ALTERNATIVE POWERSOURCES USED IN RUSSIA

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ABSTRACT

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ABSTRACT

The main goals of the thesis were to analyse the real situation of power sources in Russia and to estimate what was already being used in the country. Another goal was to discuss their efficiency. The thesis includes the whole spectrum of knowledge and research that helps understand the real situation with alternative power sources in Russia, such as, ideas about energy nowadays and in the future, analysis of world energy issues, necessity of using alternative power sources, general information about alternative power sources as well as their impact on the environment, examples of using of alternative power sources in Russia.

The constant growth of tariffs has led to the fact that autonomous energy is developing at a faster rate in the country. Energy consumers are trying to create their own sources of electricity and heat which leads to a decrease in fuel efficiency compared to the combined production of electricity and heat at thermoelectric plants and a decrease in the efficiency of the country's entire energy sector.

The thesis was conducted through detailed research of academic literature and interviewing giants of Russian energy business field. The results of interviews were reviewed and sorted according to their relevancy.

The research showed that the surplus of hydrocarbons deprives Russian enterprises of the incentive to reduce emissions, as they do not receive economic benefits from investing in new renewable energy sources.

Keywords Alternative power sources, Russia, Climate change, Emissions

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1 INTRODUCTION

1.1 Types of alternative energy

Limited stocks of fossil fuels and environmental pollution throughout the world have forced humanity to explore alternative renewable energy sources (alternattiveenergy.com 2018).

The development of life on the planet proves the provision of the Earth with various sources of energy. The animal and plant world develops continuously and they have got enough energy from the planet. The heat of the bowels, sunlight and chemical potential make it possible for living organisms to perform cyclic energy exchanges, surviving in an environment created by physical factors - pressure, temperature, chemical composition, humidity (alternattiveenergy.com 2018).

Man has long been using wind energy for the movement of ships. Renewable fuel from overgrown plants and waste products were used as a source of thermal energy for cooking. The energy of falling was used to make mills spin, for the same purpose, wind was used in mills.

- Wind power;
- Biological gas;
- Sunlight;
- Temperature difference (infoelectric.ru 2015).

These alternative energy sources have got ready-made technological solutions implemented into mass production. For example, biogas plants, wind generators, solar panels and heat pumps of various capacities can be ordered for installation in a private house or a small farm (alternattiveenergy.com 2018).

In addition to these energy sources, there is a number of other alternative energy sources that can be used either in a specific locality or elsewhere. Many of them are studied by scientists, many have already been thoroughly studied, there are also those that are just being discovered (alternattiveenergy.com 2018).

1.2 Using energy

Traditional energy based on organic fuels causes significant damage to the environment and in the long term can lead to undesirable global climate changes (Ecoteco 2011).

The concept of sustainable development of all mankind signed at the UN Conference in Rio de Janeiro (1992) also affects energy. Humanity can not continue developing in the same way which is characterized by irrational use of natural resources and growing negative impact on the environment. If we do not revise the attitude to the use of natural resources, then an ecological catastrophe on a global scale will become inevitable (Ecoteco 2011).

In the world there is not yet a sharp shortage of energy resources. However, serious difficulties will begin in the next few decades if alternative energy sources are not actively used or the growth of energy consumption is limited. The need for rational energy expenditure is clear. There are some developments to increase the efficiency of transportation and storage of energy as well as recommendations for its efficient use in a wide range of industries in everyday life and in transport (Ecoteco 2011).

Concerning the accumulation of energy, the load of power plants is variable in time of day; its seasonal fluctuations also take place. The efficiency of power plants can be increased if the excess capacity is used to pump water into a large reservoir during the hours of the failure of energy load schedules. Then it is possible to discharge water during periods of peak load by causing it to generate additional electricity at the power storage station (Biga 2010).

As to the transmission of electricity, long distances lead to energy loss. Transmission lines and distribution networks with a high voltage level are used to reduce it. An alternative direction is the use of superconductors for energy transfer (Biga 2010).

The constant growth of energy consumption not only leads to depletion of energy resources and pollution of the habitat but also can cause significant climate changes (Biga 2010).

1.3 **Energy in the future**

The resources of the planet used today will end in the nearest future, their further extraction and use can lead not only to energy but also to an ecological catastrophe. Traditionally used resources, such as, coal, gas and oil will end in several years. That’s why it is necessary to find ways of producing alternative energy and to switch to renewable resources, such as, wind, solar energy, geothermal energy, tidal energy and others. Moreover, it is vital to continue developing energy-saving technologies at the same time (FB 2017).

The energy problem will sooner or later overtake every state on the planet. The reserves of the Earth's interior are finite; therefore, planning of the future is the main task of research organizations. At the moment, mankind

has not come up with an alternative to the basic resources needed to conduct life (FB 2017).

The main goals of using natural resources are: heating of housing; transportation of goods; use in industry. All these applications led to the creation of energy problem, which formed after the rapid growth of consumption of natural resources associated with the active development of the motor transport industry. The development of the fuel industry has led to a deterioration in the ecology of the planet, which in turn led to the emergence of a new problem: how to preserve animal life and vegetation. The energy problem is considered not only from the point of view of extraction and reserves of natural resources but in terms of the side effects from fuel production (FB 2017).

Solving the energy problem will help to improve the situation in several sectors at once which is relevant for all segments of the population. All ways of exiting the fuel crisis are long and are calculated for hundreds of years. Mankind is awakening to the need for cardinal actions in the direction of replacing traditional methods of extracting energy with eco-friendly and more useful ones (FB 2017).

The energy crisis is partially solved by saving measures. It is economically estimated that the unit of fuel saved is cheaper by one third than extraction of the same amount from the bowels of the Earth. Therefore, every regime of our planet has a regime of justified energy saving, and scientists are constantly searching for more affordable and cost-effective ways of generating energy. These include electric vehicles, solar panels, batteries made of waste. The most interesting economy ideas and inventions have already received approval from the inhabitants of the countries of Germany, Switzerland, France, Great Britain. The problem of a lack of resources was solved by replacing the processing of fossils with environmentally friendly energy converters (FB 2017).

The task of research institutes on the way of solving the energy shortage in certain regions is to search for a variant of the development of technologies needed to manage the imbalance of resources. So, in the desert it is better to develop the extraction of electricity from the sun's rays and in the rainy tropics it better to use hydroelectric power stations. First of all, it is necessary to replace the use of primary resources, such as, oil and coal to preserve economic and environmental indicators at the proper level. Natural gas and other alternative sources of energy are more profitable for the society. Most converters of clean energy require enormous material costs for their implementation in everyday life (FB 2017).

1.4 **Aims and issues of the study**

It is believed that Russia is a country of contrasts. There are many regions in the country and all of them differ from each other by many things. One of them is the usage of power sources.

The main goals of the thesis are to analyse the real situation with power sources in Russia and estimate what is already being used in the country, along with how effective these resources are.

Generally speaking, the knowledge base needed can be found in public libraries in St. Petersburg, on the Internet and from reports of several public companies operating in the country. However, the aim is to also interview workers from Russian companies working with electricity and other power sources.

This thesis strives to answer the following questions:
Is Russia following the worldwide trend to use alternative power sources as much as possible?
Is Russia trying to manage the power sources wisely?
What is already used in the country regarding alternative power sources?

The objectives of research activities in the thesis include carrying out a full review of the problem and assess the possible efficiency of using alternative energy sources in Russia today.

2 **WORLD ENERGY ISSUES**

2.1 **Energy balance of the planet**

Nowadays in the structure of the fuel and energy balance of the planet, the share of oil is among the primary energy carriers. The share of coal 50 years ago strongly decreased but then it has stabilized and now it makes about a quarter of all used fuel. The share of the use of natural gas, nuclear energy and alternative sources has grown (SZEMP 2014).

Generally speaking, 62% of the world's electricity is produced at thermal power plants, 19% at hydroelectric power plants and about 17% at nuclear power plants. The share of perspective power plants (tidal, geothermal, solar and wind) accounts for about 1% of all electricity produced. Figure 1 below shows the rate of consumption of primary energy worldwide (SZEMP 2014).

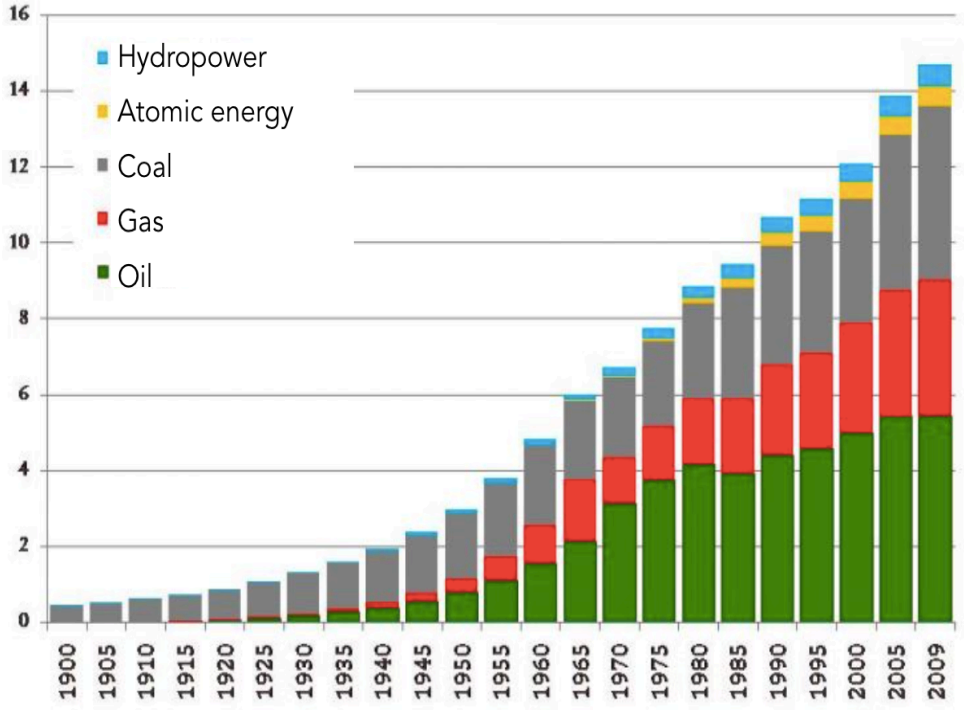

Figure 1. Consumption of primary energy in the world in the twentieth century (billion TOE) (KtoVkurse 2018)

In different countries, the structure of energy varies widely. For example, in Russia, the United States, Germany, Japan, Ukraine, Poland, China and South Africa, the majority of electricity is generated by thermal power plants; nuclear power plants dominate in Belgium, Lithuania (83%), Sweden, France and South Korea; the main power generation is carried out at hydroelectric power stations in Canada, Brazil, Norway, Switzerland, Tajikistan (SZEMP 2014).

