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# **RESEARCH ON THE USE OF RENEWABLE ENERGY SOURCES IN BRICS COUNTRIES**

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### *Abstract*

The article is devoted to the issue of using renewable energy resources in the generation of various types of energy in the territory of the BRICS countries. The article describes the impact of the process of replacing traditional energy sources with renewable ones on the development of the energy industry and the economies of countries. The types of used renewable energy resources, which are the foundation for the development of the direction of alternative energy and are considered as resources that can reduce the harmful impact on the environment, as well as the share of these resources in the energy balance, are considered. The analysis of joint technological developments and research in the industry by the BRICS countries has been carried out. Despite the fact that the BRICS countries do not have a clear uniform policy regarding the use of renewable energy sources, this issue is regularly raised at the summits held as part of the discussion of the problems of the entire energy cluster and does not stand aside. Working in this direction, the countries are working out various solutions and setting the pace of development of alternative energy, which undoubtedly has a high impact on the state of the entire energy industry and the economy as a whole. A comparison of a number of advantages and disadvantages of renewable energy resources and possible ways of developing the renewable energy industry of the BRICS countries in the future is made.

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**Keywords:** Energy efficiency, renewable energy, technology innovation, BRICS countries, energy policy.



## 1. Introduction

Currently, programs and plans for the development of alternative energy exist in most countries of the world, including Brazil, Russia, India, China and the Republic of South Africa, which form the interstate BRICS association. The influence of the BRICS countries on the development and management of various global processes in the world more and more intensified. The role of BRICS on the scale of the world economy is also characterized by the fact that more than 45% of the world labor force is concentrated in these countries (Batalina, Bordachev, & Bochkova, 2020). There is a fairly clear specialization of the countries in the association: Brazil is an agricultural country, Russia is the largest exporter of mineral resources, India supplies intellectual resources, and China, in turn, is labor resources. South Africa is also a supplier of natural resources. One of the important areas of cooperation between the BRICS countries is the energy sector, which in turn plays the role of one of the most key industries to ensure sustainable economic development and well-being (Batalina et al., 2020).

The BRICS countries are parties to all major international agreements in the field of energy and climate, including the Paris Agreement and the UN Sustainable Development Resolution until 2030 (Resolution, 2015). India, Russia and China are among the countries with the highest specific greenhouse gas emissions. Energy industry development issues include the creation and improvement of technologies for the use of renewable energy resources (Dyatlov, Didenko, Lobanov, & Kulik, 2019).

Currently, programs and plans for the development of alternative energy exist in most countries of the world, including Brazil, Russia, India, China and the Republic of South Africa, which form an interstate BRICS association (Edenhofer, Peachs-Madruga, & Sokona, 2011). The influence of the BRICS countries on the development and management of various global processes in the world more and more intensified. The role of the BRICS in the global economy is also characterized by the fact that more than 45% of the world labor force is concentrated in these countries (Batalina et al., 2020). There is a fairly clear specialization of the countries in the association: Brazil is an agricultural country, Russia is the largest exporter of mineral resources, India supplies intellectual resources, and China, in turn, manpower. South Africa is also a supplier of natural resources. One of the important areas of cooperation between the BRICS countries is the energy sector, which in turn plays the role of one of the most key industries to ensure sustainable economic development and well-being (Li & Pogodin, 2020).

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## 2. Problem Statement

Energy consumption is an important criterion for living standards and development. In connection with the rapid growth of energy consumption, the question of the development of alternative energy sources, which makes it possible to feel less dependence on the availability of hydrocarbon reserves, is increasingly being raised (Konyuhov, Gladkih, Galyautdinov, & Kiseleva, 2019).

### 3. Research Questions

The article is devoted to the study of using renewable energy resources in the generation of various types of energy in the territory of the BRICS countries. The article describes the impact of the process of replacing traditional energy sources with renewable ones on the development of the energy industry and the economies of countries. The types of used renewable energy resources, which are the foundation for the development of the direction of alternative energy and are considered as resources that can reduce the harmful impact on the environment, as well as the share of these resources in the energy balance, are considered. The analysis of joint technological developments and research in the industry by the BRICS countries has been carried out. A comparison of a number of advantages and disadvantages of renewable energy resources and possible ways of developing the renewable energy industry of the BRICS countries in the future is made (Resolution, 2015).

