# ТЕОРИЯ И ПРАКТИКА СОВРЕМЕННОЙ НАУКИ: ВЗГЛЯД МОЛОДЕЖИ

## Материалы Всероссийской научно-практической конференции на английском языке

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*Под общей редакцией заведующей кафедрой иностранных языков, кандидата филологических наук, доцента*
*В. В. Кирилловой*

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The collection is intended for a wide range of readers interested in research and development, doctors, professors, associate professors, lecturers, PhD students, master students and students of educational institutions, as well as all those who are interested in the issues under consideration for use in scientific activities and educational work.

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# PREDICTIVE ANALYTICS FOR DECISION-MAKING PROCESS IN BUSINESS

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**Abstract.** The article discusses such a method of analytics as predictive analytics. The increasing trend of using intelligent analytical tools has been substantiated. The scope of predictive analytics application by companies and the effect of its use are described.

**Keywords:** predictive analytics, decision-making process, forecasting, big data.

# ПРЕДИКТИВНАЯ АНАЛИТИКА ДЛЯ ПРИНЯТИЯ РЕШЕНИЙ В БИЗНЕСЕ

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**Аннотация.** В статье рассматривается такой метод аналитики, как предиктивная аналитика. Обоснован возрастающий тренд использования интеллектуальных аналитических инструментов. Описаны сферы применения компаниями предиктивной аналитики и эффект от ее использования.

**Ключевые слова:** предиктивная аналитика, процесс принятия решений, прогнозирование, большие данные.

The modern world is very dynamic. Technologies, customers, their needs and preferences are all changing. Today retailers need to do both: provide the identical level of service at all points of interaction with customers and be able to implement a personal approach to advertising their products.

One of the growing methods in analytics is predictive analytics.

Predictive analytics comprises of varied statistical trends and techniques ranging from machine learning and predictive modelling to data mining to efficiently analyze the historical data and information so as to process them to create predictions about the unknown future events [1].

Initially, this analytics method was developed for credit institutions. It allowed them to assess the solvency of clients when issuing a bank loan. For example, if in the past a group of clients was caught in untimely repayment of their debt obligations, and a real client partially fits the described behavior model, then there is a possibility that the issuance of borrowed funds will be refused.

The central task of predictive analytics is to determine a characteristic or a group of characteristics that affect the predicted event [2]. They are different in any field. For example, insurance companies distinguish characteristics such as age, driving experience.

Intelligent analytical tools use highly advanced algorithms to predict what might happen in the future. Often, these tools use artificial intelligence and machine learning technology, which imply independent (without a person describing a detailed algorithm of actions) performing the tasks assigned to it by the computer to find patterns and solutions based on the proposed data. The interest in predictive analytics stems from the fact that researchers and companies are concerned with predicting the future.

Changes analyzed by predictive analytics tools develop like S-curves. Once events have arisen, they begin to repeat themselves more and more often, forming after a while a new trend or a new paradigm, which becomes the best practice. At some point, something unexpected happens, for example, a new technology appears, a new strong player in the market, an economic crisis, etc. A structural shift occurs, a new S-shaped curve arises, characterizing a new paradigm [3].

Companies use predictive analytics to solve complex problems and find new opportunities ranging from predicting consumer behavior to supporting equipment maintenance. So far, predictive analytics is used primarily in marketing and sales. Companies want to predict consumer behavior when using a particular marketing campaign, assess the possibility of using up sell sales (selling a more expensive product: motivating a buyer to spend more money in your store, for example, buy a more expensive model of the same product, add options or services to the purchased product, cross-selling: motivating the buyer to spend more money, but through the sale of goods from other categories than the one initially selected by the user), improve the building of relationships with customers and retain them.

One of the interesting directions in the predictive analytics development is predictive modelling and the choice of the best solutions based on neural networks

and machine learning using high-speed data processing and parallel computing [4].

Gradually, predictive analytics finds application in analyzing product portfolios, risks, etc. It is indicative that about 80 % of companies plan to use predictive analytics for optimization at least within the next three years. Companies are starting to use predictive analytics in operations management, manufacturing, service, and more.

Predictive analytics are actively used to support key strategic decisions and have a positive effect on the key indicators of the company. It is permissible to use it for making short-term tactical decisions within the framework of operational activities.

To sum up, predictive analytics is one of the areas of big data processing that allows companies to make smarter and more correct decisions today to achieve better results tomorrow. By analyzing data, companies gain valuable insights and can build strong relationships with consumers, discover new opportunities, anticipate threats, prevent fraud while protecting revenues and reputation. The question of data preservation, ensuring the security of information systems organized within companies, as well as adequate interpretation of data obtained from various sources remains open. In addition, the question of assessing the economic consequences of the implementation of predictive analytics requires a detailed study.

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# AIR-GEN AS A NEW GREEN TECHNOLOGY

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**Abstract.** A pneumatic generator is used as an object of research. A new way to generate electricity is considered in the article. The prospect of the development of electric power generation by pneumatic generators is substantiated.

**Keywords:** green technology, new energy source, electricity from the air, nanotechnology.

# AIR-GEN КАК НОВАЯ ЗЕЛЕНАЯ ТЕХНОЛОГИЯ

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**Аннотация.** В качестве объекта исследования используется пневматический генератор. В данной статье рассматривается новый способ получения электроэнергии. Обосновывается перспектива развития получения электроэнергии пневматическими генераторами.

**Ключевые слова:** зеленая технология, новый источник энергии, электричество из воздуха, нанотехнологии.

The development of new types of electricity generation is known to be one of the most important tasks of our time. The electric power industry is the most important branch of the energy sector, including the production, transmission and sale of electrical energy [1, p. 3].

At the moment, there are a large number of ways to generate electricity. The principle of operation of the main power plants is the rotation of the generator shaft, which is the main element of the system. Thermal power plants (they run on natural fuel) can be referred to as usual for us; hydraulic (functioning due to the energy of water, falling height); atomic (fueled by nuclear fuel); diesel (more

often used in the private sector). There are also a number of power plants better known as alternative ones. These include solar, wind, tidal and geothermal. They are powered by the forces of nature.

All these methods of generating electricity have long been known to us.

But today, scientists do not stop undertaking research in this direction and are developing new methods and technologies for generating electricity. Among them there are very exotic ones.

More than 30 years ago, scientists found an unusual microorganism on the banks of the Potomac River. This microorganism is called Geobacter [2]. According to them, this sedimentary organism is able to help generate electricity [3].

It was previously known that this microorganism is capable of producing magnetite (natural iron oxide). Scientists have also found that Geobacter is able to create bacterial nanowires that conduct electricity very well. Thanks to this, humanity has come a huge step closer to its cherished dream – to get electricity in the literal sense of the air.

In a search for practical use of this unusual ability of this microorganism, in 2020 a scientific team from the University of Massachusetts created a device called the Air-Gen, or pneumatic generator. The generator uses electrically conductive nanowires produced by the Geobacter microorganism. Air-Gen combines protein nanowires with electrodes so that an electric current is generated by the water vapor that is present in the atmosphere.

The pneumatic generator, according to its creators, is able to generate electricity in its pure form 24 hours a day [4]. This can be called one of the most rational ways to use protein nanowires.

Air-gen is environmentally friendly, renewable and, importantly, inexpensive technology. It can generate electricity even in areas with extremely low humidity, such as the Sahara Desert. The technology could even compete with other types of renewable energy, including solar and wind, as it does not require sunlight or wind and can be operated indoors [5].

Air-Gen holds significant promise as a new power generation technology. This innovation will affect the future of renewable energy sources and medicine.

If we consider in more detail the principle of the pneumatic generator, we can say that it consists of thin films that are made of protein nanowires with a thickness of 7 to 10 micrometers [6]. These films are located between two electrodes suspended in air. A nanowire film capable of adsorbing water vapor present in the atmosphere allows a continuous electric current to be generated between two electrodes. The charge is created by the moisture gradient, which creates the diffusion of protons in the nano-wire material. This charge diffusion

produces a balancing electric field and the potential is the same as the potential in biological systems of resting membranes. The nanowire device delivers a continuous output voltage due to the maintained moisture gradient.

Prior to this, other types of nanomaterials such as graphene were used to develop an optimal method for producing hydroelectric energy. But all these attempts were not very successful, because only short pulses of electricity were obtained. The Air generator is capable of generating a voltage of about 0,4 – 0,6 Volts with a current density of about 0,15 – 0,20 μA/cm² [7]. Despite the fact that these values are very small, scientists assure that by connecting several devices it will be possible to generate enough electricity to charge low-power devices such as smartphones. The pneumatic generator is surprisingly capable of working even in extremely arid places such as deserts.

Scientists are now challenged to create larger pneumatic generator systems to power entire homes. It is planned to introduce nanowires into wall paint.

So, despite the fact that Air-gen is a new method of generating electricity, it is very promising. Pneumatic generators do not need any maintenance, and are able to get electricity from literally nothing, thus the discovery of this method of generating electricity is a global step in the development of the electric power industry.

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# TECHNICAL ADVANTAGES AND STRENGTHS OF SOLAR ENERGY SOUERSES

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**Abstract.** This paper provides information on the most common sources of alternative energy, in particular solar panels. Their general definition, characteristics and classification. The features that set these devices apart from others in the field of alternative energy are also outlined.

**Keywords:** solar panel, solar power, solar energy applications, renewable energy.

# ТЕХНИЧЕСКИЕ ДОСТОИНСТВА И СИЛЬНЫЕ СТОРОНЫ СОЛНЕЧНЫХ ИСТОЧНИКОВ ЭНЕРГИИ

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**Аннотация.** В данной работе представлена информация о наиболее распространенных источниках альтернативной энергии, в частности о солнечных батареях. Их общее определение, характеристики и классификация. Также обозначены особенности, которые выделяют данные устройства на фоне остальных в сфере альтернативной энергетики.

**Ключевые слова:** солнечная батарея, солнечная энергетика, применение солнечной энергетики, возобновляемая энергетика.

Solar energy is energy produced by the sun in the form of light and heat. This type of energy is renewable and one of the most affordable energy sources on the planet.

The main way of using solar energy is through solar panels, or as they are also called – solar panels (Fig. 1) [1].

A solar panel is a device that generates electric current under the influence of sunlight; an association of photovoltaic cells that act as semiconductor devices [2].

Figure 1. Solar panels

The rapid development of technology and green energy in general allows us to categorize solar panels according to the following classification [3]:

1) Photovoltaic transducers. They are cells that are interconnected with each other. The principle of operation of these batteries is based on the photoelectric effect. Electrophysical parameters of semiconductors differ and affect the efficiency of the converter;

2) Solar power plants. These are solar plants that operate on concentrated solar energy. The principle of operation is to use lenses and concave mirrors, which concentrate solar energy. With the use of mirrors, it is possible to obtain higher efficiency, as they allow to obtain higher power;

3) Solar collectors. This type of solar panels refers to low-temperature heating stations, which provide hot water in stand-alone mode. The efficiency depends on the usable area.

4) Monocrystalline. This type of solar cells are made of high purity industrial silicon. Efficiency is 14 – 17 %;

5) Polycrystalline. This type of battery consists of a silicon melt that is slowly cooled to achieve certain conditions. The manufacturing of this type of solar panels is much cheaper. Efficiency reaches 10 – 12 %;
6) Panels based on amorphous silicon. These solar panels are thin film solar panels. The manufacture of these panels is considered the cheapest, according to this, their efficiency decreases over time and is required to be replaced over time. In addition, the efficiency is lower than other types, 5 – 6 %.

Today solar panels are used everywhere, in astronautics, in industry, in acion, rail and sea transport, in providing heating and hot water in buildings, in providing street lighting, etc. The most amazing example: in London there is a solar bridge Blackfriars, the roof of which is covered with solar panels, capable of generating up to 900 thousand kWh of energy per year [2]!

But what are the main advantages of using solar energy?

First of all, it is worth mentioning the inexhaustibility and accessibility in any place. Everyone knows that the sun is almost everywhere in the world, and it has no plans to disappear in the near future. However, if this resource does exhaust itself and the sun disappears, humanity will have to address the issue of electricity in the last place.

Secondly, a long service life. Solar panels wear out very slowly because they have no moving parts. Even if the installation uses different actuators to turn the panels to the light source, the batteries will last for twenty-five years or more. At the end of this period the battery will not fail, but the efficiency will slowly begin to deteriorate [4].

Another important quality is autonomy. For the user the installation of such an energy source is reliable, he does not have to fear that one day the supplier will stop supplying energy due to some failure. This gives a sense of security. It is also worth mentioning that there will be no problems with sharp price increase or transportation of energy.

An extremely interesting quality is the possibility to increase the capacity. In this case, the only question is the availability of the required area. The modularity of solar panels makes it possible to seamlessly increase the capacity of the system, if necessary. To do this, new panels shall be added and powered in the system. Where to get such an area exclusively for solar panels? The answer is simple – the deserts. It only takes 10 % of the Sahara to provide electricity to the entire world.

The solar panel does not need to be recharged. And this means that one does not depend on changes in the cost of fuel, its supply. Another advantage of batteries is an uninterrupted and stable supply of energy.

Thus, it is clear that the efficiency and application of solar panels will develop at a rapid pace. It is worth adding that the prospects for green energy will positively influence the use of renewable energy sources, including solar energy!

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**УДК 621.548**

# ENVIRONMENTAL BENEFITS OF WIND POWER PLANTS

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**Abstract.** This article discusses the advantages of wind turbines, namely their environmental friendliness. It analyzes why the use of this alternative energy source has become so significant, the reasons being its safety, durability and sustainability, which provides for the natural resource conservation. An example of the USA as one of the most successful countries using wind energy is also provided.

**Keywords:** ecology, wind power, wind generator, advantages of wind turbines.

# ЭКОЛОГИЧЕСКИЕ ПРЕИМУЩЕСТВА ВЕТРОЭНЕРГЕТИЧЕСКИХ УСТАНОВОК

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**Аннотация**. В статье рассматриваются преимущества использования ветрогенераторов с экологической точки зрения, а также анализируются причины, обуславливающие значимость данного альтернативного источника электрической энергии, такие как возобновляемость, способствующая сохранению природных ресурсов, безопасность и долговечность. Также приводятся успешные примеры использования ветроэнергетики в США.

**Ключевые слова:** экология, ветроэнергетика, ветрогенератор, экологические преимущества.

*Definition and general data.* A wind generator is a device that converts the kinetic energy of the wind flow into mechanical energy of rotation of the rotor,

which in turn is converted into electrical energy. Wind turbines can be industrial, commercial, and domestic (i.e. for private use) [1].

Quite often, wind generator systems are used at dachas or in localities where there are constant interruptions in the supply of electric energy. All wind turbines operate according to the same scheme, thanks to which the battery is charged (Fig.1). After that, the inverter again produces alternating current. This is necessary so that the light bulbs glow; the refrigerator works, etc. Thanks to the storage battery, you can use electrical appliances during calm weather. During strong gusts of wind, the mains voltage remains stable. After all, an unstable voltage can cause a fire due to a short circuit, and fires can damage the environment. Thus, voltage stability is advantageous both from the economic and environmental point of view.

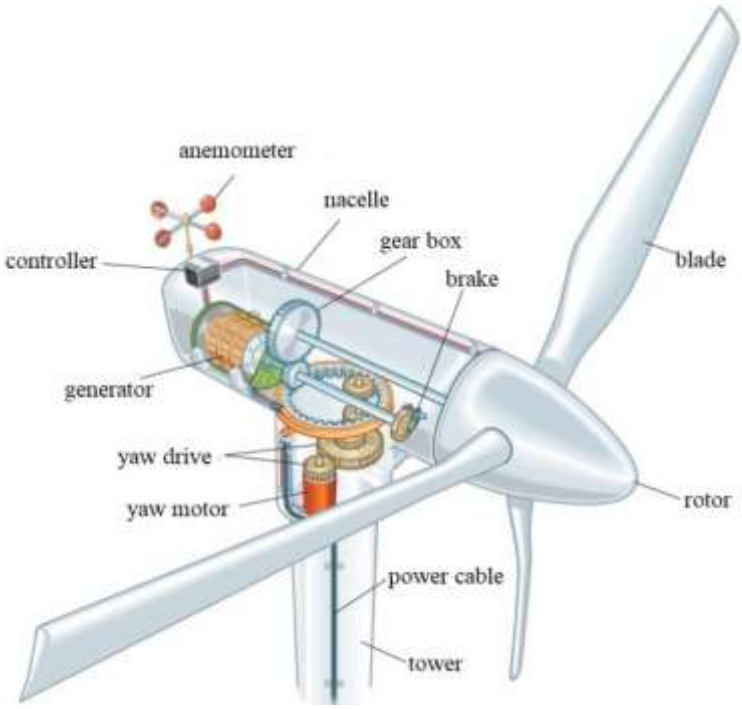


Figure 1. Wind generator structure diagram

It is also worth mentioning the principle of operation of the wind generator. The amount of energy received from the generator is proportional to the diameter of the wheel and blades of the windmill. In other words, the greater the wind flow, the faster the generator shaft starts spinning and the more energy is produced. It is important to take into account that the assembly of a wind generator takes little time and requires a small amount of materials, especially in comparison with alternative sources of electric power production [2].

Next, we would like to consider the environmental benefits of installing wind turbines.

*Wind power safety.* Wind power is clean and renewable. Compared to the environmental impact of traditional energy sources, the impact of wind power is relatively small. Unlike nuclear and fossil fuel energy sources, wind power does not consume fuel and produces no emissions such as CO2, SOx, and NOx. Most importantly, the operation of the wind generator does not affect the thermal balance of the Earth's surface (Fig. 2) [3, 4].

Figure 2. Wind power safety

*Saving natural resources and landscape.* In order to build wind turbines, it is necessary to extract materials from the subsurface, process and transport them, just as for all traditional power plants, but in smaller quantities. In other words, a certain amount of resources will be saved (Fig. 3).

Figure 3. The process of installing a wind generator

A wind farm can cover a large area of land, nevertheless, many land uses, such as for agricultural purposes, are compatible with it. At the same time, only small sections of the turbine bases and infrastructure become inaccessible for use. As for the percentage, wind energy supporters say that less than 1 % of the land will be used for foundations and roads leading to them, while the other 99 % can still be used for farming. The installation of wind farms does not require large-scale preparation of the area, that is, it does not damage the landscape much (Fig. 4).

Figure 4. Rational use of the area

*Durability*. Wind turbines are considered very enduring. Most turbines have been generating power since the early 1980s (Fig. 5). Many American wind farm mills have been in use for generations. This means that you will not have to replace old wind turbines often and at the same time exhaust the natural reserves for their construction time after time. Their durability helps to save depleted natural resources.

*Environmental wind power in the United States.* The United States provide a good example of positive environmental impact of wind turbines. The operation of wind farms in 2007 prevented the emission of about 28 million tons of $CO_2$ into the atmosphere. A single working wind turbine with a capacity of 1 MW can save approximately 29,000 tons of coal, or 92,000 barrels of oil. At present, the problem of running out of resources is very acute.

Wind power is currently developing rapidly in the United States, the total capacity of wind power plants being more than 100 GW, which is sufficient to provide electricity to 32 million American homes. This is an important milestone in the transition to a cleaner electricity supply [5].

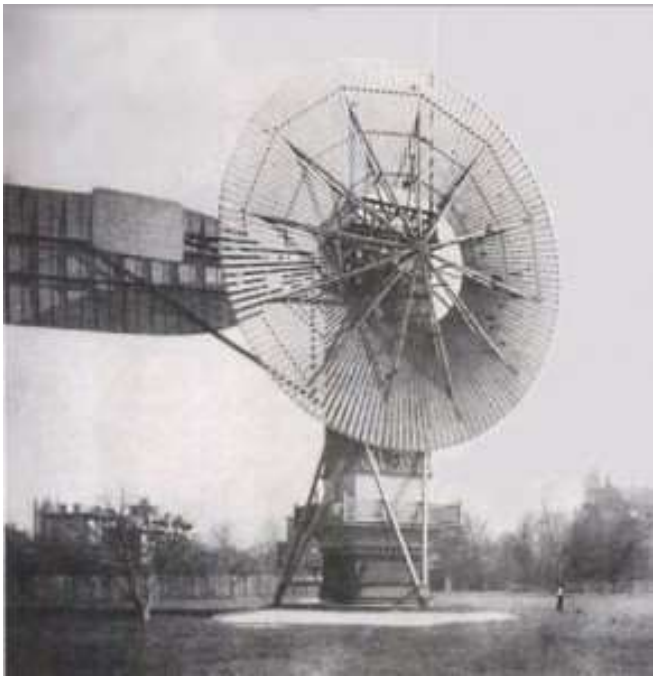

Figure 5. The first wind turbine in the USA

As wind power grows across the country, so do its economic and environmental benefits. Further implementation of wind energy also addresses the problem of air pollution and preserves the supply of fresh water needed for drinking and agriculture. In fact, wind power is one of the most affordable and rapidly deployable solutions to climate change challenges [6].