2.2 **Energy balance of several countries**

Nowadays, the technological structures are changing in the world energy sector not only in the production of fuel but also in the consumption of its species which affects the structure of the markets of different countries and their quantitative indicators (BurNeft 2016).

The growth of energy consumption was hampered by the development of new technologies. Thus, the EU countries continued implementing the plan to achieve the share of renewable energy sources to 20% in the energy balance in the nearest future (BurNeft 2016).

We consider the depressive state in which the world energy industry is located under the influence of differently directed and diverse factors, some of which are of a political nature (BurNeft 2016).

The destabilizing effect on world energy including trade in various energy sources was exerted by Russia's policy of restraint initiated by the US and

supported by some Western countries. This restrictive policy embraced the economic, political, sporting, financial spheres which led to the disruption of many established commodity flows, the adjustment of plans for the development of the Russian oil and gas industry and the timing of the implementation of promising projects in the field of transportation of raw materials (BurNeft 2016).

The structure of the national energy balance of any country depends on many factors, including the availability of its own resources, features of the economy and so on. As a rule, more than 30% of primary energy is spent on transportation (36% in the USA, 43% in Japan, and 37% in the EU) in the countries with a high level of motorization of the population. The industry and housing fund consumes about 20% - 30% of energy (Matveev&Ivanov 2016, 26).

The states that produce gas are trying to apply this more environmentally friendly fuel in comparison with coal and oil. In 2014 in the structure of the country's energy balance gas accounted for (%): Argentina -49, Russia-54, Azerbaijan-63, Algeria-65, Turkmenistan-80, and Uzbekistan-86 (Matveev&Ivanov 2016, 26).

Countries producing coal use it to cover their energy needs. Coal accounts for about 66% in the consumable part of China's energy balance; this figure is estimated at 71% in South Africa, India 56%, Australia 36%, Kazakhstan 64%, Indonesia 35% (Matveev&Ivanov 2016, 26).

The United States took the first place in the world for oil production In early 2015 (Matveev&Ivanov 2016, 26).

The main role belongs to the energy of water in the energy of several countries. In 2014 large hydroelectric power plants accounted for: in Norway - 66% of the total energy consumption, Sweden and Brazil - 28, Colombia and Canada - 268 (Matveev&Ivanov 2016, 26).

Electricity generation at nuclear power plants began to increase. This is due to the development of new technologies and an increase in the safety level of nuclear reactors.

The following countries had the leading positions in nuclear power in 2014: the USA - 104 operating reactors, France - 58 and Russia - 33 (Matveev&Ivanov 2016, 26).

Nuclear power remains the backbone of the energy complex of Bulgaria (20% of total energy consumption), Finland (21%), Switzerland (22%), Sweden (29%), France (more than 40%). Currently, more than 70 nuclear power units are being designed and built in 15 countries (Matveev&Ivanov 2016, 26).

Renewable alternative energy still requiring state support is actively developing in America (about 20% of global output based on renewable energy sources), Germany (10%) and China (17%) (Matveev&Ivanov 2016, 26).

Three states stand apart in terms of production and consumption of primary resources in the world: the United States, China and Russia whose total contribution to world production in 2014 is estimated at 44.6%, consumption at 46%. The structures of the state energy balances of these participants in the global planetary energy market have significant differences depending on the characteristics of domestic consumption and primary energy production, directions and rates of social and economic development. All these states with the exception of Russia are now net importers of energy resources (Matveev&Ivanov 2016, 27).

China is characterized by the most stable and high rates of economic development while its primary energy production does not keep up with consumption growing at a faster pace which forces the state to expand energy purchases in foreign markets and, therefore, to ensure world trade sales (Matveev&Ivanov 2016, 26).

The US is developing along the path of increasing the efficiency of primary energy use by reducing energy imports and developing its own production in order to reduce dependence on foreign supplies and further access to the trajectory of sustainable hydrocarbon exports (Matveev&Ivanov 2016, 26).

The countries of the European Union are trying to reduce domestic energy consumption due to the energy efficiency of energy use while most of the extracting enterprises in Europe are in a state of declining production (Matveev&Ivanov 2016, 28).

Russia is the only one of the main subjects of the planetary energy market has got a perceptible surplus in the production of energy resources over consumption (Matveev&Ivanov 2016, 28).

Russia outstripped its competitor Saudi Arabia by the total supply of energy resources for external consumers. It happened due to permanent development of the oil and gas industry (Matveev&Ivanov 2016, 28).

The global energy market has entered a deep depression which is characterized by a slowdown in key indicators (Matveev&Ivanov 2016, 28).

As for Russia, the world situation in the energy sector is a source of important risks but also a factor that stimulates the economy to move to a higher level which leads to the development of new processing technologies, the increase in non-primary exports, the development of natural and human capital (Matveev&Ivanov 2016, 28).

The consumption of primary energy is distributed unevenly across countries and regions (Matveev&Ivanov 2016, 28).

Figure 2 shows the energy consumption levels in 20 countries in 2015. It is evident that China, Russia and the United States are the main consumers of energy resources.

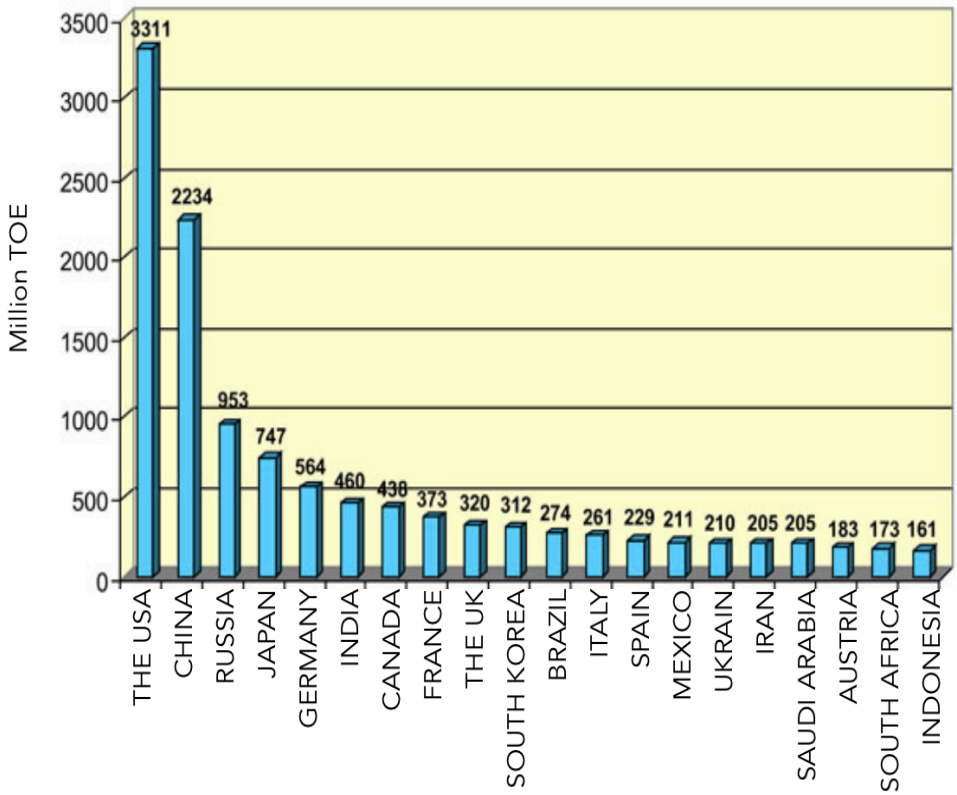

Figure 2. Consumption of primary energy in 20 countries - the largest consumers in 2015 (million TOE) (Chernova&Shmulevich 2014, 20)

2.3 **The Russian energy balance in the global balance**

The distribution of primary energy resources produced in Russia is characterized by a large share of exports of organic fuel (44%) and high fuel costs for heating (25%) (Chernova&Shmulevich 2014, 23).

According to scientists of the Russian Academy of Sciences, natural gas in Russia is used ineffectively. Steam turbines are used to generate electricity in outdated heat sources operated on gas. Their efficiency of converting the energy of burning gas into electricity is low (32-40%). The use of combined-cycle plants with an efficiency of 50-58% could improve the situation in this area. The replacement of purely steam cycles with combined-cycle plants would give an opportunity to save gas use in

thermal power plants by 30-40% or significantly increase their capacity (Chernova&Shmulevich 2014, 23).

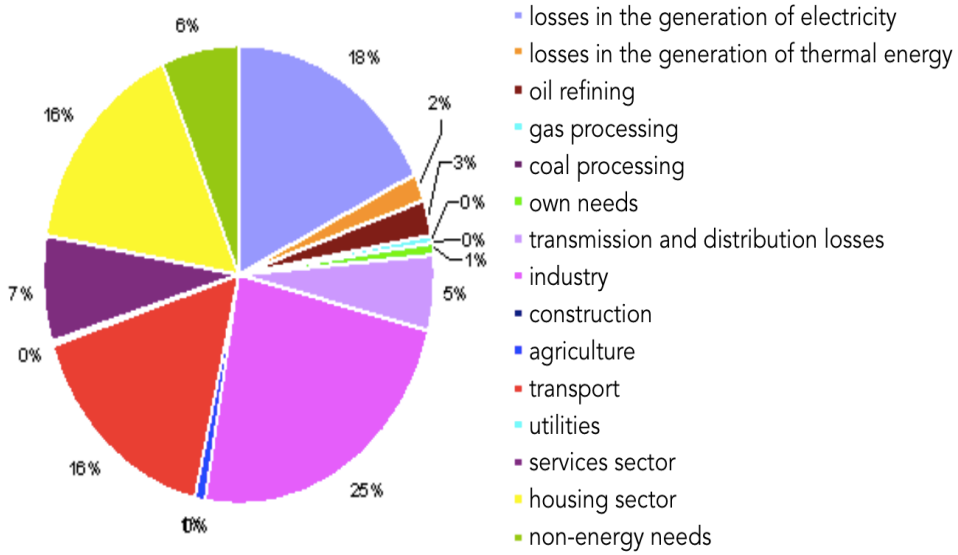

Figure 3. Structure of Primary Energy Consumption in Russia in 2010 (Bashmakov 2010)

Gas accounts for 46% in the sphere of energy production in Russia.
This situation leads to a wasteful consumption of natural gas which is a very valuable raw material used in the production of competitive products. The explored oil reserves together with the previously estimated and forecasted resources significantly exceed the accumulated production (16%) (Chernova&Shmulevich 2014, 23).

Russia has not discovered large oil fields in the past 20 years. However, the increase of the explored ones with small deposits does not change the situation in this field. It is necessary to carry out more intensive searches for geophysical and geological works (Chernova&Shmulevich 2014, 23).