### 4. Purpose of the Study

Despite the fact that when the BRICS was created, many experts argued that it is traditional energy as a source of mutual economic benefits that will be the main point of contact between countries in energy development, in various declarations of the participating countries the emphasis was shifted to the development of renewable energy sources and improving the energy efficiency of countries (Skvortsova, Latyshev, & Grabovyy, 2019).

### 5. Research Methods

Renewable energy resources are inexhaustible or replenished naturally much faster than they are consumed. The main feature of renewable energy resources is the cyclical nature of their recovery, which allows them to be used without time constraints (Kernitskii et al., 2020). Renewable energy sources (RES) include, for example: solar and wind energy, hydropower and others, the complete classification scheme for renewable energy sources is shown in Figure 01.

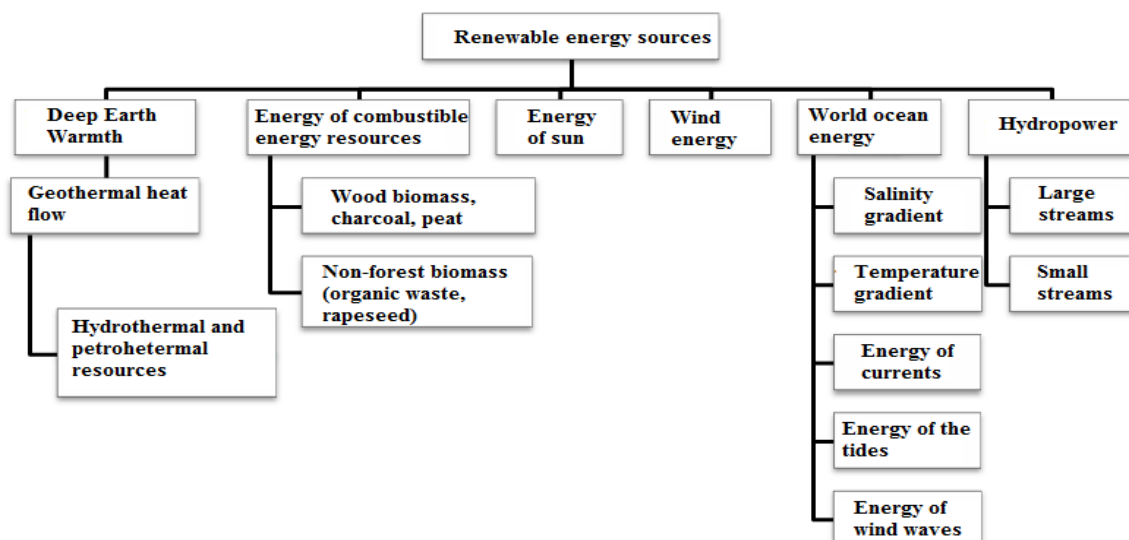


Figure 01. Renewable energy resource classification

The most used RES are wind, solar and hydropower, but other types of renewable energy sources are also used (Edenhofer et al., 2011; Konyuhov et al., 2019; Liu et al., 2018).

Wind power, the technology of using air currents to generate electrical energy, is the world's fastest growing source of electrical energy. Wind power is produced by massive multi-blade wind turbines that are mounted at the very top of tall towers and work like fans, but in reverse order. Instead of using electricity to generate airflow, turbines use wind to generate electricity, a technology that has significant potential to reduce greenhouse gas emissions.

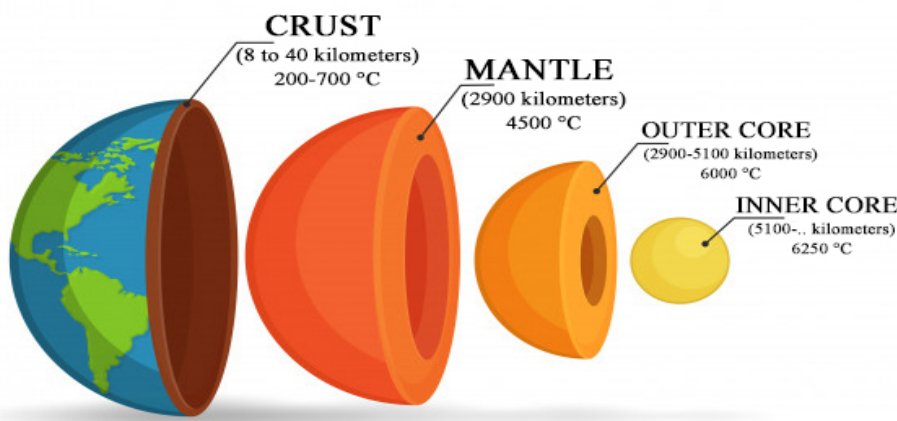
Solar energy is thermal radiation that is emitted from the outer surface of the Sun. This type of energy resource is widespread in advanced countries and is based on the use of solar radiation in order to obtain energy for heating, electricity and hot water supply. It is believed that solar energy has more potential in terms of an alternative energy source than wind energy. Moreover, the amount of solar energy coming to the surface of the planet per week is much more than the energy obtained from traditional sources such as oil, gas and coal.