*General conclusion.* Based on the analysis, we can conclude that the use of the forces of nature for self-benefit is an indicator of human development. This is about applying wind power to one's own advantage. For a very long time, people had no idea about physics and the movement of air masses along the plane of the earth's surface, but they learned to use the wind force as a traction force for navigation with the invention of the sail. Naturally, windmills, and later wind turbines appeared.

The wind power industry will continue to develop in the future, and along with this, complex projects for analyzing the impact of wind turbines (wind power plants) on the environment will be improved. The outlook for the development of wind power remains positive, and in the near future there will only be more countries implementing this alternative method of generating energy.

More often, private wind generators are in demand, which can provide the house with energy partially or completely. Traditional energy sources may soon lose their efficiency, in addition, they cause irreparable harm to the environment. It is widely believed that wind power, as well as alternative "green" methods of energy production, is the future.

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# POSITIVE ECONOMIC EFFECT OF HYDROPOWER

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**Abstract.** The economic benefits of a hydroelectric power plant are analyzed in the article. The principle of its work is considered. The prospects of hydropower development in Russia are shown.

**Keywords:** hydropower, hydroelectric power plant, electricity, economy, benefit, water.

# ПОЛОЖИТЕЛЬНЫЙ ЭКОНОМИЧЕСКИЙ ЭФФЕКТ ГИДРОЭНЕРГЕТИКИ

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**Аннотация.** В статье проанализирована экономическая выгода гидроэлектростанции. Рассмотрен принцип ее работы. Показаны перспективы развития гидроэнергетики в России.

**Ключевые слова**: гидроэнергетика, гидроэлектростанция, электроэнергия, экономика, выгода, вода.

It is impossible to imagine the modern world without electricity. Electricity became widespread about a hundred years ago and this was a real breakthrough for all of humanity. Now there are many ways to obtain electricity: thermal energy, hydropower, nuclear, alternative, etc. The way to obtain electricity is to convert primary energy (heat, wind, water) into secondary energy – electricity. Today there is not a single industry or other field of activity where electricity is not used. Each apartment and residential building has a huge number of lighting

fixtures and household appliances. Electrical work has become one of the most demanded on the market. They are carried out by specialized organizations whose main task is to ensure the safety of electrical networks and the continuity of the supply of current in the premises [1].

In this article, the aspect of generating electricity using hydroelectric power plants is examined from the point of view of economic benefits.

Consider the principle of operation of a Hydroelectric Power Plant (HPP). A hydroelectric power plant uses the movement of water masses as a source of energy. Such plants are usually built on rivers where there is a strong water flow. For the efficient production of electricity at hydroelectric power plants, two main factors are required: guaranteed water availability all year round and river slopes that are conducive to hydro-construction [2].

The power of a hydroelectric power plant depends on the amount and pressure of water passing through the turbines. Directly the water pressure is obtained due to the directional movement of the water flow. It can be water accumulated at the dam, when a dam is built at a certain place on the river, or the water pressure is obtained due to the diversion of the flow (when water is diverted from the channel through a special tunnel or canal).

The total (theoretical) hydropower potential of Russian rivers is estimated at 2,900 billion kWh per year, which is equal to 290 % of all electricity produced per year [3].

Considering all of the above, it can be concluded that hydropower can become one of the main methods of generating electricity in Russia. To what extent it will be economically feasible, we will consider below.

Let’s assess the economic benefits of operating hydroelectric power plants. Unlike a nuclear power plant or a thermal power plant, this type does not require the delivery or purchase of resources for the production of electricity, hence one of the most important positive qualities of this type of power plant – the renewability of resources, which does not require additional investment in the future.

Two-thirds of our planet is water. It is in constant circulation, which ensures its renewability for the entire surface of the globe. This allows hydroelectric power plants to generate up to 71 % of all global renewable electricity.

So, about 1300 million cubic meters of water from all over the earth are distributed as follows: rivers and lakes – 0,02 %; groundwater – 1,7 %; oceans – 96,4 % [4].

Cheap electricity from hydroelectric power plants contributes to the location of energy-intensive industries. The hydroelectric power plant does not require additional energy sources. Due to the lack of a fuel component, hydroelectric power plants are distinguished by a very low cost of electricity. Electricity generated at hydroelectric power plants is, on average, almost four times cheaper than electricity received from thermal power plants, and round-the-clock and non-stop operation is the ability to obtain a stable large volume of electricity regardless of the season. The hydropower industry is highly predictable and stable in energy production. The price of electricity will not change because it does not depend on the price of fuel and on delays in its delivery. So, according to data for 2021, the cost of electricity from hydroelectric power plants is 0,054 and 0,11 rubles per kWh. While thermal power plants usually cost 0,18 and 0,45 rubles per kWh [5].

For 2020, about 20 % of all electricity in Russia is generated at hydroelectric power plants. This is 48.51 GW of electricity. Meanwhile, energy production at thermal power plants fell by 18 %. The researchers note that by 2030, the share of energy generation at hydroelectric power plants will be up to 60 %. Hence, it can be assumed that the price of electricity generated at the hydroelectric power plant will be even lower.

The reservoir water also helps irrigate nearby farms, providing the stable water supply they need.

Dam walls control water levels in rivers, thereby often saving people and farmland from flooding and inundation, helping to avoid the costs of related activities.

And the reservoirs built for hydroelectric power plants can be used as recreation areas and profit from the tourism business.

Due to the possibility of regulating the volume of hydropower, the export of electricity generated at hydroelectric power plants is becoming a promising direction.

Summing up, we can say that hydroelectric power plants are an excellent economic solution for generating electricity. In our opinion, this method of generating electricity should be developed not only in Russia, but throughout the world, if there are natural conditions necessary for this. The presence of hydroelectric power plants in the region contributes to its overall economic growth.

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**УДК 504.75**

# THE FASHION AND THE ENVIROMENT

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**Abstract.** This article is about the harmful influence of modern fashion on the environment and the scale of this problem. It tells about the cycle of life of clothing and the harm it causes to the environment at its stages. In the end, it summarizes and gives recommendations on what a people can do to improve the environmental situation in the world right now.

**Keywords:** ecology, environmental issues, cotton production, plant emissions, waste disposal method, slow fashion, material recycling, sustainable brands.

# МОДА И ЭКОЛОГИЯ

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**Аннотация.** В данной статье рассматривается вредоносное влияние современной моды на экологию и масштабы данной проблемы. В ней рассказывается о цикле «жизни» одежды и о вреде, который она наносит окружающей среде на этих этапах. В заключение даются рекомендации, что человек может сделать для улучшения экологической обстановки в мире уже сейчас.

**Ключевые слова:** экология, проблемы экологии, производство хлопка, выбросы заводов, метод обезвреживания отходов, медленная мода, переработка материалов, экологичные бренды.

The problem of the ecological situation in the world has been actively escalating for more than a year. Nevertheless, the pollution of the environment and, as a result, the scale of pollution of nature still continues to increase. This is due to the fact that the population of the planet had information about the

environmental situation in the world, though was not motivated enough to properly study the situation and try to change the situation in the world.

According to research, the average person in 2014 had 60 % more things than in 2000. And compared to 1980, Americans bought 5 times more clothes. Naturally, by 2021, these indicators have increased significantly.

The reason for this is fast fashion. The companies were able to minimize the cost of materials and labor, as well as reduce production time to a minimum. Thus, they got the opportunity to create clothing collections at the same time as new trends and trends appear. And so, it is all year round, almost without a break.

Since the price of goods has decreased, demand has also increased. Now fashion is open to more people, regardless of their wealth. Because of this, a person's attitude to things has also changed. Now it's not a problem for him to completely update his wardrobe at least once a year, and sometimes more often. Clothing has always served as a symbol of luxury, wealth and high position in society, and now it has become more accessible.

However how can this affect the ecological situation of the world around us?

Undoubtedly, any production is not waste-free and to some extent pollutes the environment. Though if a century ago nature coped with such a load and could recover, now the limit has been exceeded.

The main blow to the natural environment is inflicted at the stages of fabric and knitwear production.

Even now it seems obvious to many consumers that cotton is more environmentally friendly than polyester. Yes, cotton is a natural material, it decomposes relatively quickly. And at the same time, the damage it causes at the stage of cultivation and processing does not allow us to say that this material is environmentally friendly.

Firstly, a huge amount of water resources is being spent. Growing cotton for just one T-shirt requires an amount of water that would be enough for one person for three years of life. The harm does not end there.

Cotton is a very attractive plant for insect pests and pesticides are used to protect the plant from pests. In addition, chemical fertilizers are added to the soil for improved and accelerated growth. These chemicals, penetrating into the soil, violate the natural state of the soil, change its properties, and getting into nearby waters, make them unsuitable for household the needs and habitat of animals there. Contamination of the biological environment leads to the fact that about 28,000 people die from poisoning on cotton plantations every year in the world.

A huge amount of both water and energy resources is consumed for the technological process of creating threads and fabrics. This depletes nearby rivers

and other bodies of water and increases emissions of harmful CO2 gas. An example of the greatest human error was the withdrawal of water from the rivers that flowed into the Aral Sea, as a result of which its area continues to decrease every year, and it turns more and more into a desert.

At the stage of dyeing the fabric, harmful and toxic substances are used to fix the color. Many factories neglect environmental discipline and poison rivers located near settlements with waste. This makes the water undrinkable, and even just being near it is unsafe.

The environmentally harmful influence of production is replaced by thoughtless disposal of clothing.

Most of the clothes (about 95 %) a person indifferently throws in with the rest of the garbage, not even guessing what consequences this decision carries. There are only two options for further use of this clothing and what fate awaits it: either disposal, or a place in a landfill.

When collecting garbage together, the most common and easiest way of disposal is incineration. If safety measures are violated in this process, there is a high probability of a carbon monoxide leak poisoning the human environment.

If the clothes end up in a landfill, a long and harmful decomposition process awaits them. Among the various garbage, this natural process takes longer even for natural fabrics.

If cotton under normal conditions is able to decompose within a week, then the same decomposition process for polyester can take as much as 200 years or even more. It turns out that one polyester T-shirt can survive 8 generations of an entire family! And there are tons of such clothes in landfills.

At the same time, clothes emit a huge amount of carbon dioxide, which contributes to the formation of a greenhouse effect. These and other harmful human emissions increase the average temperature on Earth and, accordingly, increase radiation exposure.

Even at the production stage, it is possible to reduce the amount of resources consumed and reduce harmful emissions of enterprises.

Organic cotton can be used to save resources and reduce pollution. Chemical fertilizers, pesticides and the like are not used in its cultivation. At the same time, the cost of water for irrigation is 91 % less than that of conventional. And, although experts still have many questions about organic cotton, this method of production is obviously less harmful to nature.

This also applies to wastewater emissions from production facilities. To solve this problem, the used water should not be drained immediately, it can be reused in production. This approach will save both water resources and energy, because the requirements for water reuse are much lower. And if water from

reservoirs goes through two stages of purification: before use in production and after it, then the reuse water is purified only once before a new cycle. The advantage for production is saving time and money at these stages.

That is, in order to reduce the amount of resources consumed and emissions after the production stage, it is necessary to use them rationally, that is, reuse. Including the reuse of waste washing water.

However, waste from production facilities will still exist. Therefore, it is necessary to study the principle of disposal of harmful waste.

In total, there are three most common methods of industrial waste disposal:

- thermal;
- chemical;
- physico-mechanical.

The method of neutralization depends on the type and composition of waste. Most often, the thermal method of disposal is used, since it allows you to reduce the volume of waste by 3 times, eliminate their harmful substances and get thermal energy in addition. It implies disposal by exposure to high temperatures on the object: combustion, gasification or pyrolysis [1].

It is not necessary to wait until production begins to think about the environment. Everyone can contribute now.

There is such a thing as sustainable fashion – sustainable fashion that does not harm the environment, so it can exist for a long time. It implies the use of textile materials based on the principles of environmental care and social responsibility. The concept of sustainable fashion includes three principles: Slow Fashion (slow fashion), Recycled materials, (recycled materials), Upcycling (the cycle of things in the world).

The slow fashion suggests to abandon the fast one accordingly. That is, do not chase trends that change every season, and find your own style that will be relevant at any time, in any situation. In order not to have to buy new things too often due to the wear and tear of old ones, you should approach wisely to the choice of clothing, giving preference to the most high-quality and durable materials. It will also be a plus to buy multifunctional things: a stole, which can become a dress, a blouse, and a skirt. It should be remembered that with a decrease in demand, supply also falls.

Recycling of materials assumes that old things are sent to factories, where specialized machines split fabric and knitwear into threads, and then into fibers, from which threads are subsequently reproduced again to create new clothes. On the tags of such clothes there is a special sign symbolizing the eco-friendly origin of the goods.

Last but not least, is the principle of the circulation of things in the world. It is not necessary to rush to hand over things for recycling if they are still in good condition. If you can still wear them, you should offer clothes to relatives, friends or donate clothes to charity. Everyone can give things a second life by visiting second-hand shops. Despite the biased attitude in the CIS countries, good and high-quality clothes are sold there. Moreover, buying clothes in such stores is obviously a good thing for nature and ecology.

Therefore, based on the above, it is always worth considering whether these mountains of clothes in the wardrobe are really needed.

Both major brands and aspiring designers are thinking about ecology.

It all started at the end of the twentieth century. Then, in 1994, the Moschino brand released the first “green”, eco-friendly collection. They decided to completely abandon natural wool and leather. This really improves the ecological state – it helps to preserve the population of animals and exploit them less, protect their rights. At the same time, then they did not think about the harm of polyethylene to the environment. After all, instead of furs and leather, the models on the podium were dressed in dresses and jackets made of plastic bags and plastic.

However, this has already become an impetus for the development of the theme of ecology and every year more and more brands appear, position themselves as eco-friendly, and produce special “green” collections.

The very first completely environmentally sound brand was created by American Linda Laudermilk in 2002 – Luxury eco. For the manufacture of clothes, she chose rather unexpected and unusual materials for an ordinary person: old shells, seaweed, bamboo, recycled fabrics and plastic bottles. Her brand still exists, and recently she has been developing hemp clothing.

One of the most striking examples is the world-famous brand Prada. In 2020, an Italian brand specializing in textiles, perfumes and accessories made a statement that by 2021 they would completely transfer to recycled nylon. After all, more than 700,000 meters of nylon must be used annually to manufacture products at Prada factories. The source for the new Econyl was old fishing nets and waste from textile industries.

Sports brand Adidas launched a campaign to collect plastic bottles and began to produce a certain model of shoes made of 100 % recycled plastic. Together with Parley, an ocean waste recycling company, they collect bottles and produce a collection of recycled clothing and shoes, and plan to switch completely to recycled polyester by 2024.

There are also Russian brands fighting environmental pollution, which produce clothes entirely from eco-friendly and recycled materials. So, Galina

Larina created her brand Plasticdoom. It all started with the fact that she began to melt plastic bags at home and create garments from them, such as raincoats, hats and more. She has exhibited her project at exhibitions and competitions in the United States, and has now joined Dave Hackens' Precious plastic project.

There are many projects being created in the world aimed at collectively improving the environmental situation.

In June 2018, 94 firms signed an agreement in which each has specific tasks aimed at solving the problem of pollution of nature, and common goals for more economical use of resources and the creation of fibers from recycled materials. Every year they hold forums where reports are provided that will help "industry leaders understand where to focus their efforts and how to get the greatest return on their investments" [2].

In the same year 2018, another document was signed – the charter of the fashion industry to combat climate change. "The document says that the industry should reduce carbon dioxide emissions into the atmosphere by 30 % by 2030 and achieve carbon neutrality by 2050. This is reported in the press release of the United Nations (UN)." According to this agreement, they have set themselves 16 goals and rules. And everyone who signed the agreement undertakes to follow them flawlessly [3].

In Russia, such a project is fixed at the legislative level. This is the environmental safety strategy of the Russian Federation for the period up to 2025. It prescribes a plan to improve the environment in the period from 2017 to 2025, describes the environmental situation at the time of writing this decree, the actions to be taken, and options for the development of events, depending on the implementation of the plan. The following objectives can be distinguished: "elimination of accumulated environmental damage, restoration of degraded natural ecosystems", "reduction or prevention of negative impact of economic and other activities on the environment and rational use of natural resources". The plan contains 18 sections, which talk about more efficient and rational management of industrial waste and recyclables [4].

To find out the awareness of the population about the environmental situation, an anonymous survey was conducted among residents of Russia aged 18 to 50 years. According to its results, half of them have never been interested in environmental problems at all, since this was not part of their areas of interest. That is, while a person himself lives comfortably at the moment, he does not think about future generations, or even about his immediate future. At the same time, people aged 18 to 25 are more aware of the existing problems than the older generation and are trying to make attempts to improve the situation and mitigate the impact of emissions on nature. However, regardless of age, most still took

steps to improve the environment, albeit unconsciously. Most often, this is a partial or complete rejection of plastic bags and the reuse of things: the use of unnecessary clothes as household rags, the transfer of clothes to relatives and to charitable foundations/churches.

Many noted that even if they wanted to try to do something to improve the environment, they cannot because of distrust of separate garbage collection companies, they lack knowledge, and they do not know where to get more information. It is also difficult to change the usual way of life when there are no clear instructions for action and some kind of incentive system.

Thus, if people massively think about the environment and begin to take actions in its defense, without waiting for a serious catastrophe, it is possible to significantly improve the environmental situation around the world in the near future.

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**УДК 681.5**

# TECHNICAL AND ECONOMIC JUSTIFICATION OF AUTOMATION OF A GAS PUMPING UNIT

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**Abstract.** The use of an automated process control system increases the level of organization of production and the efficiency of interaction of personnel with a technical unit. This significantly shortens the production cycle. It becomes possible to switch to optimized modes of technological processes, which increases the productivity of units, increases the efficiency of using raw materials and materials, and also prevents emergencies. The quality of the finished product improves and its characteristics stabilize.

**Keywords:** gas pumping unit, automation, control, automatic control systems.

# ТЕХНИКО-ЭКОНОМИЧЕСКОЕ ОБОСНОВАНИЕ АВТОМАТИЗАЦИИ ГАЗОПЕРЕКАЧИВАЮЩЕГО АГРЕГАТА

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**Аннотация.** Использование автоматизированной системы управления технологическими процессами повышает уровень организации производства и эффективность взаимодействия персонала с техническим подразделением. Это значительно сокращает производственный цикл. Становится возможным переход на оптимизированные режимы технологических процессов, что повышает производительность агрегатов, повышает эффективность использования сырья и материалов, а также предотвращает аварийные ситуации. Качество готового продукта улучшается, а его характеристики стабилизируются.

**Ключевые слова:** газоперекачивающий агрегат, автоматизация, управление, системы автоматического управления.

The pressure of the compressed gas on the main gas pipeline is controlled by increasing the number of turns of the gas turbine, which in turn is regulated by the pressure of the fuel gas at the inlet.

A person is not able to simultaneously change all parameters. These are the functions of the automatic control system.

First of all, the control system changes the fuel consumption into the combustion chamber depending on the operating conditions of the gas turbine unit. An impulse serving as a signal for changing the fuel consumption is generated by sensors, measuring the function that needs to be maintained or controlled according to a given law (frequency of direct electric current in the network, gas pressure behind the supercharger, gas temperature in front of the turbine, etc.) [1].

Modern automatic control systems allow you to maintain almost any idle speed. Each of them has its own synchronizer position. Centrifugal governors that allow you to control the control system in a wide range of speed changes are called all-mode.

In the control circuit, instead of the speed regulator, a meter of this value is installed (for example, a temperature, pressure, fuel consumption sensor, etc.).

In this case, the pressure of the fuel gas at the entrance to the combustion chamber of the GPU is regulated.

At the considered object, the fuel gas pressure at the inlet is maintained in the range from 2,8 to 3,3 MPa. If the value is outside the normal range, that is, less than 2,5 or more than 3,4 MPa, then an alarm is triggered. If the pressure is 3,5 MPa, then the unit is forced to stop. An emergency stop occurs when the parameter value is less than 2,0 or more than 3.,6 MPa. The operating value of the fuel gas pressure in the installation is $2,9 \pm 0,15$ MPa [2].

When choosing technical means of automated selection, the following parameters:

- manual and remote mode;
- displaying the process at the dispatcher;
- entering a task from a dispatching station;
- control accuracy (deviation from the set value does not exceed 3 – 5 %) [3].

To control low-inertia objects, single-loop control systems are usually used with controllers that implement proportional (P-), proportional-integral (PI-), proportional-integral-differential (PID-) control laws. One of the main requirements for industrial systems is to maintain the equality Y = Xgiven under the influence of a disturbing effect.

By deviation from the norm, in accordance with the requirements established by the parameters established by deviations.

When developing the structure of the control system, when choosing a control law, a requirement is established that there is no static error in a closed control system, that is, there is no difference between the output coordinate "Y" and the task "Xgiven" in the steady state due to the emergence of a risk of loss of stability of regulation when changing dynamic properties of the control object during operation, then the requirement is put forward as an optimality criterion that the control system has a given stability margin. It is also necessary to minimize the dynamic error.

The absence of a static error is achieved by introducing an integrating link into the direct channel of the control system, which will lead to an increase in the order of astatism in the system [4, 5].