The most promising are offshore areas in the Arctic zones of Russia.
Known uranium reserves are not the main factor of its accelerated development in conditions of technological development of nuclear energy in Russia. The confirmed reserves of uranium and its forecast resources are sufficient for the development of Russia's nuclear power industry if safer technologies are applied in this area (Chernova&Shmulevich 2014, 25).

The development of just hydrocarbon energy in Russia cannot solve the energy deficit problem. The alternative to traditional energy will be only nuclear power for the next decades (Chernova&Shmulevich 2014, 25).

The solution of the global energy problem is associated with the possibility of the transition to the closed cycle of fuel by the middle of the 21 century. Many countries are going to increase the capacity of nuclear power by moving to a closed fuel cycle (Larichev 2011).

The technology which uses charged particle accelerators to divide the nuclei of the actinide group is more elaborate. The technology is called nuclear-relativistic. Neutrons of a wide spectrum are used there. The advantage of nuclear-relativistic technology is that after the construction of the main reactor it is possible to start replicating them. All countries are developing this area (Larichev 2011).

Russia recently has taken a course on energy conservation in all sectors - a transition to non-waste production. This initiative is enshrined in legislation (Grigoriev&Salihov 2007).

The large uneven distribution of production and reserves of fuel and energy resources on Earth are determined by the features of the history of the development of the planet and are not connected with the changing borders of different countries (Grigoriev&Salihov 2007).

Russia plays an important role in providing a balance of supply and demand in natural gas and oil markets. It acts as one of the guarantors of overall peace stability and energy security in the long term. This situation determines the country's dependence on the development of demand and prices in world energy markets. Although Russia is not responsible for world balance sheets but it is objectively called upon in the world energy sector to play a balancing role (Grigoriev&Salihov 2007).

3 NECESSITY OF USING ALTERNATIVE POWER SOURCES

The leaders of most countries have long realized the need to use alternative energy sources. They allow to save oil and gas reserves which according to scientists will remain on the planet for 50-60 years. Every year the amount of consumed resources is growing, this trend can create serious difficulties for humanity in the near future (Mehtiev 2015, 15).

In most countries of the European Union, at present the share of alternative energy sources is more than 20-50% of the total amount of consumed resources. Every year this percentage increases, due to new developments and their implementation in practice (Mehtiev 2015, 15).

Unlike in western countries, the state of Russia's alternative energy sector is at an embryonic level, currently the country mainly uses gas and oil, which account for 99.4% of the total consumption structure. It is not

difficult to calculate that the share of alternative energy accounts for only 0.6% (Mehtiev 2015, 15).

Now in Russia there are such alternative sources as wind, Earth, the Sun, wave energy and biomass, but the amount of energy produced by such methods is incredibly small (Mehtiev 2015, 15).

Alternative sources of electricity are the future of all mankind. The planet is gradually exhausting its resources; therefore, in a couple of centuries it will be necessary to abandon the now usual methods of extracting electricity. In the cities of Ukraine, the number of working capital is increasing, both the increase and the cities themselves (Mehtiev 2015, 15).

Issues of ecology and energy security are increasingly affecting our lives. Increasing pollution of the environment, violation of the thermal balance of the atmosphere gradually leads to a global climate change (RefDB 2011).

Energy scarcity and limited fuel resources encourage a full-scale view of the transition to non-traditional, alternative energy sources. These sources are ecological, renewable, the basis of their energy forces of the Sun and the Earth. In addition, renewable energy resources are distributed relatively evenly, so leadership in their use is likely to be won by countries with a skilled workforce, a receptivity to innovation, a ray of structure and strategic foresight (RefDB 2011).

The relevance and importance of a rapid transition to alternative energy sources can be solved in several ways:

– political: the state, which at first will completely switch to alternative energy, can claim the world championship;

– global-ecological: the fact of harmful influence on the achievement of the environment has been proved, its application inevitably leads to a catastrophic change that has already begun;

– Economic: the transition to alternative energy sources allows preserving the country's fuel resources for use in the chemical and other industries. The cost of energy produced by alternative sources, most often, is less than the cost of energy from the relevant sources;

– social: density and population are constantly increasing. Well-known facts that can be used in the energy complex, nuclear power plants, large GRES (the term refers to a condenser type electricity-only thermail power station which still exist in Russia and the other former Soviet republics), well-known harm caused by giant flat hydropower plants. All these factors increase social tension.

– evolutionary-historical: in connection with the limited fuel resources on the Earth, as well as the rapid growth of catastrophic changes in the atmosphere and the biosphere of the planet, the existing traditional energy, the impasse; for the evolutionary development of society, it is necessary immediately to begin a gradual transition to alternative energy sources (RefDB 2011).

Quite a widespread view of the high cost of renewable energy equipment remains a stigma. At present, the cost of equipment for the implementation of traditional technologies and alternative technologies has been equalized. As a result of the fact that with the tightening of requirements for environmental protection, the unit cost of the stations of electrical networks (especially nuclear ones and coal) is constantly increasing, while the unit cost of renewable energy equipment is continuously decreasing (RefDB 2011).

Prospects for the future can be formulated in the following statements:

1. The development of the use of energy sources has taken an accelerated course, especially wind energy and solar energy are developing at a rapid pace. Wind power in some cases has transformed into an independent branch of the electric power industry (RefDB 2011).

2. The development of renewable energy in the world is caused by the following main advantages of RES:

a) the inexhaustibility of renewable energy sources, in contrast to the fineness of the stocks of fossil fuels;

b) the ecological purity of renewable energy sources, with the use of appropriate technologies:
- in geothermal energy - this is the reverse injection of the spent steam-water mixture;
- in small hydropower - the creation of hydraulic structures that do not interfere with the fish farm and do not lead to a significant flooding of fertile land;
- in photovoltaics - the use of chlorine free technologies for obtaining silicon "solar quality";
- in wind energy - registration of migration routes for birds when selecting sites for wind farms and location of wind turbines at the required distance from housing;

c) the undeniable advantage of RES - the absence of greenhouse gas emissions (RefDB 2011).

3. An essential drawback of only two types of renewable energy sources - the energy of the sun and wind energy is their unpredictable nature and, therefore, the need for energy storage. Power plants based on other types

of renewable energy sources (geothermal energy, biomass, hydro) are without these drawbacks (RefDB 2011).

4. Various countries are striving to develop renewable energy at the state level: large and small, rich and poor, developing and industrialized, agrarian and industrial, southern and northern. Hence, the decisive is the desire of all states without exception to ensure their own energy security (RefDB 2011).

5. World experience in the development of renewable energy demonstrates the need to support renewable energy from the government: The main obstacle to the development of renewable energy sources is the low solvent demand of enterprises and the population with a huge potential demand (RefDB 2011).

4 ALTERNATIVE POWER SOURCES

Alternative energy is a combination of different ways of obtaining energy that are of interest because of the economic profitability of their use at a low risk of harm to the environment.

An alternative source of energy is a method, device or structure that allows the generation of electrical energy (or another required type of energy) and replaces traditional energy sources operating on oil, natural gas and coal.

Types of alternative energy include: wind power, solar energy, wave energy, tidal energy, biomass energy, gradient-temperature energy and geothermal energy.

4.1 Solar energy

The use of solar energy to generate electricity is done by thermodynamic and photoelectric methods. Figure 4 shows an example of the typical elements comprising a solar power plant.

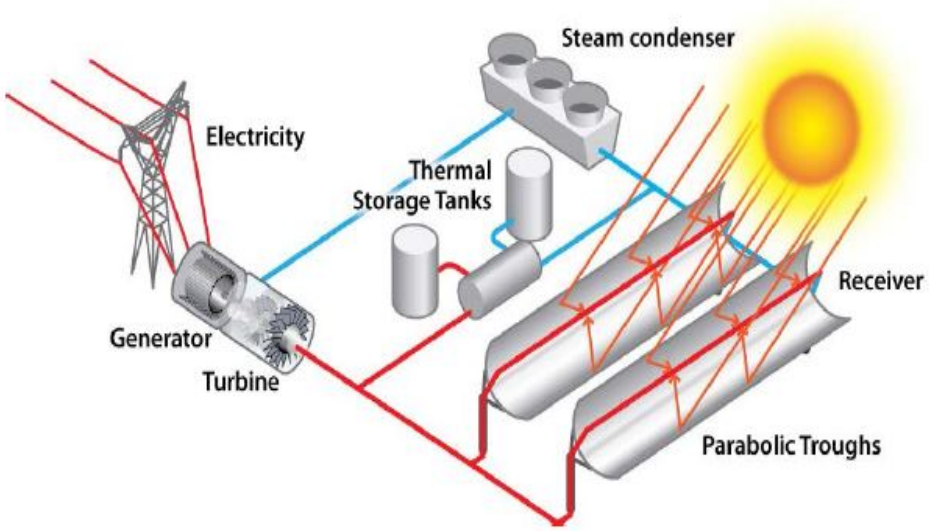

Figure 4. The production of solar power (Energy.org n.d.)

Figure 5 shows an example of how photoelectric converters can be used to direct convert the energy of light quanta into electric power.

Figure 5. Solar panels (Nikolaevka 2016)

Thermodynamic installations convert the energy of the sun first into thermal energy, then into mechanical energy and then into electrical energy. Such installations include a "solar boiler", a turbine and an electric

generator. But the solar energy that enters the Earth has a number of characteristic features: low energy flux density, seasonal and diurnal unevenness, great dependence on weather conditions (Andrianov 2012).

For instance, line-focusing systems, such as the parabolic trough collector and linear Fresnel collector track the sun position in one dimension. Point-focusing systems, such as solar towers or solar dishes, provide higher energy concentration ratios then line-focusing systems, as their mirrors track the sun position in two dimensions. Figure 6 serves as an indication of how such systems could be installed into a village house (Andrianov 2012).