Hydroelectricity is a renewable energy source in which energy is obtained from the energy of water that moves from a higher to a lower level. The mechanical energy of falling water is an ancient instrument used to generate energy, and was used by the ancient Greeks more than 2,000 years ago. The first hydroelectric power plant was built on September 30, 1882 on the Fox River, Wisconsin, USA.

Tidal Energy - The production of energy by special types of hydroelectric plants using tidal energy generated by converting the kinetic energy of the Earth's rotation.

Energy of ocean waves - the energy received by wave power plants, transforming the potential, the energy of the waves is carried over the surface of the ocean.

Geothermal energy produces energy by generating the hot power of the earth, obtained through natural processes (the heat of the planet, preserved from the time of formation, the thermal power generated by it due to radioactive elements, friction). The temperature of the Earth's core, according to various sources, is currently no less than 6250 °C, and is gradually decreasing towards its surface. 42 trillion watts of heat is constantly emitted by the Earth, only 2% of which is in the crust. Figure 02 shows data on earth temperature at a certain depth (Kukartsev et al., 2020).



**Figure 02.** Earth temperature at different depths

Bioenergy deals with the production of energy using plant or animal raw materials, as well as organic waste or organic industrial waste.

One of the most important characteristics of renewable energy sources is their energy potential - an indicator that determines the amount of energy inherent in the corresponding type of RES. Indicative indicators of renewable energy resources in the world are shown in Table 01.

**Table 01.** Key indicators of renewable energy resources

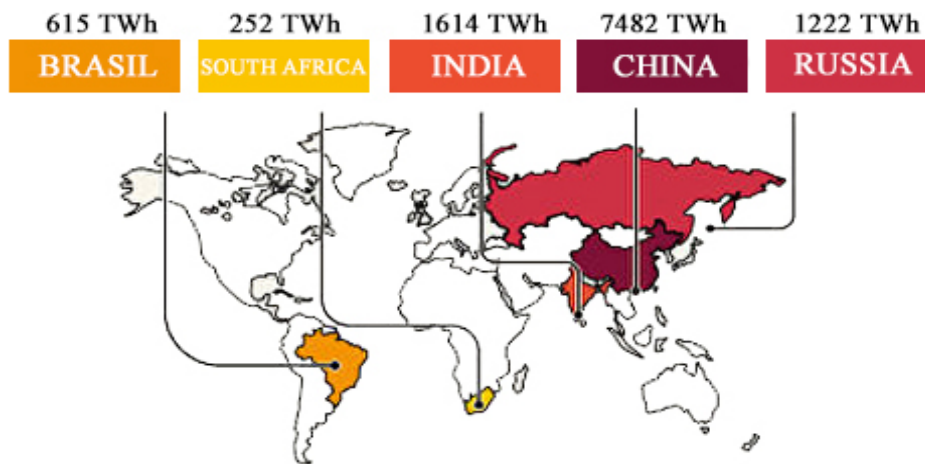
Renewable energy resources	Indicators, bln.tons of fuel equivalent (t.f.e) / year	
	Technical	Economic
Ray energy of the Sun	5	1
Heat energy of the seas and oceans	1	0.1
Wind energy	5	1
Hydropower, including:		
Energy of watercourses (small and large hydropower)	4.5	2.6
Wave energy	0.05	0.01
Energy of the tides	0.7	–
Biomass energy (excluding firewood)	2.55	2.0
Geothermal energy	0.4	0.2

To assess the energy resources of renewable energy sources that can be used, the following types of renewable energy potential are distinguished:

- Theoretical, characterizing the total amount of energy.
- Technical - part of the theoretical potential, which in principle can be used with the help of modern devices.
- Cost effective - part of the technical potential, which is currently advisable to use, based on economic, social, environmental and other factors.