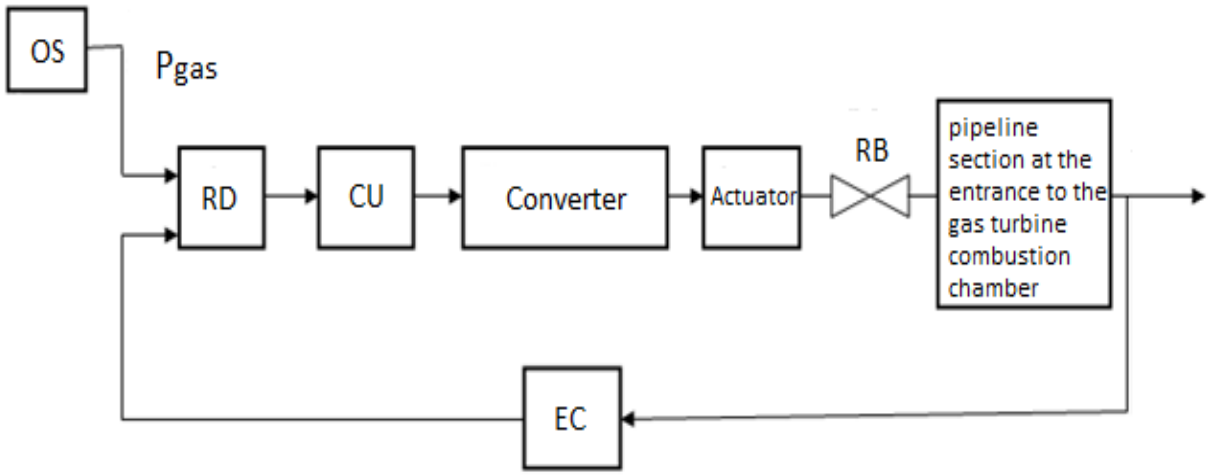


Figure 1. Block diagram of fuel gas regulation

The task signal from the operator station (OS) goes to the regulating device (RD), which processes the input value and information from the fuel gas pressure sensor (EC) and generates a control signal, then passes to the control unit (CU), in which the operating mode can be selected, then the converter passes and goes to the actuator that controls valve, and it, in turn, affects the control object.

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**УДК 004.43**

# DATA ANALYTICS AS ONE OF THE DIRECTIONS OF DIGITAL TRANSFORMATION: COMPARATIVE ANALYSIS OF R AND PYTHON TOOLS

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**Abstract.** The purpose of this article is to analyze modern tools for working with data, R and Python, their comparative analysis, identifying the features of each of them. This study will be practically applicable at the initial stages of language selection, taking into account all the details set out in the article.

**Keywords:** digitalization, Python, R, data, business.

# АНАЛИТИКА ДАННЫХ КАК ОДНО ИЗ НАПРАВЛЕНИЙ ЦИФРОВОЙ ТРАНСФОРМАЦИИ: СРАВНИТЕЛЬНЫЙ АНАЛИЗ СРЕДСТВ R И PYTHON

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**Аннотация.** Цель данной статьи – анализ современных средств работы с данными, R и Python, их сравнительный анализ, выявление особенности каждого из них. Данное исследование будет практически применимо на начальных этапах выбора языка при учете всех деталей, изложенных в статье.

**Ключевые слова:** цифровизация, Python, R, данные, бизнес.

Digital transformations in large companies have spawned highly successful projects. However, the increase of the number of digital processes in business dictates its own rules. Special technologies are needed to turn information into a

service because companies contain a huge amount of data that is a source of valuable information.

According to Yelena Semenovskaya, Research Director at IDC, “now digital transformation can be further defined: it is a change in business processes based on data analytics” [1].

This direction, with the right approach and means of implementation, allows you to get additional profit, bring new services to the market, and cut costs.

Data analytics in business is a key stage because of which each company forms a long-term and short-term strategy based on the assessment of actual data and forecasting future performance.

It helps to set development priorities, calculate the required volumes of labor, material and financial resources, and determine the directions of coverage. Inaccurate data can lead to inefficient use of resources and a decrease in the efficiency of the company. In many companies, rigorous analytics is basic to build a reliable forecasting system.

It is worth saying that SQL tools and the command line are enough to carry out primary data analysis. However, as the tasks become more complex, you will have to turn to more advanced research tools.

Table 1 – Evaluating Python Features

| **Advantages** | **Disadvantages** |
|---|---|
| methodology «check as you code» (reduces the load on testing the code due to predefined packages containing ready-made algorithms) | low speed (however R is even slower) |
| ready-made libraries (ready-made ML, DL algorithms, as well as tools for the development of cloud storage, streaming services, games) | not enough convenient ORM tools |
| easy to learn (uncomplicated syntax) | inconvenient in the implementation of very large projects |
| platform independence (packages like PyInstaller allow you to painlessly port your code, for example, from MacOS to Linux) | |
| massive community support (help and experience gained on the forums) | |
| high culture of documentation | |

Python and R are great for working with statistics. Despite the fact that Python is a general-purpose language, it has found application in the most complex technologies such as artificial intelligence, machine learning, and deep learning. The advantages and disadvantages of Python are considered in Table 1 [2].

Python is notable for its extensive set of libraries and tools. Speaking about data science, the following should be mentioned first [3]:

1. Pandas (a library for manipulating data with huge capabilities, with its help we quickly conduct research on new data, test hypotheses, get a report);

2. Scikit-learn (a large library of machine learning and data processing algorithms);

3. Keras and PyTorch (libraries for training deep neural networks);

4. IPython Notebook.

For more than 25 years of development history, R has expanded its capabilities so much that it has become widespread in various spheres of human activity.

For example, in biology, ecology, energy, R is a universal tool for statistical processing and specific data analysis.

The sides of R considered below (Table 2) suggest that it is rather difficult to attribute the property of R as a language that combines functional, procedural, object-oriented and reflexive programming to advantages or disadvantages [4].

For a professional with a mathematical background, it will be comfortable enough to work with a large number of sets of built-in functions and variables, libraries, tests, which makes the language very flexible to use.

However, if it is a beginner, these qualities will scare away due to their complexity.

Notably, working with R does not require the mediation of any graphical user interface (GUI).

However, there are several common R programming environments. The most popular of these is RStudio. StatET and ESS are similar. There are also commercial products for working with R, for example, Revolution Analytics, an R service company.

Table 2 – Evaluating R Features

| Advantages | Disadvantages |
|---|---|
| free distribution (as opposed to the S language) | difficulty in learning |
| special libraries for working in a narrow area | deep knowledge of mathematical methods and statistical procedures to study the documentation of some methods |
| multifunctionality (built-in statistical tests, mathematical algorithms, functions for analyzing data in academic and industry research) | outdated add-on packages |
| fully programmable high-level graphics (playable in a separate window and can be saved in various formats) | inconsistency in naming variables and method implementations |
| the ability to analyze several data sets at once and combine different statistical functions | R codes need additional service |
| cross-platform, with open source | |
| extensibility (modular package system) | |
| extensive developer community | |
| backward compatibility (code written 10 years ago should work now) | |
| high-quality data visualization (developed specifically for statisticians) | |
| rich set of libraries for machine learning and statistics | |
| convenient proprietary development environment RStudio | |
| native support for vector computing (fast implementations of mathematical methods using vector and matrix calculations) | |

R, like Python, contains a number of powerful libraries in its arsenal:

1. Dplyr («data manipulation grammar», a library with functionality similar to Pandas);

2. Ggplot2 and Esquisse (powerful libraries for graph visualization);

3. Shiny (a useful library for creating web applications with interactive visualizations of research);

4. Caret, randomForest, Mlr, etc. (dozens of libraries with machine learning methods).

It is worth saying that it is possible to combine the use of these two languages, for example, using RPy, an interface that allows you to take advantage of both languages in their fields.

Combining two languages can be useful in solving the following tasks [5]:

1. Improving the efficiency of settlements;

2. Increasing the speed and convenience of projects.

When analyzing data, using Python is optimal for:

1. Web scraping and crawling (beautifulsoup, Scrapy, etc.);

2. Effective work with databases and applications (sqlachemy, etc.);

3. Implementation of classical ML algorithms (scikit-learn, pandas, numpy, scipy, etc.);

4. The tasks of Computer Vision.

The advantage of R is its extensive collection of libraries, interactive graphics, and more.

Taking into account the peculiarities of both languages, you can benefit from the combination of R and Python by:

1. Exploratory data analysis;

2. Prototyping;

3. Implementation of the project / set of tasks with a wide coverage in various scientific and practical areas.

There are three main categories of approaches to combine R and Python:

1. Command line tools. Execution of scripts using the command line + intermediate storage of files on disk (filling air gap);

The bottom line is to divide the project into separate relatively independent parts, executed in R or Python, and transfer data through disk in some format convenient for both languages.

Execution of scripts using the command line is carried out according to the scheme: <*cmd_to_run*> <*path_to_script*> <*any_additional_args*>,

where:

<cmd_to_run> — command to execute an R or Python script using the command line

<path_to_script> — script location directory

<any_additional_args> — list of arguments to enter the script.

2. Interfacing R and Python. Running R and Python processes at the same time and transferring data between them in RAM (in-memory);

The key here is the direct launch of one language from another and provides for the internal (in-memory) transfer of information.

3. Others.

This category includes the following:

1. Classic jupyter and R majic syntax along with rpy2. You can also install IRKernel.

2. R Notebook. It is enough to install the reticulate library and then specify the language for each cell of the laptop.

3. Apache Zeppelin.

In summary, we can say that both languages have their own advantages and disadvantages. The choice of one of them depends on the specific tasks.

For a young specialist without experience in other languages will be more comfortable with R, since he has simple libraries and graphics. If there is a desire to develop in a scientific field, rather than in a practical direction, then R is an excellent tool. It is better to study ML methods in R, and to work with algorithms for processing big data in Python. It is better to do only data analysis in R, create applications that regularly analyze data in Python. However, for curious professionals, there is an alternative.

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**УДК 662.99**

# NEGATIVE AND POSITIVE SIDES OF DISTANCE LEARNING IN HSTE SPBGUPTD

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**Abstract.** Since 2012, there has been a large growth in the online education market around the world, and because of COVID-19 there was a huge surge in this field. In the spring of 2020, schools and universities of Russia and many other countries switched their learning technology to distant one. In this publication, the authors show the results of their own researches in the seek of answers on some questions, such as did it manage to switch to online education without losing the quality of education and how did this affect the students of the HSTE SPbSUITD.

**Keywords**: distance learning, education, online-learning, information technology.

# ОТРИЦАТЕЛЬНЫЕ И ПОЛОЖИТЕЛЬНЫЕ СТОРОНЫ ДИСТАНЦИОННОГО ОБУЧЕНИЯ В ВШТЭ СПбГУПТД

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**Аннотация.** С 2012 года по всему миру наблюдается большой рост рынка онлайн-образования, а в связи с эпидемией COVID-19 произошел скачок в этом направлении. Весной 2020 года школы и университеты России, а также многих других стран перешли на дистанционное обучение. В данной статье авторы приводят результаты собственных исследований, направленных на поиск ответов в вопросах: получилось ли перейти на онлайн-обучение без потерь в качестве образования и как это повлияло на обучающихся ВШТЭ СПбГУПТД.

**Ключевые слова:** дистанционное обучение, образование, онлайн-обучение, информационные технологии.

The forced emergency switch to a distance learning form of education in colleges in March of 2020 seriously challenged systems of education to organize continuous learning, performance of attestation tests, maintaining the stability of a university and education in general [1]. This publication was prepared based on materials of sociological researches conducted in October of 2020 and in March of 2021 among students of the Institute of Power Engineering and Automation of the HSTE SPbSUITD.

Anonymous research was carried by the authors, thus creating conditions for students to freely express their opinions. The anonymously made it easy for students to feel mentally stable and safe and interviewers to get more sincere answers to the posed questions. Nevertheless, the obvious problem with anonymous survey is that creators can't realize who exactly mentioned what problem, from which Institution was the student.

In progress of sociological survey containing two stages (October of 20$^{th}$, March of 21$^{st}$) a total of 327 students of the Institute of Power Engineering and Automation were selectively interviewed. As the result of the first stage, there was the picture that was giving the main view of the situation. The analysis of data cover the following areas: organizational problems of switching to distance learning, recourses that used, organization of lectures and seminars, assessment of the positive and negative aspects of distance learning. Mathematical processing of data of accumulated statistics was carried out by using general-purpose software such as Microsoft Excel.

Fully satisfied of distance learning was only 14 % of students, however more than the third of students stated that this form of education they like more than the traditional one [2]. 40 % of students mentioned significant increase in study load that was due to, otherwise other things, expansion of proportion of self-study. The half of respondents also reported that it was harder than usual to complete the spring session this year, citing the main reason: "It is difficult to concentrate when studying the materials on my own". Most often (multiple-choice question) the students had technical issues with Moodle and bad internet connection (62 %), lack of communication with classmates (43 %), face-to-face discussions with professors (31 %). Another 28 % face difficulties with answering to professors in online-format because of long-term feedback.

Also, the respondents mentioned advantages of distance learning form of education, one of the leading was "there is more time to sleep", it was noted by 64 % of students.

According to the authors who conducted the survey, the following advantages and disadvantages of distance learning can be noted.

*Disadvantages:*

1. Technical issues, periodic site crashes, lack of equipment
2. Adaptation, difficulty in rebuilding to the online format
3. Lack of real-life communication both with classmates and with the teaching staff.
4. The need to execute a larger amount of work than usual
5. Absence of boundaries between working and free time

*Advantages:*

1. Flexibility of the schedule
2. Possibility of individual work, communication with the teacher
3. The opportunity to study in comfortable conditions at home
4. The availability of education materials which teachers now place in information environments

The results of the second stage showed that main problem is lack of skills in working with digital and information technologies of professor-teaching staff. The students believe that lecturers should not only know digital educational competencies, but also master them, be ready to work in conditions of "indirect" communication with students to assist them and support in the period of studying (Fig. 1) [3].

a b

Figure 1. Process of learning of university students:
a – in-person, b – distant

So, the distance learning with all its convenience and mobility, possibilities of information technology and the Internet, can become worthy support and diversify traditional full-time education, realizing all its advantages [4]. According to the authors opinion, the best option it to have mixed mode which

allows you to realize the facilities and advantages of both forms of education, so, for example, due to the full-time form of education, you can significantly reduce the disadvantages in the problems of poor quality of education.

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# MODERN TRENDS IN THE APPLICATION OF INTELLIGENT TECHNOLOGIES BASED ON NEURAL NETWORK MODELING

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**Abstract.** Currently, the company uses methods and tools that are aimed at creating conditions that maximize the achievement of goals. One of the important goals of the production system is to produce products of the required quality. For a long time, intelligent technology elements have been added to production lines to perform this task, since they do not require constant refinement and updates to the program, and they also have the ability to analyze various types of data (videos, images, signs, texts). This paper presents current trends in the use of intelligent systems as automation tools for various processes.

**Keywords:** intelligent system, neural networks, database, information storage.

# СОВРЕМЕННЫЕ ТЕНДЕНЦИИ ПРИМЕНЕНИЯ ИНТЕЛЛЕКТУАЛЬНЫХ ТЕХНОЛОГИЙ НА ОСНОВЕ НЕЙРОСЕТЕВОГО МОДЕЛИРОВАНИЯ

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**Аннотация.** В настоящее время на предприятии используются методы и средства, которые направлены на создание условий, максимально способствующих достижению поставленных целей. Одной из важных целей производственной системы является выпуск изделий требуемого качества. Уже давно для выполнения данной задачи на производственных линиях добавляют элементы интеллектуальных технологий, так как они не требуют

постоянной доработки и внесения обновлений в программу, а также имеют возможность анализировать данные разного типа (видео, изображения, знаки, тексты). В данной работе представлены актуальные тенденции применения интеллектуальных систем в качестве средств автоматизации различных процессов.

**Ключевые слова:** интеллектуальная система, нейронные сети, база данных, информационные хранилища.

In today's changing conditions, the enterprise uses methods and tools that are aimed at creating conditions that maximize the achievement of the goals. One of the important goals of the production system is to produce products of the required quality. For a long time, elements of intelligent technologies have been added to perform this task on production lines, since they do not require constant revision and updates to the program, and also have the ability to analyze data of different types (videos, images, signs, texts).

An intelligent system is a system capable of independently solving assigned tasks, based on the knowledge that is stored in its memory. Intelligent systems are:

1. Inductive systems are self-learning intelligent information systems that work on the principle of induction.

2. Case-based systems are self-learning intelligent information systems that use decision cases as units of knowledge. They select and adapt the most similar examples (use cases) based on a specific query. In such systems, the knowledge base does not contain descriptions of generalized situations; they have been replaced by situations or precedents themselves. The search for a solution to the problem is reduced to the search for analogs.

3. Information storages are self-learning intelligent information systems that allow you to extract knowledge from databases and create specially organized knowledge bases.

4. Neural networks are self-learning intelligent information systems that build an associative network of concepts (neurons) for parallel search for solutions on it, having previously analyzed real examples [1].

Intelligent systems are actively used in industry – with the help of them they compose and optimize production chains, control production processes, collect and analyze current information, optimize the dispatching activity of various industries.

Intelligent technologies are also used in other areas, for example, quite recently, neural networks began to be used to identify traffic offenders.

Early all violations had to be identified manually by analyzing video recordings. However, this is an extremely time-consuming process. That is why it was decided to automate the recording of traffic violations. We decided to start by identifying the most obvious violation – the intersection of a double solid line.

The convolutional neural network U-Net, which is a sequence of layers of convolution and pooling, segments images and detects road markings by reducing and then increasing the spatial resolution of the image and passing it through other convolution layers [2].

To train the model, a training dataset was needed. To create a suitable dataset, about 1,500 screenshots from DVRs were selected, and then using the Supervise.ly service, the roadbed was marked on them. The model trained on such a dataset determines the road marking lines and forms a solid line from them, which should not be crossed by the car. Also, using a neural network, you can determine the cars that pass under cameras with other people's numbers. The system is able to automatically compare data obtained from open access with the database of the Ministry of Internal Affairs [3].

Currently, neural networks are used in almost all areas: quality control of manufactured products, monitoring systems for the state of equipment, design and optimization of communication networks, power supply networks, forecasting energy consumption, recognition of handwritten characters, automatic signature recognition, recognition and processing of video and audio signals, forecasting and assessing the risk of an upcoming transaction, predicting possible fraudulent activities, forecasting economic parameters and stock indices, forecasting sales volumes, forecasting demand for new products, comparative analysis of competing firms [4, 5].

Intelligent systems are indispensable for most enterprises, as they help not only save people from routine and repetitive work to save time, but also eliminate the human factor in production processes.

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**УДК 616.233-008.8**

# STUDY OF THE EFFECT OF SECONDARY IMMUNE DEFICIENCY SYNDROME ON THE CLINICAL PICTURE OF BRONCHIAL ASTHMA

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**Abstract.** A significant complication of the course of bronchial asthma was revealed in the presence of secondary immune deficiency syndrome in the patient. The prognosis of the course of bronchial asthma becomes heavier, a certain refractoriness to the prescribed and conducted standard basic therapy is established. This ensures the need for competent correction of the immune status, taking into account the pathogenetic specifics of the formation of bronchial asthma and the significant role of the immune system in the development of this pathology.

**Keywords:** bronchial asthma, secondary immune deficiency syndrome, glucocorticosteroids.

# ИЗУЧЕНИЕ ВЛИЯНИЯ СИНДРОМА ВТОРИЧНОЙ ИММУННОЙ НЕДОСТАТОЧНОСТИ НА КЛИНИЧЕСКУЮ КАРТИНУ БРОНХИАЛЬНОЙ АСТМЫ

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**Аннотация.** При присутствии у пациента синдрома вторичной иммунной недостаточности выявили достоверное осложнение течения бронхиальной астмы. Прогноз течения бронхиальной астмы утяжеляется, устанавливается определенная рефрактерность к назначенной и

проводимой стандартной базисной терапии. Это обеспечивает необходимость грамотной коррекции иммунного статуса, учитывая патогенетическую специфику формирования бронхиальной астмы и значимую роль иммунной системы в развитии данной патологии.

**Ключевые слова**: бронхиальная астма, синдром вторичной иммунной недостаточности, глюкокортикостероиды.

Relevance of the study. One of the most urgent medical and social problems today is bronchial asthma (BA) [1, 5]. This allergic disease is the most common chronic non-infectious pathology characterized by the relative severity of the course, the complexity of diagnosis and therapy, and high monetary costs for treatment [2, 4]. A characteristic feature of the course of allergopathology in patients can be called a combined complex of allergy and secondary immune deficiency syndrome (VIN).

The syndrome of secondary immune insufficiency is characterized more often by reversible pathologies of the functioning of adaptive mechanisms of the immune system, which to a large extent provides complications of the clinical picture of the course of the disease, in particular, bronchial asthma [3]. It is the presence of clinical and laboratory signs of VIN in patients, which provides insufficient effectiveness of standard therapy, that creates the need for the appointment of immunotropic drugs to complex therapy [3, 4, 5]. This fact makes it necessary to establish the reliability of the relationship between the severe form of bronchial asthma and the presence of VIN syndrome in the patient.