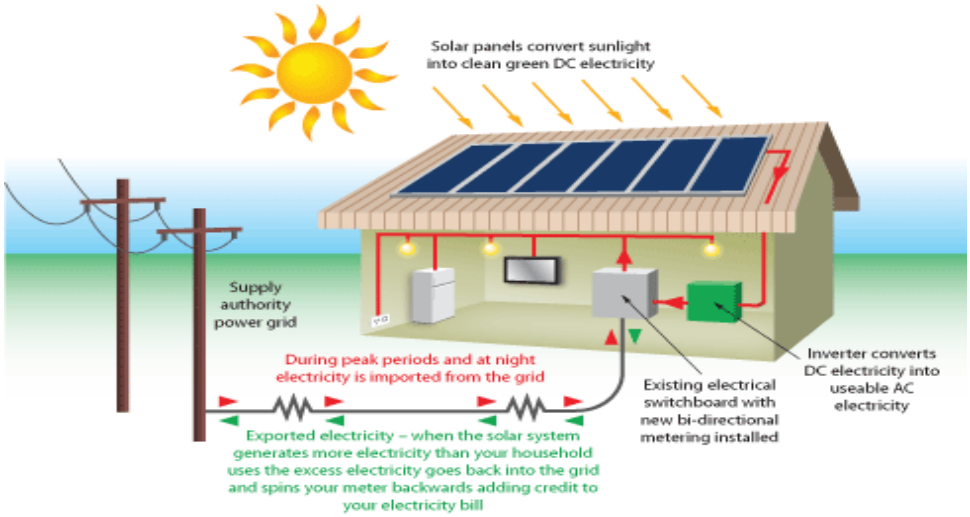

Figure 6. Depiction of main components in a village house (EPA 2015)

That's why fluctuations in thermal conditions lead to serious limitations on the operation of the system. A system using the Sun as an energy source should have an accumulating capacity to exclude various fluctuations in operating conditions or to ensure the desired change in energy production over time. It is necessary to correctly evaluate the meteorological factors and their variation over time when designing solar power stations (Andrianov 2012).

4.2 **Wind energy**

Wind energy industry specializes in the use of the kinetic energy of air masses in the atmosphere. A wind power plant is an installation that converts the kinetic energy of the wind into electrical energy. It consists of a wind turbine, an electric current generator, an automatic control device for wind turbine operation, a generator and facilities for their installation and maintenance (EcoKnowledge 2018). Figure 7 depicts how the size of wind turbines increased over the last few decades.

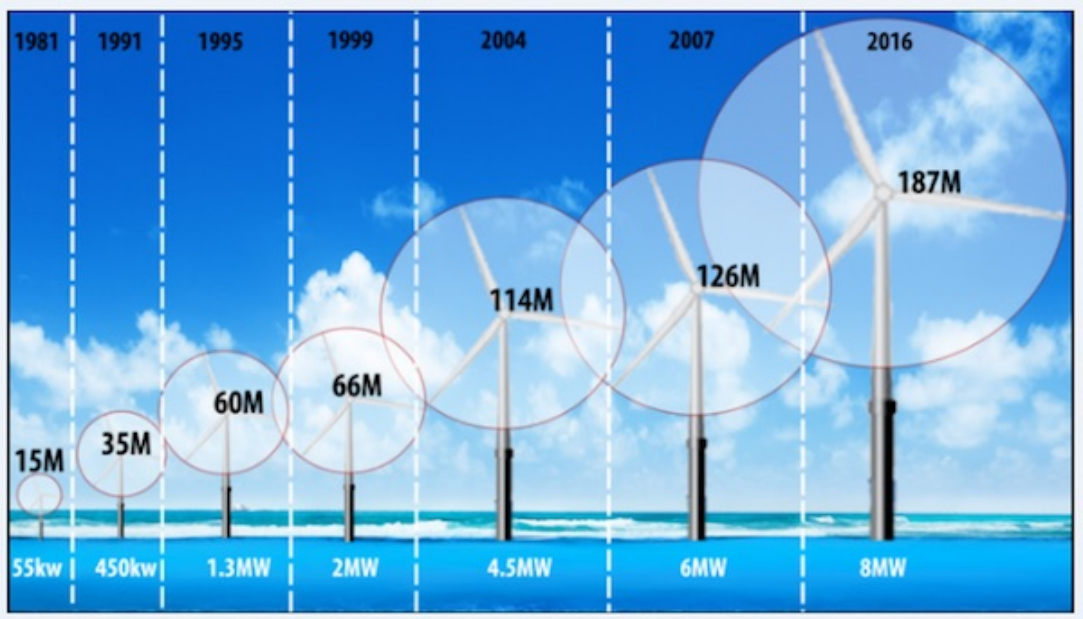

Figure 7. Size evolution of wind turbines over time (TAE 2018)

Some of the different designs used to obtain wind energy are multiblade "daisies", screws like airplane propellers, vertical rotors, etc (EcoKnowledge 2018).

The production of wind power stations is very cheap but their power is low and their work depends on the weather. In addition, they are very noisy; therefore, large wind farms have to be turned off at night. In addition, wind farms create interference for air traffic and for radio waves. In addition, huge areas are needed for the use of wind power stations, much more than for other types of electric generators. Figure 8 depicts the cross-section of an average wind turbine (EcoKnowledge 2018).

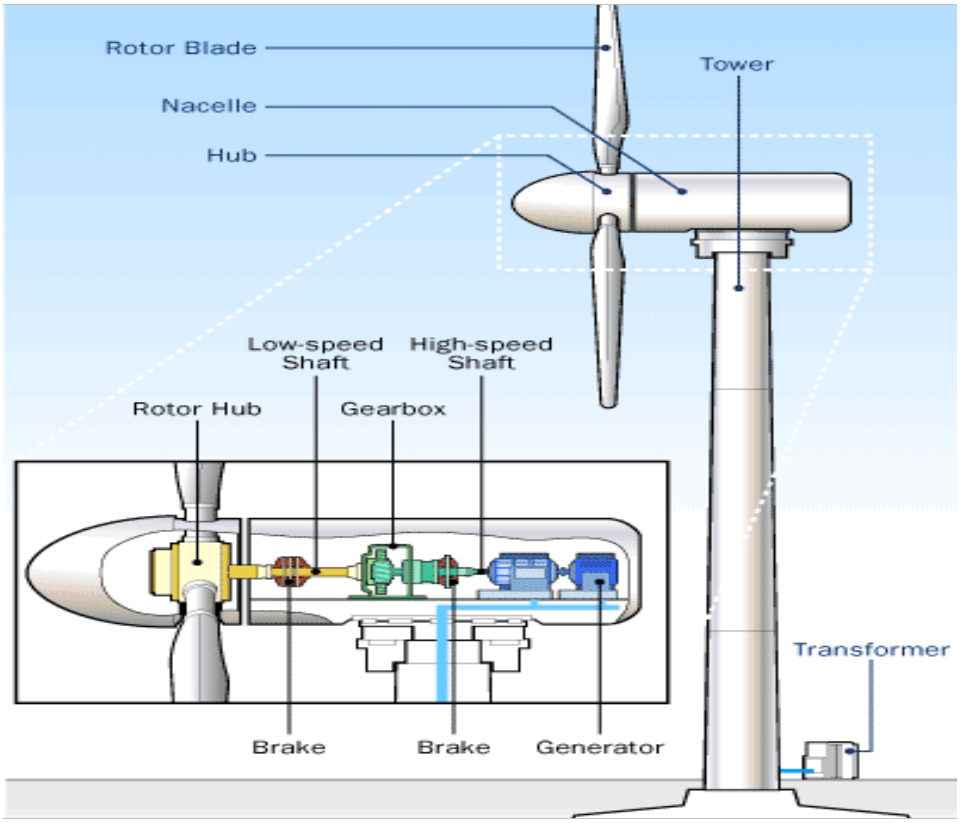

Figure 8. Main components of a windmill (LearnForSustainability n.d.)

Speaking of offshore wind farms, they a have much bigger capacity then onshore ones and not so big harm of noise since they are located quite far from land. Anyway, the maintenance of offshore wind farms is much more expensive than for onshore installations (EcoKnowledge 2018).

To some extent, offshore wind farms have very low global warming potential per unit of electricity generated, compared to onshore wind farms. While the offshore wind industry has grown dramatically over the last several decades, there is still a great deal of uncertainty associated with how the construction and operation of these wind farms affect marine animals and the marine environment (EcoKnowledge 2018).

4.3 **Geothermal energy**

Speaking of the origin of the energy of hot steam-water sources, stream has been around much longer than humans. Since water occurs naturally, so does stream. It is mostly the result of geothermal activity. Geothermal energy comes from places on Earth called hot spots. These places where magma rises from Earth's interior are just what they sound like – places where there is a lot of underground heat. Sometimes, geysers will form

these hot spots, which are springs that let out steam and hot water (EcoKnowledge 2018).

Geothermal energy is a way of generating electricity by converting the internal heat of the Earth (the energy of hot steam-water sources) into electrical energy (EcoKnowledge 2018).

This method of generating electricity is based on the fact that the temperature of rocks increases with depth and exceeds 100 ° C at a level of 2-3 km from the surface of the Earth. There are several schemes for generating electricity at a geothermal power plant (EcoKnowledge 2018).

A direct scheme: natural steam is directed through pipes to turbines connected to electric generators. An indirect scheme: the steam is pre-cleaned (before it enters the turbines) from the gases causing the destruction of the pipes. A mixed scheme: crude steam enters turbines and then gases that are not dissolved in water are removed from the water formed as a result of condensation. Figure 9 gives an example of how geothermal power generators work (EcoKnowledge 2018).

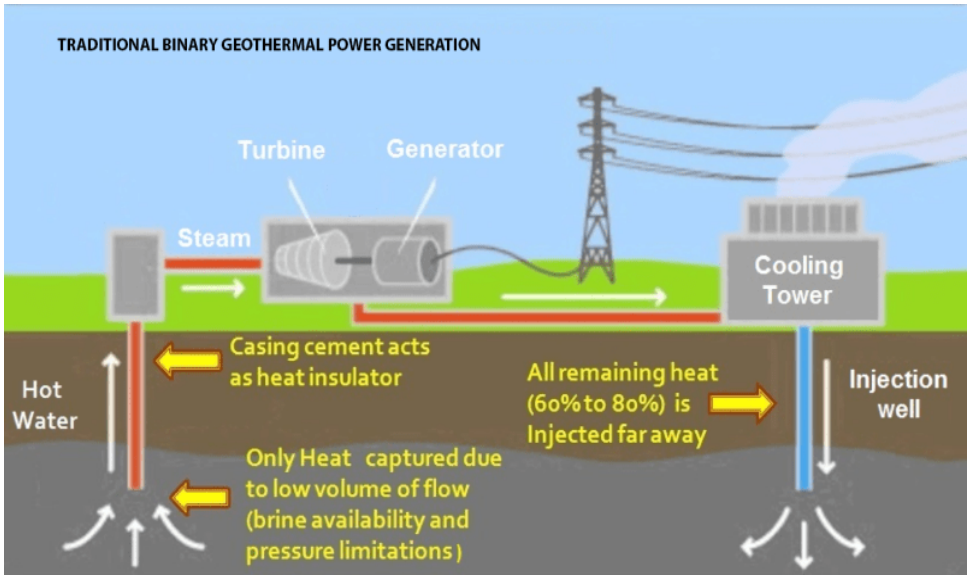

Figure 9. Structure of a traditional binary geothermal power generation (USEPA 2014)

The cost of the "fuel" of such a power plant is determined by the costs of producing wells and a steam collection system and is relatively low. The cost of the power plant itself is small since it does not have a furnace, a boiler plant nor a chimney (EcoKnowledge 2018).