Consider, on the basis of the electric power industry, as the largest branch of the energy complex, the rates of production and consumption of electricity in the BRICS countries and the share of use of the main renewable energy resources.

The rate of energy production in the BRICS countries, despite a slight decrease, remains at a fairly high level, this is primarily due to increased mobility, urbanization and integration into the world economy. According to the statistical yearbook of world energy EnerData, the total electricity production in the BRICS countries in 2019 amounted to 11185 terawatt-hours (TWh), the data is presented in Figure 03 (Fedorova et al., 2020).



**Figure 03.** Electricity production in the BRICS countries in 2019

At the same time, the share of used wind and solar energy in the production of electricity in the BRICS countries from 2010 to 2019, although it increased, in a number of countries still remains at a rather low level, the data are presented in Table 02.

**Table 02.** The share of the use of wind and solar energy sources in electricity production

Year Share of sources by country%	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Russia	0.05	0.05	0.05	0.04	0.07	0.09	0.1	0.1	0.13	0.18
Brazil	0.42	0.51	0.91	1.15	2.07	3.73	5.8	7.33	8.64	10.1
South African Republic	0.01	0.01	0.01	0.02	0.87	1.95	2.69	3.29	3.83	4
India	2.02	2.42	2.88	3.13	3.33	3.79	4.36	5.03	6.19	6.88
China	1.08	1.55	2.05	2.88	3.27	3.94	5.03	6.42	7.76	8.7

A sharp increase in electricity consumption in the period from 2010 to 2019 is not observed due to a slowdown in economic growth and more moderate temperatures in a number of large countries, the data are presented in Table 03. Contribution of the BRICS countries to the global growth in energy consumption in 2010–2019. amounted to 78%.

**Table 03.** The share of the use an electricity consumption in the period from 2010 to 2019

Year Share of sources by country TWh	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Russia	851	856	875	872	877	877	898	905	918	922
Brazil	459	476	492	509	522	514	513	520	528	536
South African Republic	214	214	209	209	208	206	205	206	208	204
India	729	802	891	891	976	1039	1111	1168	1227	1230
China	3626	1405 2	4326	4718	4939	5103	5407	5784	6230	6510

At the moment, cooperation between the BRICS countries in the development of clean (green) energy is at a low level. Despite the fact that this topic is raised at every BRICS summit and at every

meeting of ministers and heads of government departments in charge of energy issues, there are no full-fledged active joint projects for the development of renewable energy sources (Li & Pogodin, 2020).

Among the main actions aimed at deepening and strengthening cooperation of the participating countries in the field of green energy, one can single out the signing of the Declaration on the Establishment of the BRICS Business Council, which includes a group for the development of green energy and the economy. In addition, within the framework of the VI BRICS Summit in 2014, the President of the Russian Federation V.V. Putin proposed the creation of a "BRICS Energy Association", a "Fuel Reserve Bank" and the BRICS Energy Policy Institute, but this was only a proposal (Tynchenko et al., 2019).

In April 2016, the BRICS New Development Bank provided financing for the first green energy projects. It should be noted that it was the projects for the development of renewable energy sources that received the first funding from the bank.

Bank President K.V. Kamatha noted, "This is an important event for the bank, and we are delighted that we have achieved our goals and met the deadlines set by the leaders of the BRICS countries. We are starting to provide operational support for projects in developing countries. We are pleased that the projects we finance are related to green energy and renewable energy sources, and we hope that they will become catalysts for development in the Bank's member states." The BRICS Bank approved the first investment projects. This shows that the interest of the BRICS countries in the development of renewable energy is growing, and there are assumptions that this trend will continue in the future (as cited in Fedorova et al., 2019, p.43).

The Russian project for the construction of Beloporozhskaya HPP-1 and HPP-2 in Karelia was also approved. On October 11, documents were signed on the construction of small hydroelectric power plants "Beloporozhskaya HPP-1" and "Beloporozhskaya HPP-2". This is the first project in Russia to attract funding from the BRICS New Development Bank. The total hydro generation capacity of the two Beloporozhskie HPPs will be 49.8 MW. The total cost of the project is 11.8 billion rubles. The financial investors in the project were the Russian Direct Investment Fund, together with the leading Middle Eastern sovereign funds, as well as the Chinese state corporation SINOMES. The construction of the HPP began in the spring of 2017, the work was planned to be completed at the end of 2019, however, due to the breakthrough of the dam at the Beloporozhskaya HPP-2 in 2020, the complete start-up of the units was postponed until the restoration of all systems and additional safety studies.