The aim of the study was to study the nature of the relationship and the effect of secondary immune deficiency syndrome in patients on the clinical picture of the course of bronchial asthma.

Materials and methods of research. The work was carried out on the basis of the Department of Clinical Immunology, Allergology and Phthisiopulmonology of Kursk State Medical University.

To ensure the representativeness of the sample of the number of respondents in relation to the general population with a confidence probability of 85 % and a confidence interval of 15 %, it is necessary to involve at least 46 patients in the study. 52 patients with bronchial asthma took part in the study, which fully satisfies the need to ensure the representativeness of the sample. The average age of the patients was 35,4 ± 3,3 years. Among them, women – 48 %, men – 52 %.

Clinical markers of VIN syndrome were found in 33 % of patients, therefore, based on the presence or absence of these markers in patients, 2 groups of patients were identified: a group of constant dynamic control (patients with VIN syndrome) and a standard control group (patients without markers for VIN).

All patients were prescribed standard therapy – basic and symptomatic treatment. The standard basic therapy was based on anti-inflammatory treatment with inhaled glucocorticosteroids (IGCS).

Clinical manifestations of VIN in the studied patients with markers of VIN were expressed in the form of an infectious syndrome characterized by frequent prolonged recurrent acute respiratory viral infections (at least 4 times a year), periodic frequent exacerbations of various chronic purulent-inflammatory diseases with different localization and causally significant infectious pathogens, labial herpes with frequent relapses. The symptoms were accompanied by insufficient effectiveness of the standard basic therapy chosen for conducting.

The results were evaluated based on the dynamics of clinical and functional, immunological, and allergological studies. Statistical data processing was carried out using the MS Excel Data Analysis package.

The results of the study. The clinical picture of bronchial asthma in the study group with concomitant syndrome of secondary immune insufficiency is characterized by frequent, periodic exacerbations (4,60 ± 0,17 per year), forced calls for emergency medical care (7,88 ± 2,10 per year), a certain refractory to therapy in an outpatient setting during an exacerbation with indications for hospitalization (2,64 ± 0,13 per year), which naturally increases the volume of standard basic therapy during relapse and exacerbation (2,65 ± 0,15 times a year ). These indicators can characterize the uncontrollability of the course of bronchial asthma, burdened by the syndrome of secondary immune insufficiency.

In addition, naturally, the dynamic control group had frequent periodic acute respiratory infections, aggravating inflammatory diseases with frequent exacerbations. On the basis of statistical data, the reliability of the observed association of acute bronchial asthma with exacerbation of chronic concomitant inflammatory diseases, recorded relapses of herpes infection has been proven.

According to the results, it was revealed that patients with bronchial asthma combined with secondary immune deficiency syndrome may have heterogeneous pathologies of the immune system, in particular, inhibition of cellular and phagocytic links of immunogenesis together with activation of the humoral component of the immune system.

The analysis of the data obtained during the study indicates the pathology of the functioning of the opsonophagocytosis system, which provides anti-infective protection in patients with bronchial asthma with clinical markers of VIN.

These disorders may be caused by the interaction of cells of the monocyte-macrophage system with allergen, IgE- and IgG-containing immune complexes, infectious agents [5].

Conclusions. The study revealed a significant complication of the course of bronchial asthma in the presence of secondary immune deficiency syndrome in the patient. The prognosis of the course of bronchial asthma becomes heavier, a certain refractoriness to the prescribed and conducted standard basic therapy is established. This ensures the need for competent correction of the immune status, taking into account the pathogenetic specifics of the formation of bronchial asthma and the significant role of the immune system in the development of this pathology.

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**УДК 004.4**

# DEVELOPMENT OF THE PLATFORMER PROJECT IN THE UNITY

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**Abstract**. Our world is changing rapidly, the gaming industry produces a lot of content every day, and huge amounts of money are spinning inside it. This paper describes the main principles of development project in the gaming industry, studied in the process of research on the development of games on the Unity platform, any of the elements of this game can be used in any other Unity project.

**Keywords**: unity, C#, 2D, electronic entertainment, electronic games.

# РАЗРАБОТКА ПРОЕКТА ПЛАТФОРМЕРА В СРЕДЕ UNITY

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**Аннотация**. Наш мир стремительно меняется, игровая индустрия производит каждый день множество контента, а внутри нее задействованы огромные суммы. В данной работе описаны основные положения по разработке проекта в игровой индустрии, изученные в процессе исследований по разработке игры на платформе Unity, любой из элементов данной игры можно использовать в любом другом проекте Unity.

**Ключевые слова**: Unity, C#, 2D, электронные развлечения, электронные игры.

Unity is a cross-platform computer game development environment developed by the American company Unity Technologies. Unity allows you to create applications that run on over 25 different platforms, including personal computers, game consoles, mobile devices, web applications and more [1].

Platformer is a genre of video games where the player controls the main character in a 2D scene. Nowadays, games are a place of solitude, where a person can relax, get distracted from real life for a while, release aggression [2].

The purpose of this work is to outline the stages and their detailed description of creating a 2D platformer using the Unity engine. Unity specializes in creating games of any complexity, both 2D and 3D, using a variety of integrated tools. We create a 2D project, after which a new window opens, the engine itself, where the game will be created (Fig. 1).

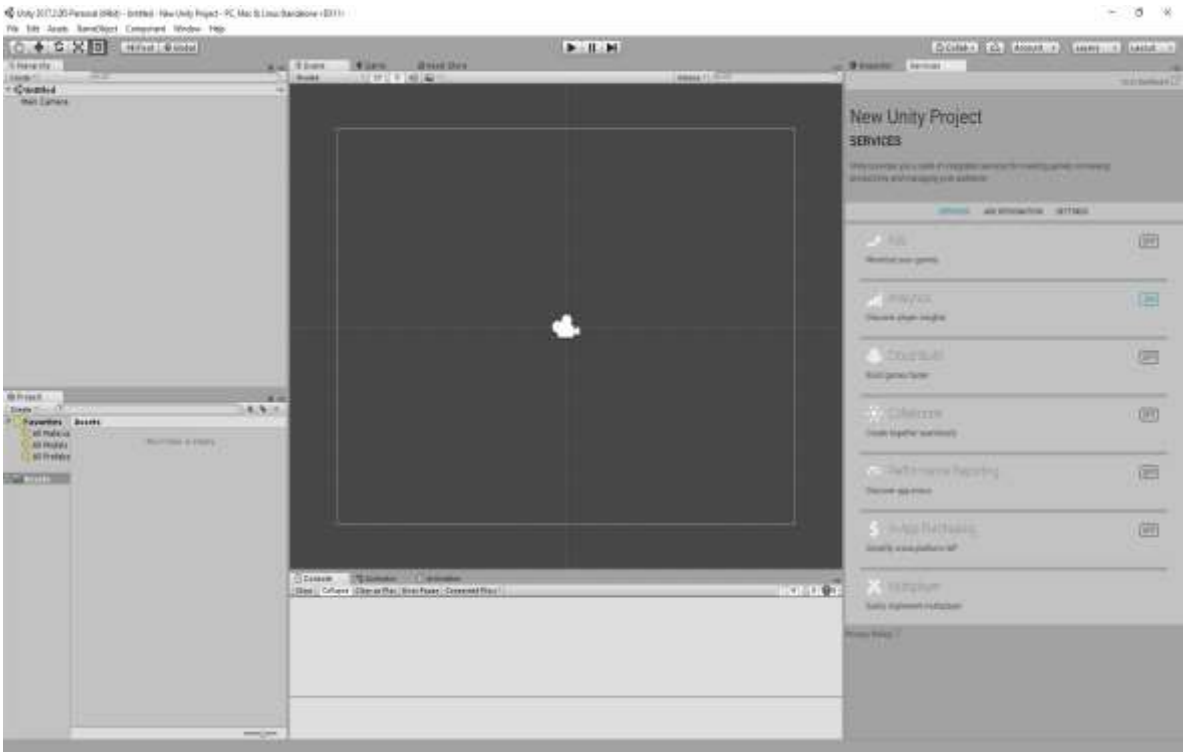


Figure 1. Work area in Unity

First, the Background for the game is created. The "Canvas" element is created in the "Hierarchy" tab. After that, the element is selected and its settings are displayed in the "Inspector" tab. In the "Render Mode" parameter, "Screen Space – Camera" is selected and after applying this setting, a new "Render Camera" field will appear. To the left of this field, you need to set "Main Camera". After these actions, select the "Canvas" created earlier, then use "UI" – "Image". Take the picture and drag it to the "Assets" folder first. there can be many files in the project, it is better to create the following folders: "Animations", "Mobs", "Objects", "Scripts". Now drag the picture into the "Objects". The image is now fully stretched.

Let’s create platforms for moving in a similar way and add the "Box Collider" property to them (Fig. 2).

Figure 2. The result of the creation of platforms

Create "Create Empty", choose "Hierarchy" – "Create Empty". Rename the object to "Character". Select the object and choose "2D Objects" – "Sprite". In the "Sprite" field, drag the character's image. Next, add 2 colliders to it: box and circle, as well as "Rigidbody 2D". Next, go to the "Scripts" – "Create" – "C # Script" folder. Now we have to write the code for the character. In the main body of the script, write the following (there are explanatory comments in the code):

[SerializeField] private float speed = 3f; [SerializeField] private int lives = 5; [SerializeField] private float jumpForce = 15f; private bool isGrounded = false; // Boolean variable that will be needed in the implementation of the character's jump, it will be required so that the character cannot jump in the air

private Rigidbody2D rb; private SpriteRenderer sprite; private Animator anim; public static Hero Instance {get; set;} // Variables that will give access to the properties of the created character

public bool isAttacking = false; public bool isRecharged = true; public Transform attackPos; public float attackRange; public LayerMask enemy;

private states state

{get {return (States) anim. GetInteger ("state");}

set {anim. SetInteger ("state", (int) value);}} // This is required for animation and their change

private void Awake ()

{Instance = this;

rb = GetComponent <Rigidbody2D> ();

anim = GetComponent <Animator> ();

sprite = GetComponentInChildren <SpriteRenderer> ();

isRecharged = true;} // Method that is automatically launched when the game starts

private void FixedUpdate ()

{CheckGround ();
} void Update ()
{if (isGrounded &&! isAttacking) State = States.idle;
if (Input.GetButton ("Horizontal")) Run ();
if (isGrounded && Input.GetButtonDown ("Jump")) Jump ();
if (Input.GetButtonDown ("Fire1")) Attack ();} // These two methods run other methods, in fact, they tell how and when to go, jump, fight, stand
private void Run () // Method for running
{if (isGrounded) State = States.run;
Vector3 dir = transform. right * Input.GetAxis ("Horizontal");
transform. position = Vector3.MoveTowards (transform. position, transform. position + dir, speed * Time.deltaTime);
sprite. flipX = dir.x <0.0f;} // Method that implements running and changing direction of the character.
private void Jump () // Jump
{rb. AddForce (transform. Up * (jumpForce / 2), ForceMode2D.Impulse);} // One of the methods that implements the jump

In order to correctly implement the jump, you need a method to check if the character is on the ground. To do this, you need to create an array colliders, and assigned a radius of 1F to it. This command should check for touch with the ground, the reference point is from the feet of the character. When the character is in the air command isGrounded = colliders.Length> 1; will give out false because the character consists of two colliders, and the reference point goes from the legs, then these 1 colliders will always fall within the radius of the array, and when the character is on the ground, another collider of the earth will fall within the radius of the array, which means that the value will exceed 1 [3]. Subsequent code for the character:

private void CheckGround () // Method for checking the ground under feet
{Vector3 dir = transform. up;
Collider2D [] collider = Physics2D.OverlapCircleAll (transform. Position, 1f); isGrounded = collider. Length> 1; if (! isGrounded) State = States.jump;}
public void GetDamage ()
{lives--;
Debug.Log ("The hero has:" + lives + "lives");} // Method that implements damage and displays the number of lives of the character to the console
private void Attack ()
{if (isGrounded)

```
{State = States.attack;
    isAttacking = true;
    isRecharged = false;
    StartCoroutine (AttackAnimation ());
    StartCoroutine (AttackCoolDown ());}} // We insert this method at
```
the end of the animation so that only when the blow is completely done, the blow is delivered

public enum States {idle, run, jump, attack} // These are the states that are used to change the animation

The character script is complete, let's move on to animating it. Select the character, open the "Animation" tab and to the left of the "samples" inscription – "Create New Clip ...". Next, select save to the "Animations" folder, in the "Animation" window, click "Add Property" – "New Sprite" – "Sprite Renderer" and look for the desired sprite, then click on the plus opposite it. Now to the right there is an area with a ruler, above it there is a scale with time. To the left are buttons for creating animation. And so, to make the animation, you need a couple of frames of the character where he is walking. Click on the record button (Red circle), select the character. Next, drag the slider in the linear area a certain number of frames to the right, select the picture where the character takes the first step and drag it into the character's sprite in the "Sprite" field. Jump and idle animations are created in exactly the same way. Next, select the character and add "Animator" to him in the components. The animation setup is complete.

Create an enemy in the form of a thorn, add a 2D Polygon collider to this texture (Fig. 3).

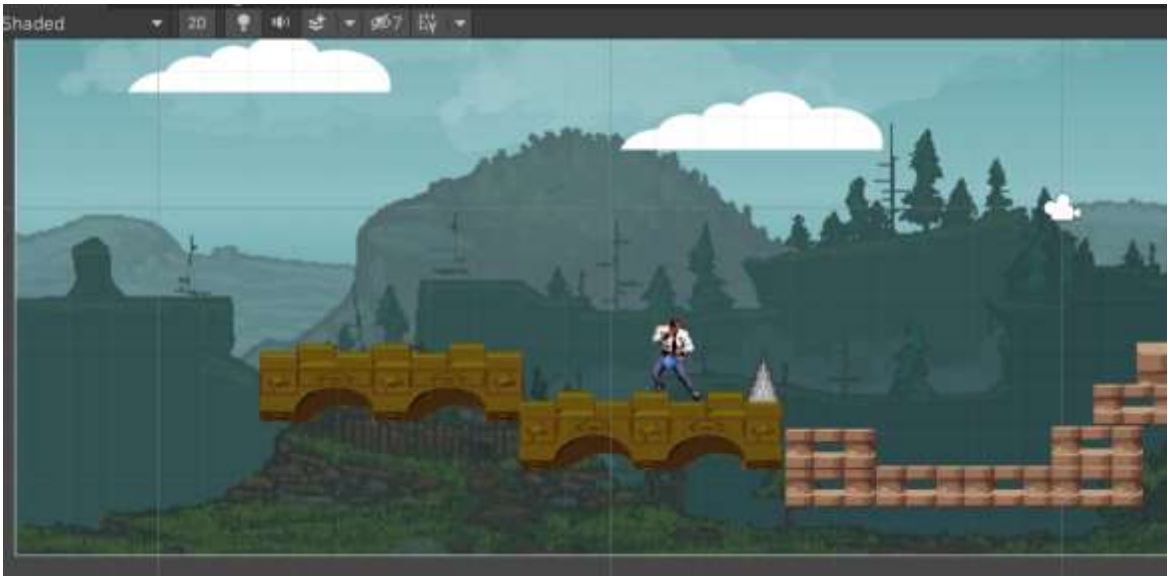


Figure 3. The result of creating a thorn

Thorn script code:

```
using UnityEngine; using System.Collections;
public class Knife: MonoBehaviour
{private void OnTriggerEnter2D (Collider2D collider)
Unit unit = collider.GetComponent <Unit> ();
if (unit && unit is Character)
{unit.ReceiveDamage ();
}}}
private void OnTriggerEnter2D (Collider2D collider)
{Unit unit = collider.GetComponent <Unit> ();
if (unit && unit is Character)
{unit.ReceiveDamage ();}}
```

Mob (English Mob, mobile, short for English mobile object) – any non-static object in a computer game. Special cases of mobs are playable characters, non-playable characters, and monsters.

Now let's move on to creating the code for the mob that will walk from wall to wall:

```
private Vector3 dir; private Rigidbody2D rb; private SpriteRenderer sprite;
private void Start ()
    {sprite = GetComponentInChildren <SpriteRenderer> ();
      dir = transform. right;
      lives = 5;}
    private void Update ()
    {Move ();}
    private void Move ()
    {Collider2D [] colliders = Physics2D.OverlapCircleAll (transform.
Position + transform. Up * 0.1f + transform. Right * dir.x * 0.7f, 0.1f);
      if (colliders. Length> 0) {
        dir * = -1f;
        sprite. flipX = dir.x <0.0f;}
      transform. position = Vector3.MoveTowards (transform. position,
transform.position + dir, Time.deltaTime);}
```

A method that implements the movement of a mob, as soon as it detects a wall within a radius of 1f, it turns around and goes in the other direction.

```
    private void OnCollisionEnter2D (Collision2D collision)
    {if (collision.gameObject == Hero.Instance.gameObject)
      {Hero.Instance.GetDamage ();
        lives--;
        Debug.Log ("Enemy:" + lives + "lives");}
```

if (lives <1) Die ();}

UI is a User Interface (literally "user interface") – a set of tools and rules for human-computer interaction. One of the main and oldest is the command line interface (or command interface).

Let's create an indicator of the number of lives (Fig. 4).

Figure 4. Complete indicator of lives

Add "Canvas", then go to "UI" and find the desired "Canvas". Create a "Panel", make it smaller and snap it to the top left corner. Now create a child object in the "Panel", in the "Source Image" setting, select the picture of lives. Let's make sure that the pictures of the lives of the hearts are equally distant from each other. To do this, select the "Panel" and in the "Add component" go to the "Layout" section, where we select the "Horizontal Layout Group". Now, in the "Child Force Expand" setting, uncheck the boxes so that Unity does not stretch the picture across the entire "Panel". Now select the image of lives and add a component to it from the "Layout" section called "Layout Element". Make 4 copies of this object, since the character will have 5 lives. Let’s make the "Panel" change the color of the icons depending on the number of lives left. To do this, we will create variables in the code itself that will store the image of an empty heart and inside the code this image will replace the icon of a full heart.

The code that is added to the character script:

[SerializeField] private Image [] hearts; [SerializeField] private Sprite aliveHeart; [SerializeField] private Sprite deadHeart; // The first variable is an array that will hold hearts. Two other variables for changing the image to red heart and gray.

private void Awake ()

{Instance = this; rb = GetComponent <Rigidbody2D> (); anim = GetComponent <Animator> (); sprite = GetComponentInChildren <SpriteRenderer> (); isRecharged = true; lives = 5; health = lives; }

Add the following lines to the Update method, which update the heart images in a loop if they are replenished or vice versa decreasing:

for (int i = 0; i <hearts.Length; i ++)

{if (i <health)

hearts [i] .sprite = aliveHeart; else hearts [i] .sprite = deadHeart;

if (i <lives)

hearts [i] .enabled = true; else hearts [i] .enabled = false; }

Now let's move on to the most important thing, to creating a menu and a level selection window. Let's start with the menu, for this we need to create a File – New Scense scene, as when creating a level, add Background, Image with the game logo and the IU-Buttom button (Fig. 5).


Figure 5. Platformer menu

Now let’s move on to creating a menu for selecting a level. Let’s create another scene. Add Background, text, semi-transparent panel and 2 buttons to it (Fig. 6).


Figure 6. Level selection menu

Figure 7. The final result

That’s it, now we have the easiest game to play. All the necessary components have been created, now you can see the result of the work done (Fig.7).

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**УДК 338.984**

# ESTIMATION OF COSTS FOR LIGHTING OF THE HSTE BUILDING

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**Abstract.** The university with all the buildings is used as an object of modernization. This article proposes replacing the existing fluorescent lighting with LED. The benefits of switching to LED lighting are substantiated.

**Keywords:** energy saving, lighting, LED lighting.

# ОЦЕНКА ЗАТРАТ НА ОСВЕЩЕНИЕ ЗДАНИЯ ВШТЭ

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**Аннотация**. В качестве объекта модернизации используется здание вуза со всеми корпусами. В данной статье предлагается заменить существующее люминесцентное освещение на светодиодное. Обосновывается выгода от перехода на светодиодное освещение.

**Ключевые слова**: энергосбережение, освещение, светодиодное освещение.

The main goal of energy saving is the lowest costs during installation and maintenance of the system, as well as the comfort of the university staff from the operation of the system. In addition, the switching to LED lighting is carried out in connection with the federal law on energy conservation and energy efficiency, and on amendments to certain legislative acts of the Russian Federation [1].

The object of modernization is the Higher School of Technology and Energy (HSTE), Saint Petersburg, Ivan Chernykh street, 4.

It was founded in 1931 as the Leningrad Institute of Promcooperations. In 1981, the university was awarded the Order of the Red Banner of Labor. In 1987 it was included in the list of the leading universities in Russia. In 2015 it was joined to SPbSUITD [2].

*Characteristics of the HSTE building*

The HSTE automation facility consists of five buildings “А”, “Б”, “В”, “В*”, “Д” and a gym, connected by galleries.