The disadvantages of geothermal electrical installations include the possibility of local subsidence of soils and the awakening of seismic activity. Moreover, gases emanating from the ground can contain poisonous substances. In addition, certain geological conditions are

necessary for the construction of a geothermal power plant (EcoKnowledge 2018).

4.4 **Biogas**

Biogas is extracted with a high content of methane when decaying biomass (dead organisms, manure, plants) which is used for heating, power generation, etc. There are enterprises (pig farms and cowsheds, etc.) which provide themselves with electricity and heat due to the fact that they have several large "vats" where large quantities of manure are dumped from animals. Manure decays and the released gas goes to the needs of the farm in these sealed tanks. Another advantage of this type of energy is that the manure remains a dry residue that is an excellent fertilizer for the field as a result of using wet manure to generate energy. Furthermore, fast growing algae and some types of organic waste (stalks of corn, reeds, etc.) can be used as biofuel (EcoKnowledge 2018).

4.5 **Water energy**

Hydro power plants are another source of energy that claims environmental cleanliness. Large and mountainous rivers of the world attracted attention at the beginning of the 20th century. Most of them were blocked by cascades of dams by giving fabulously cheap energy at the end of the century (EcoKnowledge 2018).

However, it led to a huge damage to agriculture and nature in general: the land above the dams was flooded, below - the groundwater level fell, huge ground areas lost to the bottom of the giant reservoirs, the natural flow of rivers was interrupted, water in the reservoirs decayed, fish stocks fell and so on. All these minuses were minimized on mountain rivers but one more bad thing appeared: the catastrophe could lead to thousands of human casualties in the event of an earthquake capable of damming the dam (EcoKnowledge 2018).

Centrifugal and propeller power units of hose portable hydroelectric power stations with a power from 0.15 to 30 kW were developed in detail. The most used turbine types are Francis, Kaplan and Pelton (EcoKnowledge 2018).

Another very promising development (not widely used yet) is Gorlov's newly created helicoidal turbine (named after its creator). Its feature is that it does not need a strong head. It effectively works by using the kinetic energy of the water flow of rivers, ocean currents or sea tides. This invention changed the usual view of the hydroelectric power station, the power that previously depended on the strength of the water pressure (the height of the hydroelectric dam) (EcoKnowledge 2018).

4.6 **Wave energy**

A method of obtaining electrical energy by converting the potential energy of waves into kinetic energy of pulsations and shaping pulsations into a unidirectional force that rotates the shaft of an electric generator (oscillating water column devices, overtopping devices etc.) (EcoKnowledge 2018).

Tidal energy is a renewable source of energy like other types of alternative energy. Power plants of this type use tidal energy to generate electricity. A pool (a bay overlapped with a dam or a river mouth) is needed for the device of the simplest tidal power plant. Culverts and hydraulic turbines are installed in the dam. They rotate the generator (EcoKnowledge 2018).

Water enters the pool during high tide. The gates of the culverts are closed when the water levels in the pool and the sea equalize. The water level in the sea decreases with the onset of ebb. The turbines and the associated electric generators begin to work and the water from the pool gradually disappears when the head becomes sufficient (EcoKnowledge 2018).

The construction of tidal power stations in regions with tidal sea level fluctuations of at least 4 m is considered economically feasible. The design capacity of a tidal power plant depends on the nature of the tide in the station construction area, the volume and area of the tidal basin, and the number of turbines installed in the body of the dam (EcoKnowledge 2018).

The disadvantage of tidal power plants is that they are built on the shores of the seas and oceans. They also develop not very large capacity since there are only two tides a day. However, they are not environmentally safe. They disrupt the normal exchange of salt and fresh water and, thereby, the living conditions of marine life and fauna. They also affect the climate because they change the energy potential of sea waters, their speed and the territory of displacement (EcoKnowledge 2018).

4.7 **Ocean current energy**

The energy of ocean currents can also be applied to the generation of electricity by using submersible rotors which are driven by currents. It is estimated that power plants on the energy of tides and sea currents can jointly supply up to 100 terawatt-hours of electricity per year globally (EnergoCenter.ru 2011).

Such installations in the oceans must withstand very severe conditions with underwater currents and waves that are much stronger than, for example, wind turbines. Their long-term strength testing is required for this reason (EnergoCenter.ru 2011).

4.8 Energy from the temperature difference

A field of energy that uses temperature differences, is not too widespread. It is possible to produce a sufficiently large amount of electricity at a moderate production cost with its help (EcoKnowledge 2018).

Most gradient-temperature power plants are located on the seacoast and use sea water for work. The oceans absorb nearly 70% of the solar energy incident on Earth. The temperature difference between cold waters at a depth of several hundred meters and warm waters on the ocean surface is a huge source of energy estimated at 20-40 thousand TW, of which only 4 TW can be used (EcoKnowledge 2018).

At the same time, marine heat stations built on the difference in temperatures of sea water contribute to the release of a large amount of carbon dioxide by heating and lowering the pressure of deep waters and cooling of surface waters. These processes cannot help affecting the climate, flora and fauna of the region (EcoKnowledge 2018).

4.9 Energy obtained from the difference in salt content in fresh and sea water

An osmotic power plant is a completely new kind of energy generation. It uses the osmotic pressure that arises between saline and fresh water when they are pumped into a double chamber and separated by a special semipermeable membrane. The technology is still at the very beginning of its development (EnergoCenter.ru 2011).

5 ANALYSING THE POSSIBILITY OF USING ALTERNATIVE ENERGY MEANS IN RUSSIA

5.1 Solar energy

Solar energy has a great potential but not yet fully implemented in practice. This is hampered by the lack of necessary laws allowing private producers to trade in electricity received from sunlight (Petrenko 2014).

In addition, the use of photovoltaic systems requires significant investment and the payback period is highly dependent on weather conditions. However, solar alternative energy in Russia can be a solution to the problem for remote sites. The greatest potential for solar energy is the Krasnodar, Stavropol, Magadan and Yakutia regions (Petrenko 2014).

According to statistics, nowadays there are about 10 million people without centralized electricity supply in Russia. It makes people think about the need for the development of the industry. Certain developments in this direction already exist: there are enterprises in Russia that have got

the technology of production of photovoltaic power plants and their installation in order to generate electricity (Petrenko 2014).

One of the positive examples of using solar energy is a solar power station located in the Belgorod Region (Yakovlevsky District, Krapivensky Dvory Farm) with a nominal capacity of 0.1 MW. It's location was specifically chosen according to the map of solar insolation that can be seen below in Figure 10 (Petrenko 2014).

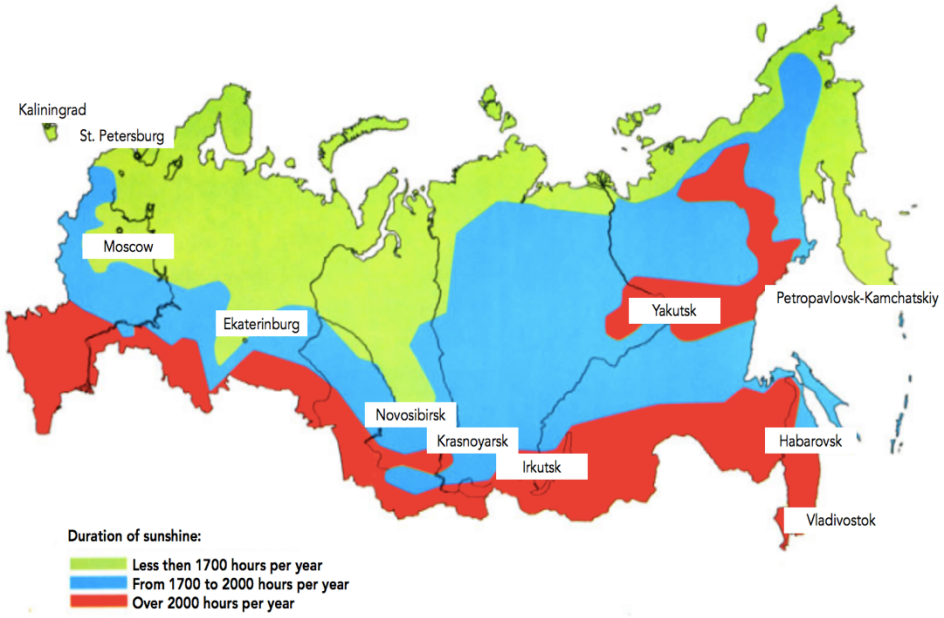

Figure 10. Map of solar insolation in Russia (EnergoCon n.d.)

5.2 Geothermal power engineering

Alternative energy in Russia can be based on the use of the thermal energy of the earth's interior: this possibility is available only in a few countries. Reserves of geothermal energy of the country are more than 10 times higher than coal reserves (Petrenko 2014).

These riches often lie literally on the surface: geothermal sources of Kamchatka with a temperature of up to 200 ° C at a depth of only 3.5 km can ensure the operation of more than one mini power plant. There are places where water comes to the surface: this greatly facilitates access to its energy (Petrenko 2014).

The geothermal power industry of Russia began its development in 1966: the first such power plant was built at that time. Today it is possible to produce about 300 MW of electricity with the help of Kamchatka sources but just 25% is actually used. The geothermal waters of the Kuril Islands have a potential of 200 MW: this is sufficient for the full provision of electricity throughout the region (Petrenko 2014).

Not only the Far East is attractive for the development of geothermal energy: The Stavropol Krai, the Caucasus, the Krasnodar region have a great potential. The temperature of groundwater reaches 125 ° C over there. A geothermal deposit was recently discovered in the Kaliningrad region which can also be used (Petrenko 2014). Other potential areas of the Russian Federation can be seen in the Figure 11.

