is still primarily used for fuel pellet exports. In 2017, export volumes carried by sea increased by 255,000 tons. Carriage by rail doubled, while carriage by road remained stable (figure 5).

Figure 5. Supply volumes of wood pellets by various transport types, tons.

In general, trade was positively influenced by state support through subsidizing of transportation costs. According Russia export center, since 2017, within the framework of support for high-tech
exports, producers of wood pellets are able to compensate up to 80% of their actual export costs incurred during transportation of their products into foreign markets [18].

The development of wood pellets export in Russia should be focused on Integrated Programme of Work (PoW) of ECE Committee on Forests and the Forest Industry (COFFI) and the European Forestry Commission (EFC) 2018-2021 [19]. The PoW is considered as a part of a strategic review, which covers the scope, structure and content of the resources, methods, partnerships, results and objectives of the joint subsidiary bodies of the EFC and COFFI.

4. Conclusion
The results of the analysis have shown that the Russian WES market is poorly developed and focused mainly on exports. The wood pellets is the main kind of WES in terms of market demand. Russian forest sector, mainly WES market, has a great potential of its investment attractiveness. However, it leaves open the question of what mechanism government will choose. The capacity-building of the Russian WES market based on the availability of resources and the projected demand growth from the EU. The Russian wood pellet market continued to grow in 2019, and 2018 export volumes exceeded 1.5 million tons. It is also growing the interest in Japan, South Korea and other Asian countries. The relevance of the use or transition to RES, the WES in particular, is dictated by the Paris Climate Agreement, ratified by Russia on September 23, 2019.

In order to implement government regulatory actions, today, WES market analysis and statistics in this area are the main tools that can make it possible to assess its development trends. The form of JWEE in this part can be a starting point for gathering and analysing data on WES market. It is possible to evaluate the use of WES not only on an industrial scale, but also at the level of the residential sector. This tool will provide an idea of the volumes of consumption, production, export and import of wood-based fuels. However, at this moment, statistics of the domestic consumption of the WES in the Russian Federation are practically absent, as well as the official classification of their species.

Wood energy is a knowledge-based, innovative branch of sustainable development, so the need for applied studies is obvious. World experience in the WES market development is based on the successful implementation of government support programs in this field.

The development of domestic consumption is a key problem of state regulation of this area, especially in regions with a low level of gasification such as Arctic area regions.

In order to solve this issue it is appropriate to propose the following actions on Russian WES market:

- Develop and adopt state support programmes for biofuel direction.
- Provide coordination and interaction of government bodies at all levels on the biofuel industry and bioenergy development.
- Prepare an updated “The development of biotechnology and bioenergy roadmap in the Russian Federation” with government bodies and development institutions.
- Provide funding for BAT programs for developing new effective technologies for the production and use of all biomass fuels types and creating an updated database of statistics on the wood energy state, consumption, production, export and import of wood fuels.
- Provide cooperation of the constituent entities of the Russian Federation in the field of development and implementation of effective technologies for the deep forest resources processing, including collection, storage and wood biomass processing.
- Develop a cooperation agreement with major international biofuel organizations in order to promote the interests of Russian participants in the biofuel market.
- Develop proposals for rationing the transfer part of the energy sector for the biofuels consumption. Ensure the implementation of effective schemes for the wood waste utilization at the regional level by delivering relevant regulations and standards.
- Expand existing programs to support industry and exports to the bioenergy industry in parts of:
  - reducing transport tariffs and rates for railway pellet transportation;
stimulating the use of pellets in the private sector based on appropriate government support programs.

- Appoint official representatives from Federal Forestry Agency (national correspondents) to the group of specialists on forest statistics and the group of specialists on wood energy to provide information on the forms of JWEE and JFSQ in IEA ECE/FAO, as well as to formulate the topic of study work on the assessment of the wood consumption to obtain energy in households as an example of a pilot region, because it is necessary to work with JWEE.

- Formulate a wood energy direction in the Russian Federation and submit work plans according to the structure delivered by UNECE/FAO. At the same time, it is recommended to note the topics of scientific research on economic, social and environmental aspects in the development field of wood energy in the Russian Federation.

In addition to the actions stated above, it is necessary to standardize not only products, but also the processes of production and WES production and consumption for the Russian market. The process approach in analyzing the interaction functions of the state, business, research institutes, regulatory bodies and other stakeholders will allow us to plan the launch of the development mechanism of the wood biomass market and bring it to a high quality level.

5. Acknowledgments
The article was supported and funded by grant project №18-310-20008 by Russian Foundation for Basic Research.

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