Height of buildings: building "А" – 5 floors (11800 m2); building "Б" – 7 floors (13700 m2); building "В" – 6 floors (4560 m2); building "В*" – 6 floors (8 573 m2); building "Д" – 2 floors (2680 m2); gym – 3 floors (970 m2).

S (total) = 11800 + 13700 + 4560 + 8573 + 2680 + 970 = 42288 m2 – the total area of all buildings.

*Organization of lighting control*

Each building has work and duty lighting, which includes the following functions:

*Work lighting* – designed to ensure the implementation of the production and educational process and aisle lighting.

*Emergency lighting* – designed to illuminate the protected premises of the university during non-working hours and is approximately 5 % of the total consumption, coinciding with the dark time of the day, providing minimum illumination for duty and security.

One should pay special attention and adhere to the norms when choosing luminaires in educational institutions. The number of fixtures can be calculated, focusing on the number Lux (Lx) – a unit that shows the ratio of Lm/m2. [3]. So, in classrooms, the illumination of the working surface should be at least 500 lux (GOST) [4].

Now the university mainly uses 36W and 18W fluorescent lamps.

Consider the switching to LED lamps with a power of 10 W (900 lm) and 18 W (1800 lm) [5]. The first type of luminaires consists of 4 10 W diode lamps. The second one consists of 2 lamps of 18 watts. The luminaires are approximately equivalent to each other in terms of power, therefore, in further calculations, they will not be divided by type. First, the area that one lamp should illuminate is found. After that, the number of fixtures, the amount of energy consumed by the lighting and the cost of it for the month are considered. Next, a calculation is made that shows how much more profitable it is to use LED lamps. It is worth considering the operating time of the working and standby lighting, as well as the cost of one kW of energy = 8,5 rub. It is also worth considering that 5 % of the energy goes to standby lighting.

*Comparison of energy costs for LED and fluorescent lighting per one month*

900*4 = 3600 lm (luminous flux of one lamp); 3600/S1 = 500 lm (lighting standard in classrooms and rooms in accordance with GOST) [5];

$S_1$ = 3600/500 = 7,2 m2, $S_1$ is the area illuminated by one lamp;

Nlp = 42 288/7.2 = 5 873 pcs, Nlp is the total number of lamps in the university.

*Fluorescent lamps:*

Eh = 5 873*4*18/1000 = 422,8 kWh, Eh is the energy consumed by the lamps per one hour;

Ed = 422,8*12 = 5 073,6 kWh, Ed is the energy consumed by the lamps per one working day;

Em = 5 073.6*26 = 131 913,6 kWh, Em is the energy consumed by fluorescent lamps per month, excluding Sundays;

Pwt = 131,913.6*8.5 = 1,121,265,6 rub., Pwt is the cost, provided that the light is on all working time;

5% is spent on emergency lighting, which works 24/7.

Se = 42288/100*5 = 2 114.4 m2, Se is the area illuminated by emergency lighting;

Nlpe = 2 114.4/7.2 = 294 pcs, Nlpe is the number of lamps of emergency lighting;

Ehe = 294*4*18/1000 = 21.1 kWh, Ehe is the energy consumed by the emergency lighting per one hour;

Ere = 21,1*12*30 = 7 596 kWh, Ere is the energy consumed by the emergency lighting per the remaining 12 hours;

Pel = 7 596*8,5 = 64 566 rub., where Pel is the additional cost for emergency lighting.

*LED lamps:*

Eh = 5 873*4*10/1000 = 234,9 kWh, Eh is the energy consumed by the lamps per one hour;

Ed = 234,9*12 = 2 818,8 kWh, Ed is the energy consumed by the lamps per one working day;

Em = 2 818,8*26 = 73 288,8 kWh, Em is the energy consumed by diode lamps per month, excluding Sundays;

Pwt = 73 288,8*8,5 = 622 954,8 rub., Pwt is the cost, provided that the light is on all working time;

5 % is spent on emergency lighting, which works 24/7.

Se = 42288/100*5 = 2 114,4 m2, Se is the area illuminated by emergency lighting;

Nlpe = 2 114,4/7,2 = 294 pcs, Nlpe is the number of lamps of emergency lighting;

Ehe = 294*4*10/1000 = 11,76 kWh, Ehe is the energy consumed by the emergency lighting per one hour;

Ere = 11,76*12*30 = 4 233,6 kW, Ere is the energy consumed by the emergency lighting per the remaining 12 hours;

Pel = 4 233,6*8,5 = 35 985,6 rub., Pel is the additional cost for emergency lighting.

*The costs per one month were for:*

1) Fluorescent lighting is 1 121 265,6 + 64 566 = 1 185 831,6 rub.

2) LED lighting is 622 954,8 + 35 985,6 = 658 940,2 rub.

From these calculations, we can conclude that the cost of electricity consumption for fluorescent lighting is 45 % higher compared to LED lighting.

*The cost of installing of fluorescent lighting*

1) The cost of a 36 W lamp is 70 rub. [6].

The cost of a lamp construction without lamps is 524 rub.

The total cost of the lamp construction is 664 rub.

2) The cost of an 18 W lamp is 50 rub.

The cost of a lamp construction without lamps is 888 rub.

The total cost of the lamp construction is 1088 rub.

Since both types of lamps are used, let’s take the average cost – 876 rub.

The cost of all LED lamps in the university:

876*5 874 = 5 145 624 rub.

+ 30 % of the cost of lamps for installation work.

And the total cost is 6 689 311,2 rub.

*The cost of installing of LED lighting*

1) The cost of an 18W lamp is 102 rub. [6].

The cost of a lamp construction without lamps is 524 rub.

The total cost of the lamp construction is 732 rub.

2) The cost of a 10W lamp is 88 rub.

The cost of a lamp construction without lamps is 888 rub.

The total cost of the lamp construction is 1240 rub.

Since both types of lamps are used, let's take the average cost – 986 rub.

The cost of all LED lamps in the university:

986*5 874 = 5 791 764 rub.

+ 30 % of the cost of fixtures for installation work.

And the total cost is 7 529 293,2 rub.

So, the cost of installing LED lighting is 839,982 rubles more expensive. But if you take into account the cost of electricity, the cost of LED lighting is noticeably less.

Table 1 shows a comparative analysis of fluorescent and LED lamps.

Table 1 – Comparison of fluorescent and LED lamps

| **Parameter/type** | **LED** | **Fluorescent** |
|---|---|---|
| Monthly electric costs, rub. | 658 940,2 rub. | 1 185 831,6 rub. |
| Lamp price, rub. | 88 rub./102 rub. | 50 rub./70 rub. |
| Life time | Up to 50 000 hours | Up to 25 000 hours |
| Environmental Safety | Yes | No (contains mercury) |
| Disposal | Does not require special disposal measures | Require special disposal measures |
| Service | Rarely | Moderately |

Summing up, it is safe to say that the switching to LED lighting will help reduce energy costs by almost 2 times, and there will be no problems with disposal. Also, the service life of an LED lamp is noticeably longer compared to fluorescent ones.

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**УДК 334.7**

# PARTNERSHIP BETWEEN THE STATE AND BUSINESS AS A FACTOR OF ECONOMIC ACTIVITY

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**Abstract.** The article examines the models characterizing the interaction of government and business, defines their role and importance in the current economic conditions. It is noted that the analysis of the models on which the interaction of private corporations and the public sector is based is of exceptional importance for solving further prospects for the development of the domestic economy.

**Keywords:** partnership models, public-private partnership, cooperation model, concession.

# ПАРТНЕРСТВО ГОСУДАРСТВА И БИЗНЕСА КАК ФАКТОР ЭКОНОМИЧЕСКОЙ АКТИВНОСТИ

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**Аннотация.** В статье рассмотрены модели, характеризующие взаимодействие власти и бизнеса, определены их роль и значение в сложившихся современных экономических условиях. Отмечено, что анализ моделей, на которых строится взаимодействие частных корпораций и государственного сектора, имеет исключительное значение для решения дальнейших перспектив развития отечественной экономики.

**Ключевые слова:** модели партнерств, государственно-частное партнерство, модель кооперации, концессия.

In the course of the latest social, economic and institutional transformations, the role of the state, the rules and forms of its participation in the

economy, as well as the ways of regulating economic processes are changing. As a result of globalization and the increasing interdependence of economic entities, the complication of the reproductive process, the tasks of economic regulation, there is a need to study new forms of interaction of all major economic entities, primarily the state and business.

For many years, economists and practitioners have been trying to find ways to solve problems related to the decline in business efficiency, institutional shortcomings of its functioning, increased social responsibility of both the state and business entities, the merger of power institutions and business structures that generate corruption and many other deviant manifestations in the business environment, and constraining the development of society as a whole. The existing system of relations between business and the state in Russia determines the need to form new mechanisms of partnership and interaction between them based on a combination of both the principles of state regulation of the economy in order to ensure the goals, objectives and priorities of the development of society, and the motivational interests of business.

In the modern mixed market economy, regulated economic relations are being formed with close interaction and coexistence of the state and business, which is manifested in the development of various forms of partnership and their spread in various sectors of the economy. French politician and researcher L. Fabius argues that the time of the partner state is coming to replace the sovereign state in the XXI century, “the era of synthesis is coming”, which makes the state more effective and open. At the same time, the transformation of the state into an equal subject of market relations concerns, first of all, not just a quantitative contribution, but the ratio of the rights and obligations of the parties. So, the scientific search and justification of effective methods, forms and mechanisms of economic partnership and interaction between business and the state, which would contribute to business activity, is an important national economic task [1, p. 121].

Such scientists as O. Vikarchuk, M. Voynarenko, I. Bernstein, M. Boguslavsky, Z. Varnali, V. Denisyuk, V. Osipov, T. Puzanov, Ya. Usenko, V. Chepinoga, etc. studied the problems of the formation of concession relations in the process of economic transformation and the mechanisms of using the concession to attract investment resources. V. Varnavsky, V. Geets, A. Golovko, G. Deryabina, S. Dryga, T. Yefimenko, M. Klinova, A. Kuzhel, V. A. Golovko, G. Deryabina, S. Dryga, T. Yefimenko, M. Klinova, V. V. Golovko, V. V. Golovko, V. V. Golovko, V. V. Golovko, V. V. Golovko, V. V. However, there is no comprehensive study of the use of various models of public-private

partnership, justification of institutional gaps in the implementation of its individual forms and justification of a set of measures to implement a systematic approach to managing the processes of economic interaction between business and the state.

The world practice of using various models of partnership between the state and business, due to the need to implement national, strategic and major programs and projects of priority socio-economic importance; the importance of certain network and monopoly segments being owned by the state through the strategic, economic and socio-political significance of infrastructure facilities; institutional unwillingness of the owner (the state and individual regions) to transfer certain rights to business infrastructure; insufficient public funds to ensure their expanded reproduction; high-risk investment in capital-intensive facilities in the absence of state guarantees.

Let us first consider the interaction between the state and business (public-private partnership), aimed at reforming state property in order to integrate it more organically into the system of market relations, and representing an alternative to the privatization of vital and strategically important objects of state property. Public-private partnership is a kind of institutional and organizational alliance of public authorities and private business in order to implement socially significant projects in a wide range of fields of activity – from the development of strategically important sectors of the economy to the provision of public services throughout the country or individual territories [1, p. 118].

It is the scale of projects of strategic importance that necessitates the concentration and unification of financial, material, managerial resources and investment efforts of the state and the private sector.

At the heart of building a system of partnership between the state and business is the conscious principle that the fulfillment by the state of its socio-economic functions is impossible without an effectively functional business, in turn, the latter cannot develop without the support (assistance) of the state. At the same time, the methodological basis for the interaction of business and the state is the characteristic and accounting of the business itself, its goals and ways of achieving them, functions in the economy and role in society. After all, the partnership between the state and business is a priori determined by the social nature of both production and consumption. The development of this partnership strengthens the social character, which, in turn, determines the main features of social reproduction, the principles and proportions of the exchange of manufactured material goods in society, the means of realization of economic entities and society as a whole [2, p. 89].

The management of economic interaction between business and the state, in addition to the unified national foundations, also has regional aspects of application, due to the specifics of regional opportunities and conditions for their implementation. The implementation of PPP projects at the local government level contributes to the implementation of most socially significant projects in the field of road transport, social infrastructure, water management and water treatment facilities, environmental protection, housing construction, energy and gas supply.

The choice of ways and mechanisms to achieve partnership between business and the state in the regions is an urgent task of regional development of the state. Regional business concentrates significant financial and material resources for the development of territories, managerial and personnel potential, organizational and managerial and financial technologies. That is why the justification of the directions of their rational use in many issues determine the possibilities of the development of the economy of the regions and their social problems.

In the context of globalization, public-private partnership, as a result of the interpenetration of domestic and international commodity and financial flows, acts as a tool for strengthening economic, territorial and social relationships between countries and individual parts of the economic space within the country. With the strengthening of interstate economic relations, there are opportunities to attract, along with domestic, also private foreign capital to finance infrastructure networks, trunk pipelines, sea and air ports, water, gas, heat, and energy supply systems. After all, the level of infrastructure development affects the investment attractiveness of other sectors of the economy, business financial activity and competitiveness of the country on the world market and its readiness to participate in international cooperation.

Attracting foreign capital on the principles of PPP contributes to the country's integration into the global economic space, therefore, gaining the necessary experience, advanced technologies and institutions in the field of management and organization of production. Such a PPP involves the use of economic diplomacy methods to stimulate the growth of the national economy: states interact with TNCs in a global context, which serves as a condition for supporting and improving the competitiveness of national economies. As a result, the economic role of the state is growing, despite the decrease in its share in the capital of companies [3, p. 91].

The advantage of a PPP is an effective combination of the advantages and contributions of each of the participants. The business provides financial resources, efficient flexible and operational management, introduces new equipment, technologies, new forms of production organization and cooperative relations. In turn, the state performs its main functions of monitoring, regulating compliance with public interests, can provide various kinds of preferences and guarantees to a private partner, as well as material and financial resources.

Development of existing and emergence of new forms and models of partnership the state and business lie in the plane of the tasks to be solved. That is why forms of partnership are mainly spreading in the world, which are based on the advantages and combination of various models, namely organizational, financial and cooperative.

In organizational models (operational, concession, etc.) of public-private partnership, there is no deep intrusion into property relations, cooperation between the state and business is carried out through the involvement of third organizations, the assignment of certain functions and contractual obligations, the use of opportunities to transfer objects to external management. In particular, in the operational model, a private business entity assumes the responsibility for partial or full operation of an object owned by the state and receives a manager's remuneration from the state.

Under the concession model, a private economic entity carries out work or provides certain services directly to end users (the population) and thus gains the right to directly finance its expenses from remuneration or user fees. Concessions are most widespread in infrastructure industries, where there are needs for large amounts of investment and new management technologies that can be attracted from the private sector for the construction, modernization or management of infrastructure facilities. [4, p. 41]. At the same time, concession relations may be based on a different combination of property rights between the state and a private partner, as well as stipulated restrictions on economic and investment activities regarding construction, operation or management [5, p. 27].

Financing models include such forms as commercial hiring, leasing, all types of leasing, preliminary and integrated project financing. The model of cooperation (the term “social model” is also used in the economic literature) represents various forms and methods of combining the efforts of a group of partners responsible for individual stages of the overall process of creating a new consumer value as a public good. Basically, such cooperation takes place in the form of joint ventures, holding structures of the state with one or more private companies for the construction and operation of facilities and social infrastructure.

In conclusion, I would like to note that the effectiveness of the use and initiation by the state of various models and forms of public-private partnership lies in the activation of investment activities in the implementation of national projects, both the priorities of the state's investment policy and the strategy of participation of private economic entities in the implementation of projects of national importance.

Effective partnership is possible only if the strategy for further development of the country is completely clear and predictable, and the rules of the game in the business environment are stable. Otherwise, there is a threat of formal business participation in large-scale state projects for the purpose of self-preservation, hence the loss of effective entrepreneurship.

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# MARKETING RESEARCH OF THE RUSSIAN AND FOREIGN MARKET OF AUTOMATION DEVICES

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**Abstract.** The paper analyzes the market of automation devices, compares prices of Russian and imported devices, indicates the features of the functionality of domestic devices, as well as positive aspects of import substitution of automation devices in the modern world.

**Keywords:** automation devices, frequency converter, programmable logic controller, import substitution.

# МАРКЕТИНГОВОЕ ИССЛЕДОВАНИЕ РОССИЙСКОГО И ЗАРУБЕЖНОГО РЫНКА УСТРОЙСТВ АВТОМАТИЗАЦИИ

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**Аннотация.** В работе проведены анализ рынка приборов автоматизации, сравнение цен российских и импортных устройств, указаны особенности функционала отечественных приборов, а также положительные аспекты импортозамещения приборов автоматизации в современном мире.

**Ключевые слова:** устройства автоматизации, преобразователь частоты, программно-логический контроллер, импортозамещение.

## *Introduction*

Today, the level of automation of technological processes is constantly increasing all over the world. In this regard, there is a need to develop more efficient and modern automation devices. All over the world, many companies produce a variety of equipment for automating technological processes. Such diversity leads to the fact that the buyer spends a huge amount of time choosing

the right product, and time is one of the most valuable resources in our life. To solve this problem, we will analyze the market of automation devices and determine the best options.

*Frequency converters of Russian and foreign brands*

First you need to understand what frequency converters are, what they are designed for, and where they are used.

The frequency converter is used together with an asynchronous motor to automatically adjust and adjust the frequency of the alternating current to the required parameters. Thus, the device continuously monitors the speed and torque of electric motors. The use of frequency converters helps not only to automate the process, but also to save electricity – up to 50 %.

Modern frequency converters are used to automate systems and equipment such as:

- industrial machines;
- conveyor mechanisms;
- lifting equipment (cranes, elevators);
- pumps and fans;
- water purification systems.

Choosing a device that meets these criteria will ensure uninterrupted operation and reduce power consumption.

From a number of domestic manufacturers, attention should be paid to such a company as “Efficient Systems”, since it is the leading supplier of frequency converters in Russia.

If we consider imported manufacturers, then it is worth paying attention to frequency converters from “Danfoss” and “INVT”, since today they are market leaders.

At the moment, the following trend is relevant in the use of automation tools in the Russian industry: import substitution – high-quality products of a domestic manufacturer in the field of automation have reached a new level. Russian companies have not only reached the level of imported manufacturers, but can also compete with them seriously.

The frequency converter of the “Effective Systems” company has features that expand its functionality: it has high speed control depth and excellent controllability and control capabilities, and also has a vector control mode. In addition, it is possible to supply converters in dust- and moisture-proof versions (IP54) and with an extended climatic range (UHL1) [1].

Below are the prices for frequency converters:

- Danfoss frequency converters of the VLT Micro Drive series FC 51 (power 1,5 kW) – 19 565 rub. [2].

- Frequency converters “Efficient systems” ES022-02-0070 (power 1.5 kW) – 20 500 rub. [3].
- Frequency converter INVT GD10-1R5G-S2-B (power 1.5 kW) – 21 574 rub. [4].

*Programmable controllers*

In order to compare the cost of programmable controllers, it is necessary to contact foreign companies such as “Lovato” and “Siemens”, and from among the Russian companies we will consider the products of the “OWEN” company.

A controller in automated systems is a technical tool that controls physical processes in accordance with a given algorithm, using information read by sensors and output to a specific device.

Programmable logic controllers (PLCs) are usually used to control and monitor production equipment and processes performed by it. They are the main center of the automated control system. The principle of operation of such a system is based on the reception and transmission of control commands over the network. A programmable controller is an independent element that is manufactured separately from the equipment it controls.

The prices for Programmable logic controllers are presented below:

- Programmable controller “OWEN” PLC63 – 14 514 rub. [5].
- Programmable controller “LOVATO” RGK800 – 26 740 rub. [6].
- Programmable controller “Siemens” S7-1500 – 16 297 rub. [7].

PLC “OWEN” has a number of distinctive features:

1. Controls and indications are located directly on the controller itself.

2. Modbus protocols (RTU, ASCII) are supported using special libraries.

3. Ability to connect external devices with non-standard protocols by working directly with controller ports.

4. The controller has a built-in battery, which allows organizing a number of additional service functions: the ability to briefly wait out the power failure, transferring the output elements to a safe state.

*Thermostat and its scope*

In general, a thermostat is a device that allows you to maintain a given temperature of air or a certain surface. More specifically, the thermostat is an intermediate link in the chain of comfort conditions, at one end of which there is a heating or cooling device, and on the other – a temperature sensor.

The scope of application of thermostats has an extremely wide range: from control of devices heating the most ordinary apartments to huge industrial facilities. Household air conditioners and high capacity freezers are controlled by the PLC.

Thermostats control soil heating in greenhouses or de-icing of roofs. Thermostats work in a wide variety of systems. And although we are not talking about the same product, structurally they are always very similar.

Companies “Varmann” and “Danfoss” offer a wide range of temperature controllers, but the domestic manufacturer “OWEN” is in no way inferior to these two «giants». We will consider the products of these suppliers.

Prices for programmable thermostats:

- Varmann Vartronic thermostat – 8 310 rub. [8].
- Temperature regulator Aries 2TRM0 – 3 816 rub. [5].
- Danfoss Icon thermostat – 5 481 rub. [2].