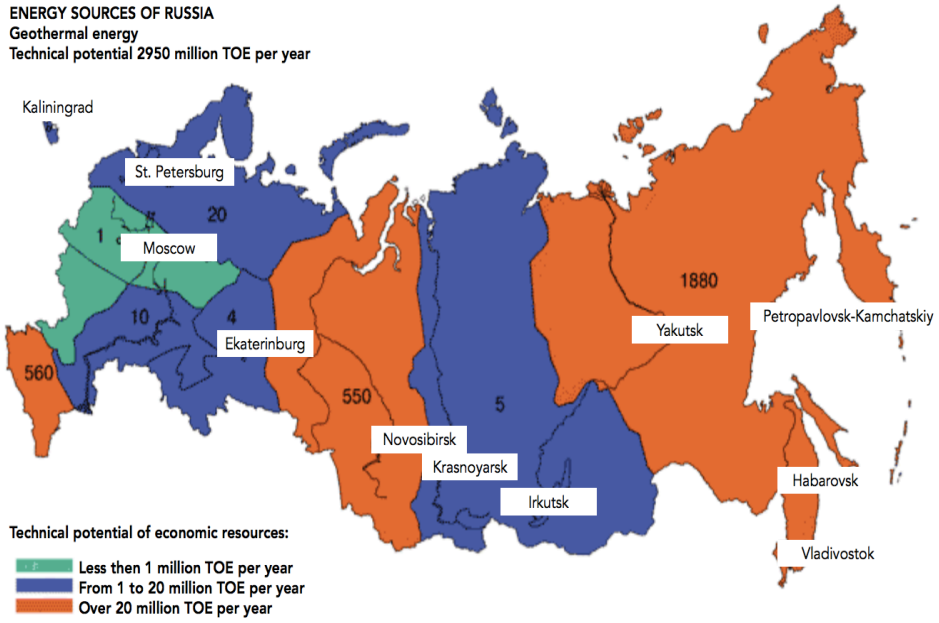

Figure 11. Technical potential of Russia in geothermal sources (Study n.d.)

5.3 **Wind energy**

The total installed capacity of Russia's wind farms is more than 75 MW. The largest of the wind power plants in Russia are located in the Crimea region that can be found in the Figure 12 include: Donuzlav wind farm, Ostaninskaya wind farm, Tarkhankut wind farm, East-Crimea wind farm; in the Kaliningrad region: Zelenograd VEU; in Chukotka: Anadyr wind farm; in the Republic of Bashkortostan: WPS Tyupkildy and the others (Alter220.ru 2017).

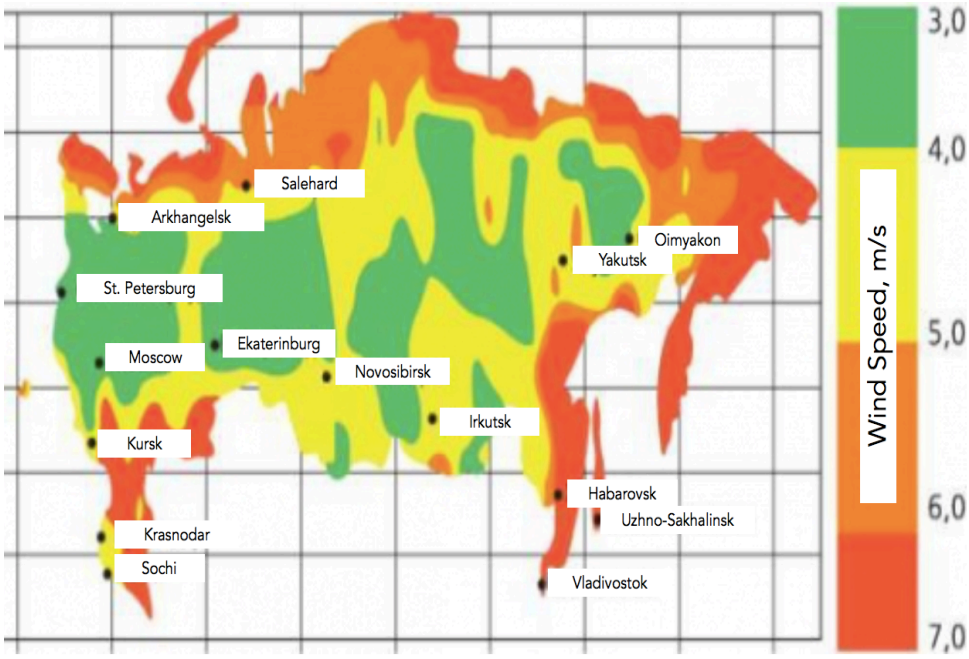

Figure 12. Distribution of wind speed in Russia (Windmap n.d.)

Preparation of initial data and development of technical documentation are in a different stage of construction. There is a number of stations that will use wind energy (Alter220.ru 2017).

The state pays attention to the development of alternative energy sources. The programs are being adopted to support and stimulate this energy sector at the federal and regional levels. There are new organizations in the country that are engaged in wind power engineering, domestic samples of wind installations of various capacities and designs are being created (Alter220.ru 2017).

There is a significant unrealized reserve in the field of wind power in Russia. Fundamental studies of wind turbine aerodynamics carried out at Central Aerohydrodynamic Institute laid the foundation of modern wind turbines with a high coefficient of wind energy use. However, the country's focus on hydropower and coal-nuclear development, ignoring innovations and environmental problems has significantly slowed the development of Russian wind energy (Alter220.ru 2017).

Today, the following scenarios for the development of wind power in Russia are possible:

– purchase and installation of foreign wind turbines;

– transfer of the western technologies and organization of production in Russia;

– cooperation with foreign companies and production of wind power in Russia;

– organization of own wind power production (their ‘know-how’ is protected by international legislation) (Alter220.ru 2017)..

The latter scenario is preferable for Russia. However, it is restrained by existing tax legislation, the monopoly of electricity producers, the lack of investment and the collapse of production (Alter220.ru 2017)..

Wind power has its drawbacks, e.g. the uneven distribution of wind blow. Because of that, the wind generator will not be able to work evenly. The current will be generated by a variable frequency, or even completely ceased. Wind turbines cause a negative impact on the environment in the form of noise and vibrations (Alter220.ru 2017)..

5.4 **Hydropower engineering**

Hydro resources are the most widely used renewable energy source in Russia compared to other types of renewable energy sources. There are almost a hundred large power plants with a total installed capacity of about 44,000 MW in Russia.
Taking everything into account, around 80,000 MW will be installed in Russia in the next 10-20 years (Duraeva 2004, 6).

About half of the hydropower resources have been developed in the European part of Russia: only a fifth in Siberia, 3.3% of the resources in the Far East. Basically, the resources are developed in densely populated areas. Volga river is the most used one (Duraeva 2004, 6).

Many Russian hydropower plants are old and their equipment is in poor condition. The hydroelectric power stations lack the means to replace obsolete equipment with the current tariff structure and ineffective centralized financing. So, it reduces the reliability of their work (Duraeva 2004, 6).

There are serious incentives for the development of medium and large hydropower projects in Russia. Large hydroelectric power stations increase the reliability of electricity supply by giving a relatively cheap, renewable, environmentally friendly source of energy (Duraeva 2004, 6).

5.5 **Geothermal power engineering in practice**

Geothermal energy is used comparatively on a small scale in Russia both directly for obtaining heat and for generating electricity. The installed capacity of geothermal power plants in Russia was estimated at 34.8 MW in January 2000:

- 12 MW at the Verkhnemetnovskaya;

- 11.3 MW at the Pauzhetskaya;
- 8 MW on the Ocean (Iturup Island);
- 2 MW on Ebeko (Paramushir Island);
- 800 kW on the Paratunskaya;
- 700 kW on the Hot Beach (Kunashir Island) (Duraeva 2004, 6).

A direct use includes heating of premises, agricultural needs (for example, greenhouses, heating of soil, breeding of fish and animals, cattle), industrial applications (for example, dressing, washing and drying of wool, paper production, oil production, etc.). Direct use of geothermal energy is widespread in the Kuriles, Kamchatka, the North Caucasus, Western Siberia, Eastern Siberia and the Baikal region (Duraeva 2004, 6).

The Russian Academy of Sciences and the Special Scientific Council on Geothermal Problems coordinate research in the field of geothermal energy (Duraeva 2004, 6).

5.6 **Biomass**

There is no exact statistics on the traditional use of biomass in rural areas for heating and hot water supply.

About 40 thermal power plants use biomass (mainly wood waste) along with the other fuels. Biomass is also used as solid fuel in some district boilers. There are about 100 plants in Russia that process biomass and agricultural waste in biogas. Household and industrial wastes are used at large incineration plants. There are two such plants in Moscow that perform many useful functions: waste disposal, energy efficiency improvement, improvement of sanitary conditions and, accordingly, health status of the population (Duraeva 2004, 6).

6 IMPACTS ON THE ENVIRONMENT OF DIFFERENT ALTERNATIVE POWER SOURCES

Energy development has an impact on various components of the natural environment: the hydrosphere, the atmosphere, the lithosphere. Nowadays, this impact acquires a global character affecting all the structural components of our planet. The introduction of new technologies (for cleaning, recycling emissions, for processing and storing radioactive waste, etc.), the distribution of alternative energy and the use of renewable energy sources should be the exit for the society from this situation (Lisichkin 2002).

More and more discussion is being given to power plants using renewable energy sources, such as, tidal, geothermal, solar, space solar, wind and some others. The new projects are being developed. To add, several experimental and first industrial installations are being built. It was caused by both economic and environmental factors. The "alternative" power plants have got high expectations in terms of reducing the anthropogenic impact on the environment (Lisichkin 2002).

The spread of "alternative" power plants is hampered by a variety of technical and technological difficulties. These power plants are not deprived of ecological shortcomings (Lisichkin 2002).

Thus, wind power plants are sources of noise pollution. Solar power plants of sufficient capacity occupy large areas which spoils the landscape and removes land from agricultural traffic. The action of space solar power plants is associated with the transfer of energy to Earth through a highly concentrated beam of microwave radiation. Its possible action has not been studied and is characterized as supposedly negative (Lisichkin 2002).

Tidal power plants are characterized by a negative impact on the environment. The construction of the dam leads to an increase in the amplitude of the tide. Even a slight increase in the amplitude of the tide causes a significant change in the distribution of groundwater in the coastal zone which increases the flooding zone, disrupts the circulation of water masses, changes the ice regime in the part of the basin behind the dam (Lisichkin 2002).

A zone of hydrogen sulphide contamination similar to those observed in bays and bays with natural thresholds may be formed when building dams in the temperate climate zone. The fjords of the Scandinavian Peninsula having a natural threshold are a classic example of such natural hydrogen sulphide contamination (Lisichkin 2002).

Geothermal power plants are worth mentioning. Their influence on the atmosphere is characterized by possible releases of arsenic, mercury, sulphur compounds, boron, silicates, ammonia and the other substances dissolved in groundwater. Water vapour is also emitted into the atmosphere which is associated with changes in air humidity, heat release, noise effects. The impact of geothermal thermal power plants on the hydrosphere is manifested in the disturbance of groundwater balance and the circulation substances associated with groundwater. The impact on the lithosphere is associated with changes in reservoir geology, soil contamination and erosion. Seismic variations in areas of intensive use of geothermal sources are possible (Lisichkin 2002).

7 EXAMPLES OF USAGE OF ALTERNATIVE POWER SOURCES IN RUSSIA

An exhibition "Power engineering. Resource-saving. Kazan 2018 " was held in March 2018 in the exhibition centre "Kazanskaya Yarmarka". The separation of the use of alternative energy sources was also discussed there. People were sharing their experience of using various technologies from the 13th to the 15th of March.