Within the framework of Russia's chairmanship in the BRICS association, the Russian Ministry of Energy held the BRICS Energy Week from 10 to 16 October. The main topic of discussion was the need to deepen the energy dialogue between the BRICS countries in the context of a pandemic and energy transition. Based on the forecast given in the report of experts, in 20 years the fuel and energy balance of the BRICS countries will change significantly. And this will happen due to "an increase in the share of renewable energy sources, natural gas and the atom, and a decrease in the share of coal and oil." If in 2018 the share of coal in the fuel and energy balance was 49%, and oil - 23%, then by 2040 the figures will decrease and will amount to 36 and 18%, respectively. The share of gas will increase from 13% in

2018 to 19% in 2040, the share of renewable energy sources - from 12 to 20%, the share of the atom - from 3 to 7%.

At this stage of the BRICS development, there are no fully implemented projects yet. However, it is clear that the countries of the organization are interested in cooperation and offer possible options for mobilizing existing funds and efforts for the development of joint projects in the field of green energy. This topic is periodically discussed at the ongoing BRICS summits and is gradually moving from a state of "discussion" to "implementation", as demonstrated by the New BRICS Development Bank by providing financing for the development of renewable energy sources to four BRICS member countries at the end of April 2016. So far, most of the initiatives are observed at the bilateral and trilateral levels of interaction between the five countries. Since in these cases the transaction costs of cooperation are lower than in the implementation of projects within the framework of the five-sided dialogue.

## **6. Findings**

In the modern practice of business relations, the use of electronic documents increases rapidly. This tendency is reflected to a certain extent in the Russian procedural legislation. The Civil Procedural Code of the Russian Federation provides for the use of information technologies in the activities of general jurisdiction courts in civil proceedings. The organization of a videoconference with the court; filing of a complaint to the court in electronic form; submission of electronic evidence; organization of an electronic document management system and other elements of e-justice are now part of legal activities. The Civil Procedural Code of the Russian Federation provides for the possibility to file a lawsuit in court in electronic form. The peculiarities of filing a complaint in electronic form and the subsequent procedure for its acceptance or dismissal are specified in Order No. 251 of the Judicial Department under the Supreme Court of the Russian Federation of December 27, 2016 "On approval of the Procedure for filing documents in electronic form, including in the form of an electronic document, to federal courts of general jurisdiction".

In practice, the right to appeal to the court in electronic form is realized as follows. Filing a complaint in electronic form is carried out by filling out the appropriate form posted on the official website of the court in the Internet. Submission of documents is made on the official site of the court in the section "Submission of procedural documents in electronic form", which is integrated into the "Electronic Justice" service of the online portal of the State Automated System (SAS) "Justice". This system of court proceedings automatization used in Russian courts ensures that court proceedings are conducted and the results and course of proceedings conducted by the court and other participants in the proceedings are electronically fixed. In order to submit documents to the court it is necessary to be registered on the Internet portal of SAS "Justice". When an individual's personal data is confirmed on the court's website, a user profile is automatically created. Access to this account is performed either with the help of an enhanced qualified digital signature of the user or with the help of a confirmed account of an individual in the Unified Identification and Authentication System (UIAS). The mentioned information system provides authorized access to the information contained in state information systems. Documents filed to the court via the Internet can be submitted both in the form of an electronic document signed by an electronic signature and in the form of a scanned document.



The capabilities of SAS "Justice" should be evaluated positively, as registered users can easily track the movement of cases in which they are participants and perform various procedural actions. They can also receive information on the status of complaints, including out-of-court ones, which are filed in the judicial authority. Nevertheless, such a positive innovation of modern technology is not available to everyone, taking into account the economic inaccessibility for some elderly citizens or, for example, their place of residence and Internet coverage area in villages that are difficult for the operator to use.

Information technologies have provided the court with an opportunity to hold court decisions (rulings, decrees) in electronic form. The said decisions must be certified with an enhanced qualified electronic signature by the judge. When making a court decision in electronic form, an additional copy of it is made as hard copy. Persons participating in the case, but not present in the court session, at their request or with their consent can be sent copies of the court decision by placing them on the official site of the court in the Internet in the section to which access is provided to the parties and other participants of the process. To public authorities, other bodies and organizations involved in the case, whose representatives were not present at the court session, copies of the court decision can be sent by posting them on the court's official website in the Internet in the mode of limited access.