The main advantages of the OWEN 2TRM0 regulator:

1. Improved noise immunity: 2TRM0 fully complies with the requirements of GOST R 51522 (IEC 61326-1) for electromagnetic compatibility for class A equipment (for industrial areas) with performance criterion A;

2. Increased measurement accuracy: measurement error does not exceed 0.15% (with an accuracy class of 0,25 / 0,5);

3. Improved climatic performance: permissible operating temperature range from –20 to +50 °C;

4. Extended range of supply voltages: 90 ÷ 245 V, frequency 47 ÷ 63 Hz;

5. Built-in 24 V power supply in all modifications of the new 2TPM0 for powering active sensors or other low-voltage ACS circuits.

*Conclusion*

Based on the above description of the equipment, it can be concluded that in most cases the cost of domestic products is lower than the products of foreign firms with relatively similar characteristics. Russian consumers should give preference to a domestic manufacturer, as this will help develop the domestic market of automation devices, and will also save a significant amount of resources. Given the growth of the national currency against the ruble, it can be concluded that imported equipment will only increase in price. That is why the development of import substitution in the market of automation devices in Russia is now the most relevant.

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# DISPOSAL OF SOLID HOUSEHOLD WASTE

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**Abstract.** The issue of disposal of solid household expenses (hereinafter MSW) is very acute all over the world. The absence or imperfection of waste recycling technology leads to environmental pollution and ecological disaster. The purpose of this article is to give an idea of the situation in the Russian Federation with solid waste. The study gives an idea of the existing methods of waste processing and disposal, considers their advantages and disadvantages, searches for the most environmentally friendly solution to this problem.

**Keywords:** solid household waste, waste disposal, waste recycling.

# УТИЛИЗАЦИЯ ТВЕРДЫХ БЫТОВЫХ ОТХОДОВ

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**Аннотация.** Вопрос утилизации твердых бытовых расходов (далее ТБО) во всем мире стоит очень остро. Отсутствие или не совершенство технологии переработки мусора ведет к загрязнению окружающей среды и экологической катастрофе. Задача данной статьи дать представление о ситуации, сложившейся в Российской Федерации с ТБО. В исследовании дано представление о существующих методах переработки и утилизации отходов, рассмотрены их преимущества и недостатки, осуществлен поиск наиболее экологичного решения данной проблемы.

**Ключевые слова:** твердые бытовые отходы, утилизация отходов, переработка отходов.

The issue of solid household waste disposal has been very acute for the last few decades. Solid waste is the result of human activity, goods or objects that have lost their consumer properties, consisting of organic and inorganic parts – these are broken dishes and glass, worn clothes, food waste, various packaging materials, etc. – all this requires processing.

Let's consider the morphological composition of solid waste, which is presented in Table 1.

Table 1 – Percentage and weight composition of solid household waste on average in Russia (with the formation of solid waste in the amount of 110,000 tons/year) [1]

| **Name** | **Average density, t./м$^3$** | **Quantity** | |
|---|---|---|---|
| | | **%** | **t./year** |
| Paper, cardboard | 0,06 – 0,09 | 37 | 40700 |
| Food waste | 0,31 – 0,5 | 24 | 26400 |
| Wood, branches, leaves, wooden packaging | 0,17 – 0,19 | 4,9 | 5390 |
| Ferrous metals | 0,18 – 0,39 | 4,3 | 4730 |
| Non-ferrous metals | 0,18 – 0,39 | 0,1 | 110 |
| Dice | 0,44 – 0,49 | 1,1 | 1210 |
| Leather, ceramics | 0,18 – 0,23 | 1,5 | 1650 |
| Textile | 0,17 – 0,22 | 5,5 | 6050 |
| Shards of glass | 0,37 – 0,52 | 5,5 | 6050 |
| Stones, ceramics | - | 0,8 | 880 |
| Stones, ceramics | 0,01 – 0,1 | 5,3 | 5830 |
| Fractions less than 16 mm | - | 9,0 | 9900 |
| Other materials | - | 1,0 | 11009 |
| Total: | 0,16 – 0,23 | 100 | 1110000 |

From the table presented, it can be concluded that most of the MSW falls on paper and cardboard – 37 %, as well as food waste – 24 %. If we consider each type of waste separately, a deceptive idea is created that there are not so many types of waste, and those that are contained in large quantities are not so dangerous, but they all pose a serious threat to the environment. Unpleasant smell, inability to use the territory occupied by landfills, attraction of homeless, wild animals that can be carriers of dangerous diseases, toxicity – this is only a small part of the harm caused by non-recycled garbage [2]. With the help of processing

of raw materials, many problems related to ecology and the occupation of territories by landfills can be solved.

The first stage in waste recycling is sorting garbage into categories in order to subsequently select the appropriate recycling technology. When sorting, as a rule, the following categories of solid waste are distinguished:

*Waste paper* – paper, cardboard, various paper products (food packaging, furniture boxes). At the same time, juice packs and paper cups are not pure waste paper. Their packaging consists of cardboard, polyethylene and foil.

*Glass* – is any kind of glass containers for drinks: bottles, cans, as well as vials, laboratory transparent tableware.

*Metal* – aluminum and tin cans, metal products that have fallen into disrepair.

*Plastic* – plastic bottles for drinks, packaging for cosmetics, food and other household items [3].

Sorting garbage allows you to select valuable substances from the total mass of waste, for example, non-ferrous or ferrous metals, glass, etc. And garbage is selected, which will decompose for a very long time, while releasing toxic substances.

- organic waste is recycled and converted into thermal energy and organic fertilizer;
- inorganic waste is used for the synthesis of building materials;
- the separated metal is pressed, packaged and sent to the foundry;
- glass waste goes to the production of technical glass, which is widely used in construction;
- plastic is also recycled and converted back into plastic.
- Thus, approximately 70 % of solid waste can be used. Recycling of garbage into secondary raw materials can bring a good profit, which speaks in favor of this method [4].

Among the disadvantages there are: high initial financial costs for equipment, as well as unhygienic and unsafe places where waste is stored before sorting [5].

In addition to recycling garbage as secondary raw materials, there are other methods of solid waste disposal. Let's consider the main methods and technologies for processing solid household waste.

1. *Waste disposal.* This method of waste disposal is suitable for household garbage, construction, equated to household waste, as well as a certain type of industrial solid waste. These types of waste are placed outside the city limits on specially selected territories – landfills where the risk of air contamination is minimal. Then conditions are created that contribute to a more efficient

decomposition of organic components – an oxygen-free environment (anaerobic), provoking the formation of biogas (combustible gas that occurs as a product of the vital activity of microorganisms in the nutrient medium), accelerating disposal.

There are few advantages of this technology. These include: the absence of the need to purchase expensive, complex equipment and the possibility of involving unskilled labor. In contrast, there are a sufficient number of disadvantages: harmful biogas is released into the airspace, toxic substances are released inside the soil, which subsequently enter the groundwater. There is a danger of spontaneous ignition, there are large costs for the maintenance of the territory and transportation of waste to the place where the burial will take place, the growth of landfill areas [6].

2. *Composting of waste.* This method is used for organic waste that can decompose independently, which is beneficial in agriculture. The resulting compost is further used for fertilizer. The disadvantage is that special territories are required for disposal, the method is applicable only for organic materials, and it also takes a sufficiently large amount of time to carry out the composting process.

*3. Waste incineration.* Incineration is an effective method based on the decomposition of garbage under the influence of heat. In this process, the remainder of a much smaller volume of waste from the original is formed [7]. In this case, we do not mean the usual disposal of garbage with the help of a campfire in the open air, but we are talking about the burning of solid waste in the walls of a high-tech plant. Simple gorenje in a non-specialized place carries more harm than good, in this case, the formation of toxic gases that enter the atmosphere, pose a threat to both people and the environment.

With this method of disposal in the process of incineration, waste is decontaminated, their volume decreases. In addition to the above, energy is released in the form of heat. The disadvantages of the method include the fact that special technical equipment is required, as well as highly qualified employees who know the specifics of the equipment and understand the process of its operation. The disadvantages also include environmental pollution. In the process of gorenje, smoke containing carbon dioxide, carcinogens, dust, heavy metals, etc. is formed, which negatively affects both humans and the environment [7].

*4. Plasma processing (gasification) of solid waste*. This type of recycling allows not only to safely dispose of waste, but also to receive energy during this process. It is possible to use the technology for both simple household waste and hazardous waste. For example, this technology is applicable even to hazardous biomedical waste, as well as to construction waste, scrap, coal with a high ash

content, etc. – all this can be turned into useful, and, consequently, market-value materials.

The main essence of this technology is that the waste is exposed to incandescent plasma (ionized gas heated to 5000 – 10000 ºC) in the complete or almost complete absence of oxygen. The plasma torch destroys waste, completely decomposing them into chemical elements. After gasification, the molecules are rearranged into useful compounds, of which the most important are those that can serve as energy raw materials. The final products are high-quality gas rich in carbon monoxide and hydrogen, and silicate slag, which can be used for the production of building materials, road surfaces, as well as jewelry. The only wastes from this technology are heavy metals and activated carbon generated during processing.

The advantages of solid waste plasma processing are:

- The plasma system is self-sufficient because it has its own closed cycle. So, for example, as a result of processing 1 ton of garbage gives 1-1,5 MWh of electrical energy – this is 80 % of the feedstock. Only 2 – 5 % goes to the gasification process, the rest of the energy can be sold.
- The following follows from the previous plus: the resulting gas is not released into the atmosphere, but is supplied to generate energy, which allows us to talk about the environmental friendliness of this method.
- No additional garbage preparation is required before recycling.
- Waste disinfection takes place

The disadvantages of this method are the need for expensive equipment and skilled workers who are able to operate this equipment [3, 8, 9, 10, 11].

Having considered the main methods of processing solid household waste, it can be concluded that one of the most promising options at the moment is plasma recycling. The absence of the need for mandatory sorting of garbage, the ability to recycle various types of waste, while some types of recycling are suitable only for certain MSW – this is only a small list of advantages over other methods. Plasma gasification solves the most pressing problems of mankind – it is limited fuel resources and pollution of nature. This type of recycling not only destroys garbage, but also brings benefits. Not all countries of the world can afford to carry out this process due to the high cost of equipment and the huge price for the construction of the plant, we can already say that plasma processing is the technology of the future.

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**УДК 620.91**

# USING MINI-CHPS IN RESIDENTIAL BUILDINGS

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**Abstract.** This article discusses applications of mini-CHPs in residential buildings. The article gives a brief description of mini-CHPs. According to the title, the article considers different types of their use. Conclusions about the conditions of their use are made. The pros and cons of using mini-CHPs are mentioned.

**Keywords:** mini-CHPs, energy generation, losses, autonomy.

# ПРИМЕНЕНИЕ МИНИ-ТЭЦ В ЖИЛЫХ ЗДАНИЯХ

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**Аннотация.** В статье рассматривается применение мини-ТЭЦ в жилых зданиях, дано краткое описание мини-ТЭЦ, представлены разные виды их использования. Сделаны выводы об условиях их использования. Отражены плюсы и минусы использования мини-ТЭЦ.

**Ключевые слова:** мини-ТЭЦ, генерация энергии, потери, автономность.

When transmitting the coolant over long distances, heat losses can reach 40 %, as well as the significant cost of transporting energy sources, so it makes it necessary to pay attention to alternative ways of generating heat and electricity, able to provide heating and electrical appliances. Under certain conditions, this task can be solved by a mini-CHP, working on various fuels, but most often in cities use natural gas [1].

Mini cogeneration plant (small combined heat and power plant) – is an energy plant, which generates electricity and heat in units with unit capacity up to 25 MW, regardless of the type of equipment (Fig. 1).

Figure 1. Mini-CHP

Modern mini-CHPs operate on the basis of gas piston units (abbreviated as GPU), which generate electricity by using a reciprocating internal combustion engine and an alternator. The energy source can also be a steam or hot water boiler, or a gas turbine unit [2].

The use of mini-CHPs is mostly used at facilities remote from the central line and at enterprises, where the production technology is conditioned by a constant need in heat energy.

Application of mini-CHP is possible at such facilities as:

- Industrial enterprises
- In the sphere of housing and communal services (housing and utilities)
- business centers
- industrial parks
- agro complexes

Mini-CHP for the house on solid fuel or other types of energy sources allows you to use the heat loss characteristic of generators to produce a significant amount of thermal energy.

If the key unit for CHP is an internal combustion engine, the mini-CHP on wood or wood waste does not stop working due to direct combustion of fuel in the boilers.

The following variations of CHP units are very common:

1. Combustion engine (internal combustion engine) based units. These can include equipment with gasoline engines and diesel engines, gas piston and gas turbine units.

The work of the cogeneration plant with a diesel engine (Fig. 2) is complicated by the fact that this unit must operate almost at full power. Otherwise, the engine is not sufficiently heated, it will be quite problematic to remove thermal energy from it [3].

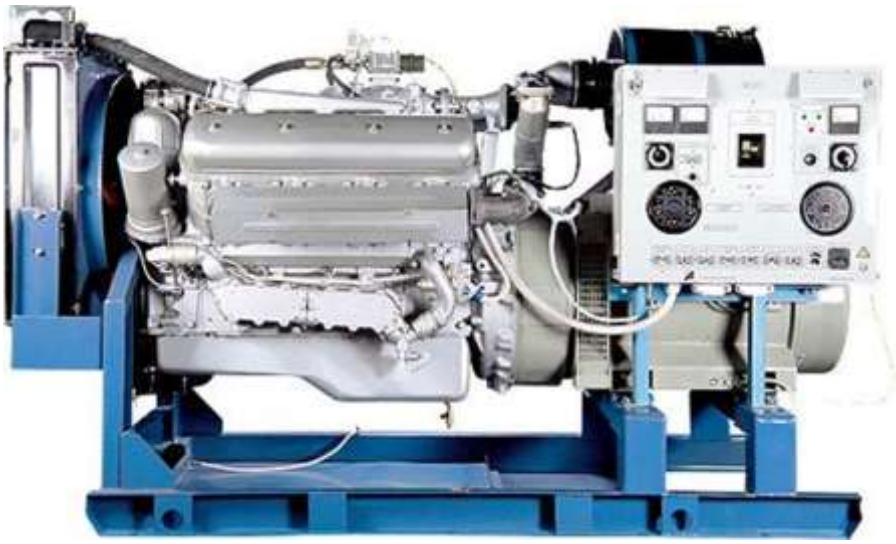

Figure 2. Mini-CHP working on diesel fuel

2. Cogeneration plant on woodworking waste (Fig. 3). Such cogeneration plant may well be used in forest areas or if there is the availability of an inexpensive source of fuel.

Figure 3. Mini cogeneration plant working with wood wastes

3. Various companies recommend mini-CHPs on biological fuel for the house (Fig.4). When selecting such units, it is necessary to take into account the fact that the economic use of these devices will be present only with an annual consumption of electricity of at least 3000 kWh and 20 thousand kW of heat.

Figure 4. Mini combined heat and power plant running on biofuel

Only equipment that operates at maximum load will pay for itself quickly. Otherwise, the payback period of such equipment can significantly increase. This option is suitable, for example, for 3 – 5 country houses or a small village [1, 4].

Advantages of using a mini-CHP.

For a particular consumer, the construction of a mini-CHP gives a number of advantages in contrast to large CHP or other power plants:

- The quality of electricity is higher and controlled by the consumer himself
- Cheaper electricity and heating supply
- Reduced losses in heat and power transmission
- Significantly less frequent mains outages
- Disadvantages include:
- The need to operate the mini-CHP, as well as to monitor the performance of the equipment.
- Difficulty in finding a contractor for the construction, commissioning and maintenance of the mini-CHP.

In conclusion, it should be noted that when used in residential buildings, mini-CHPs can guarantee both energy independence from the central grid and the independence of heating systems from the heating grid.

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# CONFLICTS IN BUSINESS COMMUNICATION

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**Abstract.** The article deals with the concept of conflict in business communication. The types of conflicts with examples, causes and ways of resolving conflicts are presented. Shows the psychology of business communication and conflict management.

**Keywords:** conflicts, business communication, psychology.

# КОНФЛИКТЫ В ДЕЛОВОЙ КОММУНИКАЦИИ

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**Аннотация.** В статье рассматривается понятие конфликт в деловой коммуникации. Представлены виды конфликтов с примерами, причины и способы их решения. Показана психология делового общения и управление конфликтами.

**Ключевые слова:** конфликты, деловая коммуникация, психология.

*Conflict* is the most acute way of resolving contradictions in interests, goals, views that arise in the process of social interaction [1].

Business communication plays an important role in the formation and development of any organization. After all, employees have to communicate with partners, colleagues and bosses. How such communication develops can affect the success of transactions, career growth, and other important things. Conflict situations that can negatively affect relationships both within the team and with partners should be avoided. Therefore, a competent leader should know what conflicts in business communication are and what ways exist to overcome them.

The very concept of conflict is known to many sciences and it is interpreted in different ways. But conflict is always understood as a clash of interests, their confrontation. A characteristic feature of this situation is the fact that neither side is willing to make concessions. A business conflict is specific to what always happens in a professional environment. In this regard, *several varieties of it are distinguished:*

1. Pointless. When the conflict is based on something abstract and serves only for the emotional release of people. This type is the least common in the business environment. For example, during general cleaning, girls wash windows. One of them, inadvertently, dropped a bucket of water on the floor and sprayed the teacher heavily. The girl is embarrassed, asks for forgiveness. The teacher swore a little, took her darling away. And that's it!

2. Realistic. Its goal is to achieve a specific result. An excellent example of such a conflict is a common work situation: a manager and a subordinate cannot come to a single solution, an agreement regarding their joint activities. After the conversation and expression by each participant of their position, a compromise is found, and the leader and the subordinate find a common language and their relationship becomes positive.

3. Destructive. It is also called destructive, and it is the most dangerous. Fighting is a typical example of destructive conflict on the physical level. On the mental level, a scandal. On an intellectual level – a dispute. In a fight, a person tries to destroy the opponent's body. In a scandal, in a mental state. The image of the world is in dispute.

4. Constructive. It is based on facts and is constructive. The teacher and the child cannot come to an agreement; the child's parents talk with the teacher and, knowing the characteristics of their child, help him find a common language with the teacher. As a result – the settled relations of the members of the conflict and a favorable outcome [2].

*What are the causes of conflicts?*

Any conflicts in business communications arise for specific reasons. The most known and studied reasons for constructive conflicts:

- Different vision of the parties to the final result of the work.
- Differences in intellectual level and education.
- Not perceiving someone else's opinion, unwillingness to accept the position of the interlocutor.
- Lack of ability to interact with each other.

Destructive conflicts always arise for reasons of a subjective nature. This may be an illiterate management policy, incompatibility of the characters of employees or intrigues with the aim of moving up the career ladder [3].

*Solutions:*

The ways of solving any conflict situation are different. But they are always phased:

At the first stage, the conflicting parties must understand what led to the conflict, what is its cause and how the opponent views the problem. It helps to understand the essence and to understand the other side, and this is already half the battle. Actions are determined that both partners consider unacceptable to resolve the conflict. Next, a common goal is sought, because of which the dispute needs to be resolved as quickly as possible. At the last stage, we jointly find options for action that will lead to the end of the conflict.

The psychology of business communication and conflict management suggests maintaining a conversation in the language of the interlocutor:

- Use in conversation such words as: “you”, “your”, “sorry”, “please”, “thank you”.

- Speak in simple words. Short words are used more often. And they are remembered better.

- Avoid taboo topics. Questions of religion, nationality, politics, economics, health can cause conflict.

- Exclude jargon, slang, swear words from your speech.

- Say what you think.

- Do what you say.

To resolve any conflict, the following methods are used:

- Rivalry.
- Compromise.
- Care.
- Device.
- Cooperation.

See your opponent as an ally. Then you can constructively approach the problem.

And to make the conflict constructive, stick to these methods of resolving conflicts in business communication:

- Show authority. Begin your speech with the personal pronoun “I”.
- Be honest with yourself and others. Name your emotion: “angry”, “angry”, “Worried”, “upset”.
- Remember the interests of the opposite party.

- Do not insult!
- Describe your perception of the action of the opposite side of the conflict.

These simple rules will allow you to effectively build a business conversation and avoid disputes at work.

It is important to resolve such situations as quickly as possible so that they do not drag on and become aggravated.

*Preventive actions:*

It is easier and wiser to prevent and prevent every business conflict than to solve it later. The following guidelines can be a great help to this:

- Maintain fair organizational policies to ensure equal distribution of roles for all employees.
- Creation of a comfortable working environment.
- Prescribing measures to resolve controversial situations.
- Avoiding workload.
- Prevention of the influence of personal problems on the labor activity of the entire team.

When faced with a conflict situation, a person can go two different ways: try to avoid it, or take it for a constructive solution. The first path leads either to a painless solution to the problem, or, conversely, to delay. The second path is active and therefore often turns out to be productive. He helps to develop his communication skills, as well as gain experience in difficult business communication [4].