The exhibition was attended by representatives of large industrial companies and private craftsmen who managed to save by using renewable energy. The organizers of the event also conducted some online interviews with several speakers that were talking about their experiences. There are examples of the use of alternative energy sources presented at this exhibition shown below. Experts were interviewed by companies and owners of private properties about using technologies for getting solar, wind and the other types of energy. Some of the most interesting stories from those people are mentioned below. Their names are not mentioned for privacy reasons.

7.1 **Solar power plant in the Crimea**

The conversation was conducted with the technologist of solar collectors, an engineer of the highest category.

The Austrian company Active Solar has built and put into operation a “Perovo” solar power plant with a capacity of 106 MW. The project was implemented in 2011. Figure 13 depicts one such solar plant installed in Crimea.

Figure 13. Solar panel power plant “Perovo" in the Crimea (LiveInternet 2015)

The power plant releases electric power to the general state power grid.

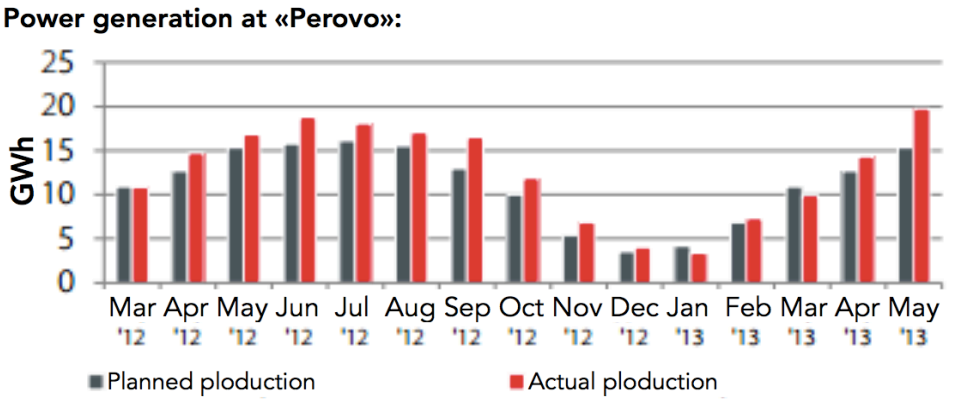

Figure 14. Power generation at "Perovo" from March 2012 to May 2013 (Solar 2013)

The power plant consists of 440,000 solar crystalline photovoltaic modules connected by 1,500 km of cable and installed on more than 200 hectares of area (LiveInternet 2015).

Russia has plenty of everything on the peninsula after 2014 including five solar-powered power plants: Perovo, Mityaevo, Nikolayevka, Rodnikovo, and Okhotnikovo. The company engaged in the construction of solar-powered power plants and the maintenance of production processes was the Austrian Activ Solar - an international group of companies specializing in the development and production of solar technology (LiveInternet 2015).

Solar-powered power plants were erected in the Crimea according to the following business plan. Activ Solar creates and maintains the generation of solar electricity. The owner pays for services due to bank loans and contracts with foreign investors. The State of Ukraine undertakes to purchase electricity from the Crimean solar-powered power plants until 2030 at an inflated tariff fixed in euro (€ 0.446 per 1 kWh). The costs of Ukraine are compensated at the expense of funds sent by Europe to support renewable energy sources in return. So, it was originally conceived. It was planned to pay off creditors by 2030 due to the guaranteed very high tariff (LiveInternet 2015).

Payments to the Crimean solar-powered power plants at a high tariff in euros from Ukraine were stopped in April 2014. After all, Russia began to purchase solar energy at a generally accepted tariff in roubles of 3.47 roubles. Surely, payments on bank loans stopped at first and then the work of the solar-powered power plants stopped, too (LiveInternet 2015).

The station operates at half capacity at the moment due to financing from the Russian budget. There is talk of an imminent freezing of the station since its service by a foreign company turns out to be unprofitable (LiveInternet 2015).

In fact, it has a huge potential. Anyways, it is impossible to use it because of the lack of specialists and some political reasons.

7.2 **Kalmyk wind farm**

The conversation was conducted with the former senior master of the station, now an employee of the project organization.

20 km from Elista in Kalmykia is the territory of the Kalmyk wind farm. The designed power was 22 MW. Anyways, only 1 MW was built and the station worked regularly for a long time. The station stopped operating at the moment. Its service is considered inexpedient due to high operating costs and frequent outages of equipment, frequent expensive repairs.

7.3 **Solar batteries lighting**

The conversation was conducted with the electrician of the village of Moscow region.

They have street lighting on solar panels in the village. Lanterns are connected to the batteries in parallel with the connection to the normal network. They feed the lights with electricity in the daytime, in sunny weather, the batteries are charged, at night. The system is automatically connected to the public network in the event of battery discharge.

The system was mounted three years ago. It fully paid for its investments for the first year. Savings of funds for the year amounted to about 20 thousand roubles.

7.4 **Energy supply of a small closed monastery in the south of Russia**

The conversation was conducted with the worker who serves all the engineering systems of the monastery. The man also studies at the Moscow Power Engineering Institute (part time). He presented the project of an autonomous power supply of a small house to the exhibition.

The monastery has got its own small solar power station and a windmill generating electricity. Everything has been working for four years. The equipment was produced in Russia. Repairs are done on their own when something goes wrong. There is even hot water in showers, a bath and a kitchen in the monastery.

7.5 Solar panels on a house in the Moscow Region

The conversation was conducted with a man who bought a system with solar panels and came to the exhibition to share experience of exploitation.

He purchased solar panels with a power of 200 W and a grid-inverter rated at 300 watts of power. A couple of days after the purchase it turned out that the panel has too little voltage in a single configuration. It was insufficient for the proper operation of the grid inverter.

Therefore, it was necessary to change for two 100 W panels. Theoretically, they should be slightly more effective, in fact they are simply more expensive. This is a panel of high quality (the Russian brand Sunways).

The grid inverter was purchased in China. The device is made qualitatively and the autopsy showed that the internal components are designed for power up to 500 watts (instead of 300 written on the body). Grid-inverter is a converting device. On one hand, plus and minus the solar panels is connected to it, and on the other hand it is connected to any electrical outlet at your house with a conventional electrical plug. The grid is tuned to the frequency in the network and starts to "pump" the alternating current (converted from a direct current) to a house network of 220 V in the process of working. An example of such system can be found in Figure 15.

Figure 15. Solar panel in the Moscow Region (Borisov 2016)

The grid works only if there is a voltage in the network and it cannot be considered as a backup power source. This is its only negative side. All electricity generated by solar panels immediately gets into the network. If there are energy consumers in the house, then it will be spent all the time

and the meter will not operate at the entrance to the house. However, if the instantaneous generation of electricity exceeds the current consumption, all energy will be transferred back to the grid. That is, the counter will operate in the opposite direction. However, there are some obstacles.

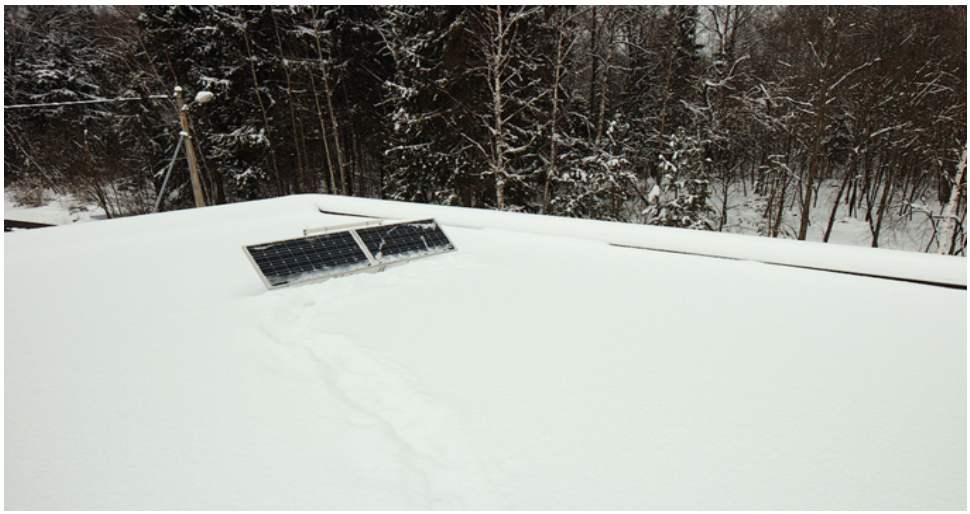

Figure 16. Cleaning the panels from snow (Borisov 2016)

Firstly, many modern electronic meters consider the current flowing through them without regard to its direction (it makes people to pay for the electricity returned to the grid). Secondly, the Russian laws do not allow individuals to sell electricity.

About 117.5 kWh of electricity was generated during the year. As you see, savings are not that great. Investments in alternative energy can return only after 32 years.

7.6 **A solar-powered system in a village house in the suburbs of Moscow**

The conversation was conducted with a man who mounted a system with solar panels.

A solar-paneled system was assembled and put into operation a solar-powered system in a holiday home in the suburbs, on June 12, 2016.

The system is composed of 6 panels of 300 Watts Sunways FSM-300P connected in three groups in parallel, group two panels in series. The nominal voltage of the panels is 24 V, the entire battery is 48 V respectively. The actual operating voltage on the panels under load is around 65 V, without load it is 90 V. All is assembled on the southeast roof slope, i.e., insolation is close to optimal in summer (the slope of the ramp is slightly more than 30. In winter it will be worse (the sun is low and rare) and most likely everything will be covered in snow.

For monitoring and accounting, two counters were installed - one at the inverter input from the 220V network, the other at the inverter output to the load. That is, the first meter considers the electricity consumed from the network, and the second - the electricity consumed by the load. The difference is obtained from the sun. An example of such arrangement can be found below in Figure 17.

Figure 17. Solar panels on the roof (Ruba 2017)

Battery 48 V - 4 front-terminal gel batteries of 180 Ah is used because they received new for free.

The results are as follows: about a third of the electricity consumed is produced by solar panels. Today, since June 12, 2018, 750 kWh has been consumed, of which 500 kWh from the grid, and 250 kWh from the sun. This ratio has not changed for quite some time. To see why, a simple estimation of solar panel outputs can be made: when the sun shines and the system generates electricity, no one is at home, the consumption is small, and the battery is charged.

In general, it turns out that it made no sense using the system.
The savings are a little more than 100 kWh of electricity per month. The cost of electricity is enormous in the settlement in question, about 5 roubles per kilowatt-hour, and, therefore, savings of about 500 roubles per month. In the suburb this event will never pay off.