In the activities of general jurisdiction courts in civil proceedings, documents in electronic form are currently used, which include electronic images of documents and electronic documents. Electronic image of a document (electronic copy of a document made on paper) is a copy of a document translated into electronic form by means of scanning tools and certified with an electronic signature. Electronic document is a document created in electronic form without prior documentation on paper, signed with an electronic signature.

It should be noted that Russian legislation does not regulate electronic evidence as an independent means of proof, does not use or disclose this concept. Civil Procedural Code of the Russian Federation classifies electronic means of proof as written evidence, indicating that these are electronic documents and other materials made in digital form and obtained using special technical means of communication.

One of the problems with the use of electronic documents as evidence is verifying their authenticity. The reliability of electronic evidence is ensured by the possibility of identifying the author of the created file or the person who signed the electronic document. Verification of the reliability of electronic evidence in court may be carried out in several ways. One way of verifying the authenticity is to establish the identification of the sender and the recipient; the authority of the sender and the recipient to make the relevant decisions constituting the subject of the electronic communication; and recognition by a party of the authenticity of the electronic communication content.

The second way to verify the authenticity of electronic evidence is to notarially record the evidence. The notary is able to inspect text and multimedia messages; he can set the phone number to which the message was sent, the name of the subscriber in the recipient's phone, the date and time of receipt of the message, its content.

The possibility to turn to the services of specialists and experts, if it requires special knowledge in the field of information technology, is the third way to establish the reliability of evidence. A specialist or expert, as a person with specialized knowledge in programming and information technology, may answer questions, such as whether an electronic document have been modified or not, and other questions where

their usual perception is not sufficient. If necessary, the court has the right to request a forensic investigation in accordance with the current norms of the Civil Procedural Code of the Russian Federation.

In our opinion, the greatest use of electronic documents can be in civil cases under simplified and ordered procedures using computer programs called "electronic judge". There are no objections from the debtor in these procedures of civil proceedings, there is an indisputable right of claim, actual recognition, but the defendant's failure to comply with the amount of the debt, and so on. Therefore, the courts can freely examine the electronic evidence submitted by the applicant with the use of necessary technical devices and issue the relevant court act in electronic form without court sessions and summons to court or the need to involve third parties. Starting from the receipt by the court of an application for the issuance of a court order or a statement of claim under the simplified procedure, signed in accordance with the established order, together with electronic documents (or) electronic images of the document, which confirm the requirements, through the SAS "Justice" and ending with the issuance of the final court act, a civil case may acquire an electronic form, unless the court has grounds for requiring the parties to confirm their signatures, original documents in paper form.

## 7. Conclusion

Functioning of such elements of e-justice as filing a lawsuit in the court in electronic form, organization of an electronic document flow system within the court and communication of the court with other public authorities, maintenance of electronic archives of court cases is impossible without using documents in electronic form, in particular electronic documents. In the activities of general jurisdiction courts in civil proceedings, documents in electronic form are currently used, which include electronic images of documents and electronic documents. Electronic document is a document created in electronic form without prior documentation on paper, signed with an electronic signature (Lapteva & Solovyanenko, 2019). In order to act as evidence in civil proceedings, an electronic document must meet the following requirements: it must be created, transmitted and stored using software and hardware; it must have details that allow it to be identified and determine the legal validity of the document; it must be presented in a form that is understandable to human perception; it must be authentic. These ways of formalizing procedural legal relations with the use of information technologies have a positive impact on the constructive interaction between entrepreneurs and government agencies, prompt access to justice for entrepreneurs, and openness of justice.

A positive aspect of the use of electronic documents in civil proceedings is the rapid search for information and documents, saving time and labor resources, openness and accessibility for all participants in the proceedings. The effectiveness of the use of electronic documents is reduced if the material and technical support of the court is low, its staff is not ready to work with information technologies, the court has difficulties in assessing the reliability of electronic documents as evidence, given the risks of forgery, not widespread availability of the Internet due to the large territorial remoteness of settlements.

The use of electronic documents in civil cases in the simplified and ordered procedure, for example with the use of computer programs with artificial intelligence elements called "electronic judge",

is relevant. When hearing civil cases under the above procedures, due to the indisputable right of the applicant to claim, the courts will be able to issue the relevant court decisions in electronic form without court sessions or summons of the parties.

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