*Finally.* It is simply impossible to completely prevent business conflicts, because they are an integral part of the workflow. The most important thing for a leader is to minimize them and learn how to get out of the situation correctly, acquire useful skills. Many negative consequences of such situations can be avoided if each employee of the company takes it as a rule to resolve all arising disagreements in the most operational mode.

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**УДК 697.92**

# ANALYSIS AND PROSPECTS FOR THE DEVELOPMENT OF VENTILATION SYSTEM IN THE BUILDING “B” OF HSTE

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**Abstract.** Different types of ventilation systems are considered in this article. The ventilation system of the building “B” of the Higher School of Technology and Energy (HSTE) is described. The advantages and disadvantages of this ventilation with its further development prospects are shown.

**Keywords:** ventilation systems, ventilation, energy savings, frequency converter.

# АНАЛИЗ И ПЕРСПЕКТИВЫ РАЗВИТИЯ СИСТЕМЫ ВЕНТИЛЯЦИИ КОРПУСА «В» ВШТЭ

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**Аннотация.** В данной статье рассмотрены различные виды систем вентиляции. Описана система вентиляции корпуса «В» Высшей школы технологии и энергетики (ВШТЭ). Показаны преимущества и недостатки этой вентиляции с ее дальнейшими перспективами развития.

**Ключевые слова:** вентиляционные системы, вентиляция, экономия электроэнергии, преобразователь частоты.

Today, fresh, and most importantly, clean air is an important factor for work, study and, in general, for staying in an enclosed space. For this reason, proper attention must be paid to ventilation in the premises.

Ventilation is a set of technical means responsible for air exchange in rooms and creating a microclimate favorable for a person’s condition. Ventilation systems maintain temperature and humidity conditions within acceptable values inside rooms for various purposes.

At HSTE, the control system for the supply and exhaust ventilation of the classroom is partially automated using the RKN 8 controller. This controller is designed to regulate the air temperature in rooms equipped with a supply ventilation system with a water heater.

As a result of technical and household processes, heat and moisture enter the air. To maintain a given microclimate in a room, it is necessary to supply air with special parameters to it. Outside air parameters change over time. Therefore, before supplying outside air to the room, it must be specially processed, giving it certain conditions. The process of creating and automatically maintaining certain parameters of the air mass is called air conditioning. Basically, in air conditioning, it is subjected to heat and humidity treatment.

A set of technical means and devices for preparing supply air with specified parameters and maintaining a given state of air space in places where people are staying is called an air conditioning system. The air conditioning system allows you to maintain automatically the set temperature, humidity and speed of air movement, its purity, gas composition, aromatic odors, the content of light and heavy ions, in some cases, a certain barometric pressure [1].

*1. Modern ventilation systems. Ventilation system classifications*

There are many different air conditioning systems in the world today. Table 1 shows the classification of these systems.

Table 1 – Classification of ventilation systems

| **Classification of ventilation systems** | | | |
|---|---|---|---|
| By appointment | By the way the air moves | By the method of supplying and removing air | By the way of providing meteorological parameters |
| Working | Natural | Exhaust | General exchange |
| | | Supply | Local |
| Emergency | Mechanical | Supply and exhaust | Mixed |
| | Mixed | Supply and exhaust with recirculation | Supply and exhaust with recirculation |

Natural ventilation. Natural ventilation is characterized by the absence of a forced driving force. Air exchange in it occurs naturally, due to wind and thermal pressure.

Mechanical ventilation. Mechanical ventilation can be general and local. General exchange, in turn, can be canalless and canal. The most common of them is canal ventilation, it is characterized by the implementation of air change by ejector installations that move the air through special canals, centrifugal or forced axial fans. Mixed ventilation. Ventilation, in which both mechanical and natural types of ventilation are combined [2].

*2. Description of the ventilation system of the building "B" HSTE*

2.1. General information

To obtain optimal and comfortable microclimate parameters in the university building classrooms are equipped with mechanical general ventilation systems, including filtration and heating.

The supply of new air to the classrooms, administrative premises and bathrooms is carried out by three inflow units I1, I2, I3. Removal is carried out by three extraction units E1, E2, E3 (Fig. 1).

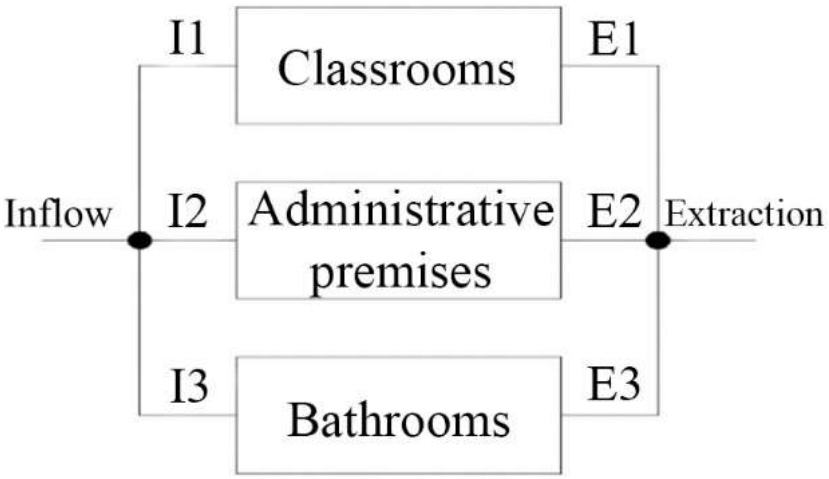


Figure 1. Inflow-room-extraction scheme

Each group of rooms is served by independent ventilation systems that bring the air to the parameters required by the relevant standards [3, 4].

The air parameters before entering the room, in the room and after the room are shown in Fig. 2.

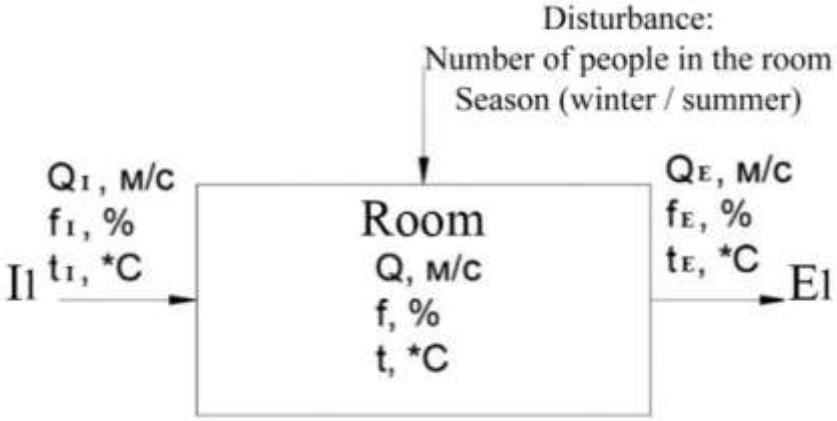


Figure 2. Air parameters and disturbance

2.2. Technological process

The technological process of air preparation at this room includes: air intake from the atmosphere, filtration of atmospheric air, muffling of street noises in the ducts, heating the air to a predetermined temperature, muffling the noise of the installation, spreading the prepared air through the ducts to the premises, removing the exhaust air from the rooms in atmosphere.

*3. Prospects for the development of the ventilation system of building "B" HSTE*

Maintaining a constant supply air temperature is carried out using an electronic microprocessor controller. The temperature is controlled by a sensor installed, as a rule, in the air duct at the outlet of the air handling unit. The actuator is a heating medium control valve.

It is advisable to change the air flow by adjusting the engine speed.

Increasing the engine speed increases the air consumption. At the same time, the necessary conditions for conducting classes are provided.

Decreasing the engine speed results in a decrease in air consumption. Consequently, energy savings are increased.

It is proposed to include a $CO_2$ feedback sensor in this ventilation system, which will be installed in the duct of the extraction unit (E1). When classes begin in the classroom, the level of carbon dioxide in the air increases and this is recorded by a sensor, which sends the received data to the controller, which, in turn, will control the engine speed through a frequency converter (FC) in the range from 900 to 1500 rpm.

The disadvantage of this method: the use of one $CO_2$ sensor in the exhaust duct in the presence of several rooms is undesirable. The $CO_2$ sensor will register the total concentration of carbon dioxide and the air exchange in the rooms will equally increase.

It is also proposed to install a temperature sensor, which will be installed in the duct of the inflow unit (I1). The data from the temperature sensor will be

recorded by the controller, which will send a signal to the inverter, which, in turn, will send a control action to the motor. The heater temperature will be set at a fixed level. The outlet temperature of the air handling unit will change due to the change in the air flow rate.

Thanks to the introduction of the controller, it will become possible to make the system fully automated, as well as to apply various control algorithms for the automatic microclimate control system in the building "B" of the Institute. Nowadays, it is difficult to imagine a motor without a frequency converter. The use of a frequency converter in the ventilation system is economically feasible, since it will save energy and also increase the service life of the motor.

The article examined the ventilation unit of the building "B" of the HSTE, and also revealed its advantages and disadvantages, working on which can significantly reduce electricity costs, increase labor productivity, increase the service life of motors and installations, and also reduce the load on service personnel.

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# INNOVATIVE MEASURES TO IMPROVE ENERGY EFFICIENCY OF AN APARTMENT BUILDING

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**Abstract.** This article discusses the main measures to improve the energy efficiency of a one-section sixteen-story frame-panel house of the 1MG-601D series. The house is located in the city of St. Petersburg and is a consumer of district heating. The authors considered a number of measures aimed at eliminating overheating in the heat supply system by minimizing heat energy losses through the building envelope.

**Keywords**: energy efficiency, insulation, energy saving, elevator, thermal insulation.

# ИННОВАЦИОННЫЕ МЕРОПРИЯТИЯ ПО ПОВЫШЕНИЮ ЭНЕРГОЭФФЕКТИВНОСТИ МНОГОКВАРТИРНОГО ДОМА

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**Аннотация.** В данной статье рассматриваются основные мероприятия по повышению энергоэффективности односекционного шестнадцатиэтажного каркасно-панельного дома серии 1МГ-601Д. Дом расположен в городе Санкт-Петербурге и является потребителем централизованного теплоснабжения. Авторами рассмотрен ряд мероприятий, направленных на ликвидацию перетопов в системе теплоснабжения, путем минимизации потерь тепловой энергии через ограждающие конструкции здания.

**Ключевые слова:** энергоэффективность, утепления, энергосбережение, элеватор, теплоизоляция.

In the Russian Federation, there is an acute issue of energy saving, which is one of the priority directions in the development of the country's economy. Every year there is an increase in tariffs for heat energy, which is used by consumers for heating and hot water supply. However, at the present time there is a serious deterioration of residential and public buildings, heating networks, as well as the sources of thermal energy themselves.

Housing companies do not seek to resolve issues of energy conservation in buildings, although today many basic methods have been developed to minimize heat losses in the heat supply system. The main factors associated with heat loss are:

1. Building envelope (5 – 15 %).

2. Untimely shutdown of heating in case of inconsistency with the current weather conditions (15 – 20 %).

3. Lack of DHW recirculation among consumers (15 – 25 %) [1].

To solve the problems of energy saving in an apartment building, first of all, it is necessary to start with an energy survey. It allows you to find out accurate data on the amount of consumed resources, determine the potential for energy savings and increase energy efficiency [2]. With this information, energy conservation measures can be developed. The information obtained is entered into the energy passport of the house. As an example, the authors considered a typical project of a residential building of the 1MG-601D series (Fig. 1). These houses are the first standard series built using panel-frame technologies.

Figure 1. Sixteen-storey frame-panel house of the 1MG-601D series

To improve the energy efficiency of a sixteen-storey building, firstly, it is necessary to replace the windows with a wooden frame with a heat-and-energy-saving glass unit with increased heat-and-power saving. Secondly, installation is necessary in order to insulate the walls and increase the thermal insulation of a residential building, which is produced using a technology called “wet façade”, shown in Fig. 2.

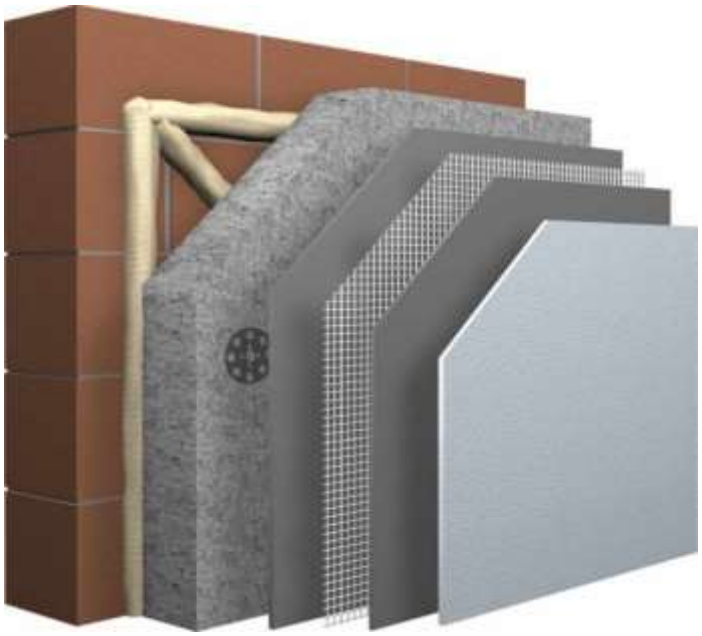

Figure 2. House insulation using the “wet façade” technology

The insulation process is the installation of a multi-layer facade system. The main layer of this system is insulation. Installation of a wet facade takes place after preliminary preparation of the base. This stage includes sealing interpanel joints, cracks and other wall surfaces, cleaning from dirt and dust, and priming. The next stage is the fastening of the insulation. First, glue is applied to the slab both along the perimeter and in the center, then the slab of heat-insulating material is sweaty pressed against the prepared facade. The first row of slabs supports the basement profile, while the next rows of slabs are fastened with a horizontal joint offset. After the glue dries, the boards are reinforced with umbrella dowels. The third step is to lay the protective layer. First, a layer of insulation is reinforced with durable construction glue, and then a fiberglass mesh is laid in it. The last stage is facing with a decorative and protective layer. At this stage, the reinforcing layer is first primed and then covered with either decorative plaster or facing tiles.

Since heat loss also occurs through the attic and basement floors, it is necessary to take care of their insulation (Fig. 3). At the first stage of installation of insulation for a reinforced concrete attic slab, it is necessary to carefully level the surface, cleaning it from dirt and dust.

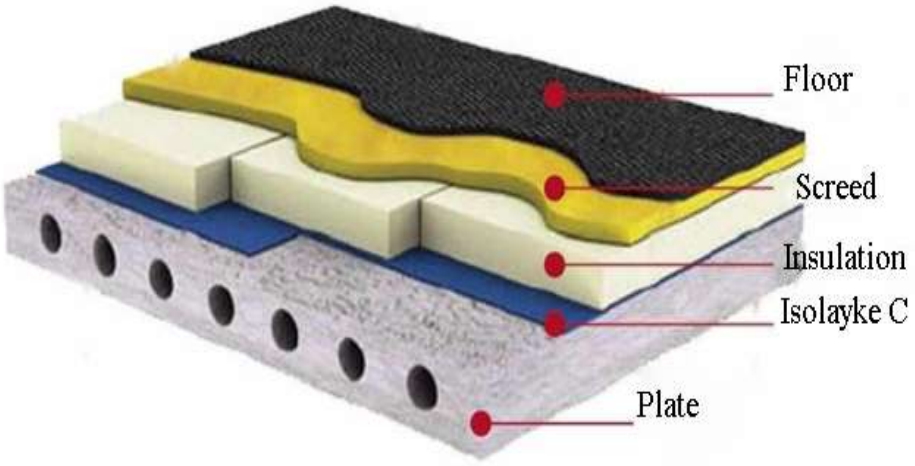


Figure 3. Insulation of a reinforced concrete attic slab under a screed

If cracks are present in the slab, then they should be filled with a cement-sand mortar and the mixture should be leveled. The second stage is the laying of the Isolay S layer. At the third stage, the installation of insulation in the form of slabs takes place. First, glue is applied to it, then the heat-insulating material is firmly pressed against the horizontal surface. After the glue dries, the boards are reinforced with umbrella dowels. Next, a layer of waterproofing is laid. At the last stage, the reinforced cement-sand screed is laid.

Let's consider how the floor insulation is carried out. The stages of work are as follows (Fig. 4). To begin with, the floor surface is completely cleaned from the old finishing materials (if any) to the "bare" soil (or to the slab).


Figure 4. Insulation of a reinforced concrete slab above the basement

Sand or clay is poured onto or on top of the slab. On top of the dump, several layers of dense polyethylene film are laid – a waterproofing agent. The film should extend onto the walls by at least 10 cm. Expanded clay is poured onto the film. The layer is determined by the desired performance (a noticeable effect will be noticeable at a layer of about 10 cm). On top of the expanded clay, the first layer of screed is made, approximately 5 cm thick. The screed is leveled along the pre-exposed beacons. A reinforcing mesh made of metal is recessed into the screed. On top of it, a sheet of EPSP is recessed half, 5 – 10 cm thick [3].

These energy-saving works will allow:

1. Keep indoor warm longer and maintain a relatively stable temperature in both summer and winter.

2. Prevent roof icing by insulating the attic space.

3. Reduce your total home utility costs.

Unfortunately, in addition to the advantages of the considered method, this project has disadvantages. It is long-term and high-cost, since it requires significant capital expenditures for implementation, and its payback period is over five years. Which gives priority to projects of medium- and low-cost energy saving measures. Which consist in a fairly short payback period, namely from 2 to 5 years and up to 1 – 2 years, respectively [4].

Low-cost activities have a priority, since they do not require large sums of money. These projects include the elimination of overheating in systems with elevator connection. The essence of this project is to eliminate overheating of the heat energy consumer, that is, both in residential and office buildings, in order to reduce the consumption of heat energy. To lower the temperature, many buildings are connected through special mixing devices – elevator units.

Advantages of elevators:

1. Low cost.

2. Absolute reliability.

3. Lack of operating costs and electricity requirements.

Disadvantages of elevators:

The impossibility of promptly changing the mixing ratio, which leads to autumn-spring overheating. On average, for St. Petersburg, overheating takes about 10 – 15 % of the annual heat consumption for heating [5].

The solution to this problem is the adjustable elevator assembly. It allows you to almost completely eliminate overheating, while maintaining all the advantages of the elevator unit:

1. Reduction of heat consumption for heating in the autumn-spring period;

2. Trouble-free operation in the event of equipment failure;

3. Trouble-free operation during power outages;

4. Minimum power consumption in regulation mode;

5. The minimum set of equipment, including the existing elevator at the entrance to the building and the regulator of the available pressure in front of the elevator.

The approximate payback period for a residential building is 1,5 heating seasons (autumn, spring, autumn), for an administrative building 0,8 seasons due to heat reduction during non-working hours (with a twelve hour working day).

Thus, the elimination of overheating in the heating system in the autumn and spring periods with the help of an adjustable elevator unit is a low-cost measure, since the cost of equipment is about 100 – 150 thousand rubles, and the payback is 0,8 – 1,5 heating seasons, depending on the purpose of the building. [6].

Thus, we came to the conclusion that there are several ways to reduce energy costs and improve the energy efficiency of a building, depending on the technical characteristics and existing problems of the building, which can be identified through an energy survey. Here it is necessary to take into account two basic principles: it is good to use all the technologies “little by little” and to consider their feasibility, which, first of all, is connected with the return on investment. Thus, it is quite possible to reduce by four times the cost of supplying energy to the entire building, as well as the costs of all residents of the house.

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**УДК 621**

# ECONOMIC PROBLEMS OF BIOENERGY DEVELOPMENT IN THE WORLD

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**Abstract.** In the XXI century, great attention is paid to energy industries that interact with alternative energy sources. Nowadays, the global trend is to obtain energy with minimal damage to the environment. One of the most promising industries is bioenergy.

**Keywords:** bioenergy, biofuels, energy, economy.

# ЭКОНОМИЧЕСКИЕ ПРОБЛЕМЫ РАЗВИТИЯ БИОЭНЕРГЕТИКИ В МИРЕ

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**Аннотация.** В XXI веке огромное внимание уделяется отраслям энергетики, которые взаимодействуют с альтернативными источниками энергии. В наше время общемировой тенденцией является получение энергии с минимальным ущербом для окружающей среды. Одной из самых перспективных отраслей является биоэнергетика.

**Ключевые слова:** биоэнергетика, биотопливо, энергия, экономика.

Bioenergy is an energy industry specializing in the production of energy from biofuels. Biofuels are obtained from raw materials as a result of processing biological waste. Currently, technologies for processing biological raw materials have not found wide application for energy production everywhere [1].

There are three types of biofuels:

1. Solid – firewood, briquettes, fuel pellets, wood chips, straw, husk, peat.

2. Liquid – for internal combustion engines. For example, bioethanol, biomethanol, biobutanol, dimethyl ether, biodiesel.

3. Gaseous – biogas, biohydrogen, methane.

This type of energy has a number of significant disadvantages from an economic point of view.

The growing demand for biofuels forces agricultural producers to reduce the acreage under food crops and redistribute them in favor of fuel. A decrease in acreage can lead to more imports of food products, which, due to state duties and various taxes, can lead to higher prices for goods [2].