7.7 **Small solar power plant in the Klin district of the Moscow region**

The conversation was conducted with a man who mounted a system with solar panels in the Moscow region. The exhibition was visited by a

company representative working on a different issue, where he discussed solar batteries in the corridors during lunch. There is a site in the Klin district of the Moscow region, where there is no electricity on the site (garden partnership). It has been promised for many years, but there is little hope.

As of today, the representative has a small solar power plant assembled from solar panels with a total capacity of 1000 watts. The system is 24 volts, contains 8 panels of 100 watts polycrystalline and 4 more pieces of 50 watts monocrystal. Also, the inverter 24 / 220Volt PN5-24-1000, two controllers at 30A and another one with 10A.

Controllers operate in parallel for 4 car batteries of 190 A each, the batteries are connected to 24 V. Also, in the system in case of lack or lack of electricity, a gasoline generator is provided. The gas generator TSS ELAB-3000E, this year was launched once for a circular and grinding machine, and then because the inverter is weak, and since the energy from the solar panels is always enough with a margin.

Electricity-consuming appliances: refrigerator NORD ДХ-403-010, daily consumption maximum 390 W, lighting - LED lamps 8 pieces, TV old, small TV, children watching cartoons, consumption about 40W, washing machine such as Fairy-2 or Baby. Laptop, children's tablets, chargers for phones, radio tape recorder and other small electronics, consumption is difficult to calculate.
The solar power plant started 3 years ago.

The main task of providing the amenities of civilization is what the system provides, and everything else is not so important.

7.8 **Wind-solar power station in the suburbs of Kazan**

The owner of this station was also interviewed.

Many people pass to the sun and the wind as sources of energy, who from necessity, and who for the sake of interest and hobbies. Here is one proof that windmills and solar panels are a reality, even for ordinary people. A private mini power station is proposed for consideration.

The power station is in the garage. On the roof of the garage there are four solar panels. Batteries are installed on self-made racks. In the design there is a regulation of the angle of inclination of batteries for the season. Below, Figure 18 shows an example of a wind-solar power station.

Figure 18. Wind-solar power station in Yamal (AiF 2017)

A 500-watt wind turbine is needed to provide battery support when there is no sun. The windmill is effective in winter, on days when it is overcast and the weather changes with the wind. In the garage, controllers and batteries are mounted, as well as a 24 V DC converter to a 220 V alternating pure sine wave. The accumulators are alkaline and lead automobile, the total capacity is still 200 Ah, but in the future the capacity is planned to increase.

The system works and the owner is satisfied.

7.9 **Biogas plant with processing of livestock waste**

The conversation was held with the Director General of Ltd. "Regional Center for Biotechnologies". The project of biogas plant was presented at the exhibition.
Biogas station "Bajtsury" with a capacity of 0.5 MW is located in the Borisov district of the Belgorod region near the Strigunov pig complex.

A biogas plant with processing of livestock waste and receiving heat and electricity is the first facility in Belgorod and in Russia to be put into commercial operation.

The official opening of the Baysury BHS was held in April 2012.
The biogas station has four items of revenue: electricity, heat, organic fertilizers, a service for neutralizing the waste of the 3rd or 4th hazard category. These revenue items form the payback of the project. Figure 19 below shows a scheme of such biogas station.

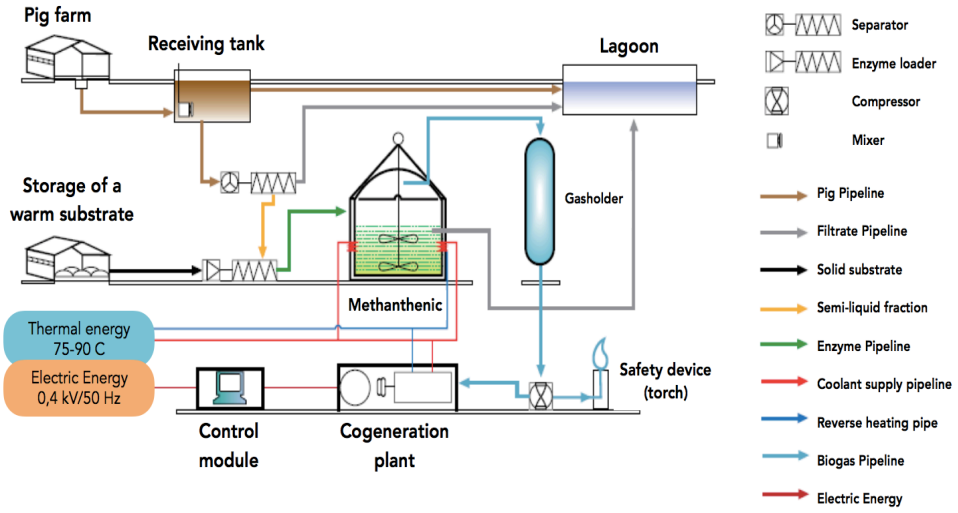

Figure 19. Scheme of Biogas station "Baysury" (Profiz 2013)

The biogas station " Baysury " of the Regional Biotechnology Centre in the winter of 2012 has survived with dignity and now in practice we can say that the project really works. Since April 2012, the station has completely switched to biogas.

From October 1, the process of transition to beet pulp was initiated. Corn silage was gradually replaced with a new substrate, today the volume of the substrate is 40 tons of pulp, 2 tons of silage.
The project works leading to a significant saving of energy resources.

8 CONCLUSION

Russia is abundantly provided with traditional energy resources from the point of view of macroeconomic indicators

An analysis of the energy balance shows that about 2/3 of all energy resources produced in the country are exported abroad. Today, 80% of all oil produced in Russia is exported to other countries.

The approved Energy Strategy of Russia for the period until 2030 provides for only a small decrease in the export of energy resources. Russia's export orientation is conditioned by the fact that the country's oil and gas sector accounts for about 17% of Russia's GDP and more than 40% of consolidated budget revenues. It is not easy to abandon such incomes.
Is this policy farsighted?

According to the available estimates, Russia ranks the 1st in natural gas reserves (23% of world reserves), the 2nd in terms of coal reserves (19% of world reserves), 5-7 in oil reserves (4-5% of world reserves). Russia accounts for 8% of the world's natural uranium production. But easily

accessible deposits of relatively cheap energy resources are rapidly depleted. Moreover, the development and exploration of new deposits requires high costs.

Russia's energy policy will soon require a serious correction in the direction of a more rational distribution of natural energy resources.

So far it is all fine from the point of view of Russia's international obligations on the environment in the country. The sharp drop in the production in the 1990s led to a serious reduction in carbon dioxide emissions into the atmosphere.

It turns out that renewable energy sources for Russia on a national scale are not relevant.

However, we have to look at Russia from the other positions: from the positions of the country's regions and specific energy consumers.

The facts show that a huge part of the territory of Russia with a total population of about 20 million people is beyond the reach of the networks of centralized energy supply. Many regions of Russia are really energy-deficient. They have a need to import fuel and supply energy. Only half of urban and about a third of rural settlements are gasified in Russia. As usual, coal, oil products which are sources of significant local pollution of the environment are burnt over there.

The constant growth of tariffs has led to the fact that autonomous energy in the country is developing at a faster rate. Energy consumers are trying to create their own sources of electricity and heat which leads to a decrease in fuel efficiency compared to the combined production of electricity and heat at thermoelectric plants and a decrease in the efficiency of the country's entire energy sector.

It is believed that the areas with autonomous and decentralized energy supply are most attractive for the effective use of alternative energy sources.

The contribution of alternative sources of energy does not exceed 1%. Recent state decisions prescribe to increase the contribution of renewable energy by 2020 to 4.5% which will require the commissioning of power plants on alternative sources with a total capacity of 20-25 GW.

Russia lags far behind many countries in developing technologies for using alternative energy sources. Nevertheless, there are examples of successful projects in this area.

Accelerated development of thermoelectric plants in Russia should be regarded as an important factor in modernizing the economy including

those related to the development of innovative industries, the development of new innovative technologies, the development of small and medium-sized businesses, the creation of new jobs, improved social conditions, improved ecology, etc.

Currently thermoelectric plants are not competitive as the conditions for various technologies for the production of electrical energy prove to be unequal. Renewable energy technologies are very difficult to compete in the Russian energy market due to significant subsidies to traditional energy (fossil fuels).

On one hand, the abundance of fossil fuels, such as, oil, gas, coal is the greatest good for Russia. On the other hand, it is a disaster since the surplus of these resources dictates a relatively low price for electricity in comparison with the European countries. It reduces the efficient implementation of measures for energy conservation and development of renewable sources. The surplus of hydrocarbons deprives Russian enterprises of the incentive to reduce emissions even in conditions of global warming proved by scientists and the struggle of developed countries with greenhouse gases. They simply do not receive economic benefits from investing in new renewable energy sources.

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Appendix 1

Interview 1.

Interviewer: Snitovskii Alexandr

Interviewee: Technologist of solar collectors in ‘Perovo’, Highest category engineer

Event: "Power engineering. Resource-saving. Kazan 2018 " exhibition

Date: March 2018

Interview 2.

Interviewer: Snitovskii Alexandr

Interviewee: Former senior master of the Kalmyk wind station, current employee of the project organization

Event: "Power engineering. Resource-saving. Kazan 2018 " exhibition

Date: March 2018

Interview 3.

Interviewer: Snitovskii Alexandr

Interviewee: Electrician of the village of Moscow region

Event: "Power engineering. Resource-saving. Kazan 2018 " exhibition

Date: March 2018

Interview 4.

Interviewer: Snitovskii Alexandr

Interviewee: Maintenance engineer of energy systems of the ‘Serpolovo’ monastery

Event: "Power engineering. Resource-saving. Kazan 2018 " exhibition

Date: March 2018

Interview 5.

Interviewer: Snitovskii Alexandr

Interviewee: Solar panelled house owner

Event: "Power engineering. Resource-saving. Kazan 2018 " exhibition

Date: March 2018

Interview 6.

Interviewer: Snitovskii Alexandr

Interviewee: Solar panelled house owner

Event: "Power engineering. Resource-saving. Kazan 2018 " exhibition

Date: March 2018

Interview 7.

Interviewer: Snitovskii Alexandr

Interviewee: Solar panelled house owner

Event: "Power engineering. Resource-saving. Kazan 2018 " exhibition

Date: March 2018

Interview 8.

Interviewer: Snitovskii Alexandr

Interviewee: Wind-solar power station owner

Event: "Power engineering. Resource-saving. Kazan 2018 " exhibition

Date: March 2018

Interview 9.

Interviewer: Snitovskii Alexandr

Interviewee: The Director General of Ltd. "Regional Center for Biotechnologies"

Event: "Power engineering. Resource-saving. Kazan 2018 " exhibition

Date: March 2018