The second problem is soil degradation. Growing the same crops (monocultures) will lead to soil depletion and an increase in the number of pests. Chemical pesticides will be used to combat them, which reduce soil fertility, which leads to major economic losses.

Fig. 1 shows the quality of the soil in the world.

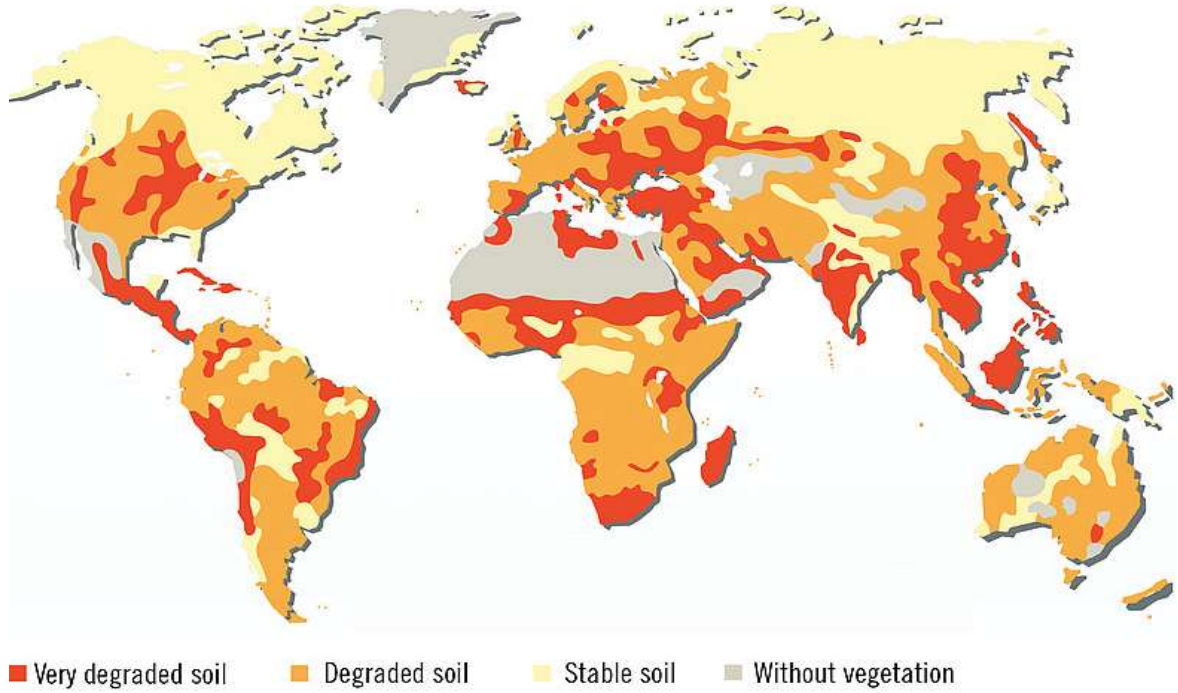


Figure 1. Map of soil degradation

Land degradation means a long-term decline in the functioning and productivity of ecosystems. The intensity and scale of land degradation are increasing in many regions of the world. 20 percent of arable, 30 percent of forest and 10 percent of pasture lands are degraded. In turn, it will cost a lot of money

and time to restore fertility to degraded soils [3]. In 2012 – 2018, 471 billion rubles were allocated for fertility restoration programs in Russia. The UK, which is ten times smaller than Russia and where the scale of soil degradation is much more modest, spends around 3 billion pounds (about 300 billion rubles) annually on restoring fertility.

Let's touch profitability of biofuels. EROI (energy return on investment) is the ratio of the amount of energy received from a certain resource to the energy spent on the creation (extraction) of this resource. The higher the EROI index, the more useful the resource is, since it gives more energy per unit than others [4].

Fig. 2 shows the data from the study of the profitability of various types of fuel.

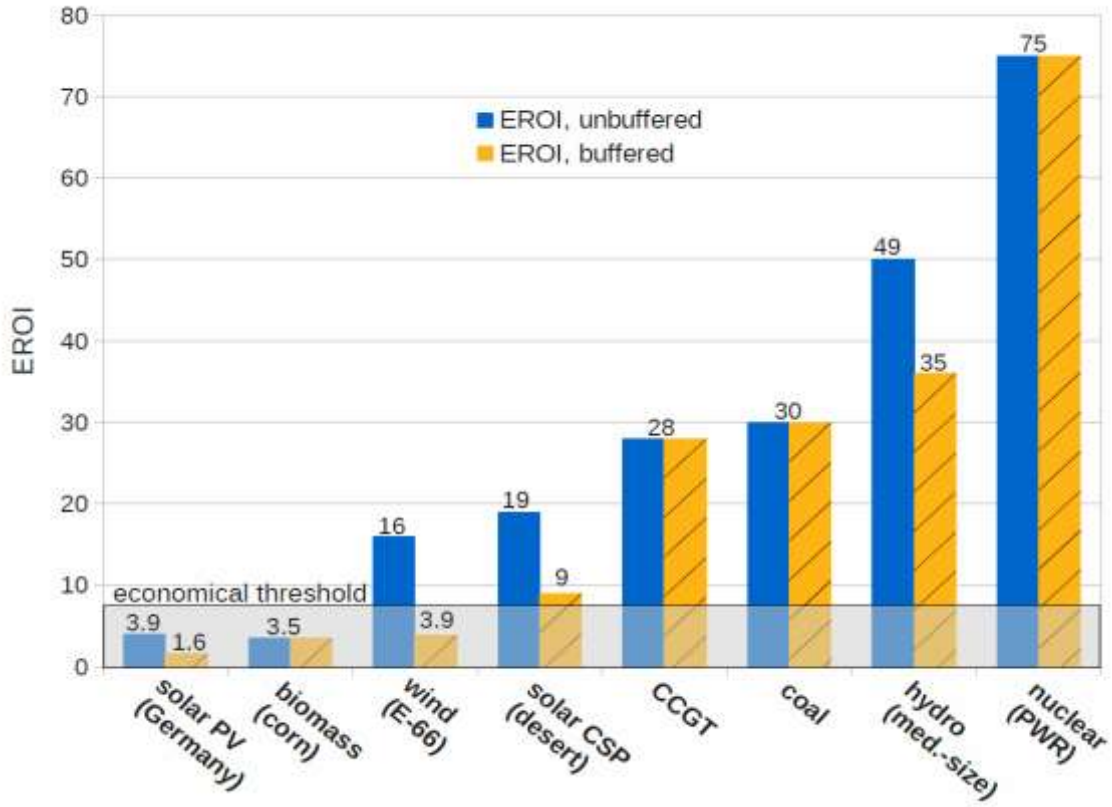


Figure 2. EROI research

From the data obtained, it follows that the profitability of biofuels is inferior to wind energy by about 4,5 times, and coal by 8,6 times. At the moment, in order to provide energy to the world with biofuels, it is necessary to increase greatly the production of biofuels, and this entails additional economic costs for a short period of time, as well as the degradation of huge acreage in the future.

If we consider biofuels as a modern analogue of diesel fuel, then the problem of the impossibility of a quick transition of cars to biofuels arises. Biofuel manufacturers suggest replacing the fuel pump after switching to biofuel mixtures, since components in old fuel systems can become clogged with released deposits. In addition to deposits in the fuel system, biofuels destroy rubber components. Some parts in old systems become unusable due to the rubber or rubber-containing composition. Although many manufacturers have included in the list of warranty breakdowns the repair of defects that biofuels create, the danger of a malfunction that the layman will have to repair at his own expense remains. Therefore, biofuel in its pure form cannot be used for refueling a car, since it is an oxidizer and solvent. Its use requires the reconstruction of a car with the replacement of fuel system elements with components made of stainless steel and resistant plastic.

Also, a big disadvantage of liquid biofuels is the inability to use them at cold temperatures. Biofuels must be stirred in a ratio of 1/5 with conventional fuel or heated.

Storage of biofuels. Modern, expensive storage facilities are required for the storage of gaseous biofuels. And liquid biofuels are not stored for more than 3 months – this is another significant drawback [2].

Also, improper storage of solid biofuels entails an administrative offense. Over the past few years in Russia, persons engaged in entrepreneurial activities have been fined ranging from 50 thousand rubles to 300 thousand rubles for improper storage of solid biofuels [4]. Solid biofuels should be stored in specialized hangars, non-compliance with storage rules can lead to uncontrolled fires, which leads to large economic costs, as well as environmental problems.

The last considered disadvantage of bioenergy is the economic risk associated with weather conditions on Earth. For example, in the summer of 2010, there was an abnormal heat wave in Russia, which led to widespread forest fires, as well as the death of 17% of all cultivated areas, which means the death of raw materials that could later be processed into energy [5].

Bioenergy has many significant economic disadvantages, which forces us to consider other ways of obtaining energy.

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**УДК 631**

# USING ROBOTS IN AGRICULTURE

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**Abstract.** The article describes the reasons for the need to switch to the use of robotic technology in the field of agriculture, (cattle breeding) and field cultivation. The possibilities of robots implementation in everyday life are evaluated. The advantages and disadvantages of such implementations are described, the possibility to reduce the cost of the products with the use of robots is presented.

**Keywords:** agriculture, robotics, automation.

# ИСПОЛЬЗОВАНИЕ РОБОТОВ В СЕЛЬСКОМ ХОЗЯЙСТВЕ

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**Аннотация.** В статье рассказывается о причинах необходимости перехода к использованию роботизированной техники в области земледелия, животноводства и растениеводства. Оцениваются возможности применения роботов в повседневной жизни. Описываются достоинства и недостатки такого рода внедрений. Представлены возможные способы снижения себестоимости получаемой впоследствии продукции.

**Ключевые слова:** сельское хозяйство, робототехника, автоматизация.

Humankind will not be able to survive in the near future without agriculture. It is the branch of agriculture that is aimed at providing humankind with the resources necessary for existence. These resources can be considered as food and raw materials for various branches of industry. Such industries are light

industry, microbiological industry, flour and feed industry, as well as the fuel industry.

Raw materials for light industry can be flax, cotton and other crops. Of greater interest is the fuel industry, the raw material for which can be obtained from agriculture and can be used to produce heat and electricity. These fuels are pellets and biogas. Biogas can be considered the most effective. After obtaining and cleaning it from impurities, the purified biogas on calorific value is analogize with the natural gas, all boilers and cogeneration plants of large cities are now operated.

The need to introduce robots in this industry is the continuing growth of the population, increasing costs of agriculture, reducing the availability of labor in agriculture. Fig. 1 shows the work of robots in the field. The use of robotic systems makes it possible to increase the accuracy of land cultivation and to increase crop yields.

Figure 1. The use robots to process fields

A significant disadvantage in the use of robots at this stage of robotic science development is their narrow specialization. For example, a robot for picking strawberries will not be able to pick other berries, and if you decide to reprogram the algorithm of this robot, we will not get the desired result. Another huge disadvantage of robots is their dependence on electrical power.

However, the use one and the same territory divided for crops planting, for a livestock farm, for a biogas plant and for a cogeneration, plant can solve the problem of electricity consumption by robots. Stagnant fruit and animal waste can be sent for processing to produce biogas. After its purification and combustion in the cogeneration plant, the electricity can be used to charge the robots batteries and keep other systems running. The resulting surplus electricity can be sent to the common grid with the city. Thus, such a farm will reduce interruptions in the power grid. Thermal energy from the cogeneration plant can be sent to the

livestock farm, to maintain favorable conditions for the existence of animals, and part of the thermal energy can be sent to the biogas plant to increase the generation of biogas. Heat energy can also be used to create an ideal growing environment for plants in greenhouses and hothouses.

When harvesting crops, a large part of the biomass remains, which can be used to produce mixed fodder, and the surplus can be used to generate biogas. The waste biomass can be used as fertilizer for plants. Such production can be fully automated with the help of robots.

At any farm robots can monitor the process of vegetation and special algorithms can predict the possible yield. In addition, robots can help to reduce the cost of the resulting products by improving its quality. At the same time, robots can spray pesticides over vast areas without risk to life and health of employees. Robots can also be used for the livestock production modernization: milking cows, feeding livestock. Thanks to this approach it is possible to have the most accurate information about each cow, and based on the received data to prevent the development of cattle diseases.

The main advantage of using robots in agriculture is their ability to perform their tasks routinely and punctual with constant quality. Such monotonous work as picking strawberries, grapes, apples, cucumbers, zucchini and other fruits and vegetables can be done by robots effectively. For example, robots can find a fruit, check it, carefully cut it off and transport it to a warehouse. Thanks to the development of media structures and neural networks robots can not only see the fruit or vegetable, but also determine its species, diagnose its maturity, whether the fruit is of proper quality, then send it for processing; count the exact number of fruits.

To become versatile and multitasking tool it is enough for robots to have only some cameras and neural networks. For example, while picking strawberries one robot being of the right design can replace10 employees. With further development of the robot design, it will be able to replace up to 100 people.

Introducing robots into agriculture appears to be a labor- and resource-consuming task. To maximize the benefits of agricultural production large investments and huge territories are required. Nowadays the use of robots represents only a theoretical benefit due to the lack of development of robotics. The use of hired labour and agricultural equipment such as tractors and combines are sufficient for harvesting today.

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# ASSESSMENT OF THE STATE OF THE PROCESS OF IMPLEMENTATION OF LEAN MANAGEMENT AT THE DOMESTIC EENTERPRISES

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**Abstract.** The author of this article raises the problem of applying lean management approaches in the modern realities of the domestic economy. An assessment of the results of the activities of Russian companies that have embarked on the path of introducing lean management into the business processes of their enterprises has been carried out. The results of studying the methods of state regulation at the federal level of the adapted methodology of lean management are presented. The conclusion is made about the prospects for further application of lean manufacturing approaches in domestic enterprises

**Keywords:** lean management, lean manufacturing, lean management, business processes.

# ОЦЕНКА СОСТОЯНИЯ ПРОЦЕССА ВНЕДРЕНИЯ БЕРЕЖЛИВОГО ПРОИЗВОДСТВА НА ОТЕЧЕСТВЕННЫХ ПРЕДПРИЯТИЯХ

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**Аннотация.** Автором данной статьи поднимается проблематика применения подходов бережливого менеджмента в современных реалиях отечественной экономики. Проведена оценка результатов деятельности российских компаний, вставших на путь внедрения lean-менеджмента в бизнес-процессы своих предприятий. Приведены результаты изучения способов государственного регулирования на федеральном уровне адаптированной методологии lean-менеджмента. Сделан вывод о

перспективах дальнейшего применения подходов бережливого производства в отечественных предприятиях.

**Ключевые слова:** lean-менеджмент, бережливое производство, бережливый менеджмент, бизнес-процессы.

As you know, the concept of lean manufacturing or “Lean management” originated in the Japanese company Toyota in the 1950s thanks to the outstanding engineers Taiichi Ohno and Shigeo Shingo. The main idea of this concept is to maximize customer orientation by eliminating any actions that consume resources and do not create final value. Using this approach, Toyota was able to completely rebuild the production system and from an outsider in the automotive industry to become a leading player in the market [1].

Today, the concept of “lean manufacturing” is used by the largest companies around the world, such as Nike, Amazon, Kimberley-Clark, Caterpillar, Intel, Ford, etc. Let us consider whether the lean manufacturing philosophy has been applied to Russian business. In Soviet times, managers turned to the “scientific organization of labor” to improve the production system, but the lack of qualified personnel and the limitations of the planned economy did not lead to the expected result. In modern Russia, the practice of lean production was attempted to be introduced in 2008 by state-owned companies such as Russian Railways, Russian Post, and Sberbank [2].

According to experts, since the start of the new practice, Sberbank has managed to quadruple the volume of retail sales, reduce the waiting time in queues by 36 %, and reduce unnecessary movement of employees in the bank’s office by 383 km. Sergey Starykh, Head of the Center for Building and Developing a Lean Production System of Russian Railways, noted that in the period from 2010 to 2017, the number of line divisions of the company implementing lean manufacturing increased from 47 to 2 thousand, and the number of new projects exceeded 5 thousand. The total effect from the events held at Russian Railways amounted to 560 million rubles in 2013, 1 billion rubles in 2014, and 1,14 billion rubles in 2017. Demonstrating high results from the use of lean production, other state corporations began to adopt positive experience, including: United Carriage Company, Rostec, Kamaz, Russian Helicopters, Aviation equipment, KRET, Kalashnikov, United Engine Corporation, Rosatom. Of the private companies that successfully apply this practice, it is important to note the Basic Element group of companies, namely Rusal, En +, Russian Machines, Basel Aero, which are part of this group [2].

“Certain difficulties in the face of painless implementation of lean manufacturing in domestic enterprises create national peculiarities of the Russian mentality,” notes Valery Kazarin, an independent consultant. In his opinion, the compulsory, directive implementation of lean management principles will not result in adequate efficiency. At many, long-established enterprises, employees still have a negative attitude towards any kind of optimization, after unsuccessful attempts made by the management [2].

At the federal level, a lot of attention is paid to lean manufacturing techniques from the government. In 40 regions of the country, the Ministry of Health, together with the state corporation Rosatom, is successfully implementing the Lean Clinic program. The main idea of this program is to save human, material and time resources of all involved participants in the process. To solve this problem, the logic of receiving and distributing visitors, the activities of doctors and laboratories, the process of distributing sick and healthy patients has been worked out in detail [3].

For enterprises applying for state subsidies, the Ministry of Economic Development has prepared a “Federal Program for the Development of Labor Productivity in the Regions” [4]. Such enterprises should be guided by the recommendations on the application of the principles of lean production in various industries, developed by the Ministry of Industry and Trade [5]. The aim of the program and recommendations is to unify lean management approaches in different industries and organizations. The need for such unification is caused by the need to create national standards for the application of lean technologies for industrialists. For those market participants who have embarked on the path of implementing lean management, the Ministry of Industry and Trade organized a voluntary certification of the LinSert lean production management systems. Passing such certification means that the company uses mechanisms to reduce losses and risks, and can also apply for government support. At present, the Government of the Russian Federation has approved a prize for the successful implementation of the lean manufacturing model. The function of receiving recommendations on its application from Japanese experts on a free basis has been implemented.

The international consulting company PWC has developed its own approach to increasing the efficiency of teams, based on lean management techniques. This approach is aimed at adapting the principles of lean manufacturing to office spaces, operations centers, project teams, sales offices [6]. It is based on two proposed:

- improving the efficiency of teams;
- improving the efficiency of processes.

Depending on the specific needs of the company and based on a certain choice of proposed solutions, the implementation of the PWC approach implies the improvement of the following aspects of activities:

1. The voice of the client, vision and goals – the implementation of this aspect implies the determination of the direction of improvement of the team, the value and vision of further development by the management, analysis of customer feedback.

2. Information Centers – the use of a visualization method to increase the transparency of the data.

3. Stand-up meetings – a regular meeting of teams, at which all employees are actively involved in the process of generating ideas.

4. Visual management – the rational use of tools aimed at organizing physical and virtual space.

5. Problem solving – analysis of business processes in relation to value creation. Building an Ishikawa diagram, using the idea generation method, prioritization matrix, kaizen sessions.

6. Standards – standardizing operating procedures to enable best practices.

7. Validation of the process – the use of tools for monitoring the business process and the employee, looking for weaknesses and suggestions for improvement.

8. Load management – the process of forecasting and flexible management of capacity utilization.

9. Coaching and Opportunity – developing and empowering the team. Attaching a coach to the staff. Analysis of the competency matrix and drawing up a load management plan.

10. Celebration of success – confirmation of the best results achieved and their public recognition in order to raise the competitive spirit of teams and stimulate the achievement of goals [6].

As a result of the analysis, I would like to note that our country has all the prerequisites for the effective application of lean management principles both in the commercial sector and in government agencies. The active support of the state, as well as the absence of obstacles to the exchange of international experience at the large level, gradually leads to an increase in the popularity of the application of the principles of lean production in domestic industries.

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# DEVELOPMENT OF A PREDICTIVE MODEL

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**Abstract.** The predictive model concept is described, different types of predictive models classifications in relation to technical processes are considered. The necessary requirements for such models development are provided. The basic principles and rules, defining the properties and ways to obtain them for a predictive model, are presented.

**Keywords:** predictive model, forecasting object, classification of models, properties and principles of the model.

# РАЗРАБОТКА ПРОГНОСТИЧЕСКОЙ МОДЕЛИ

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**Аннотация.** В статье описывается понятие прогностической модели, рассматриваются различные виды классификаций прогностических моделей применительно к техническим процессам. Раскрыты требования, необходимые для разработки подобных моделей; представлены основные принципы и правила, определяющие свойства и способы их получения для прогностической модели.

**Ключевые слова:** прогностическая модель, объект прогнозирования, классификация моделей, свойства и принципы модели.

The problem of analyzing the forecasting object in prognostics is a more general issue reflection of analyzing the research object in general. In each case the analysis method and results are determined by the study objectives and the object nature. It’s possible to formulate this target in prognostics like this: the purpose of the forecasting object analysis is to develop an adequate object

predictive model, allowing to obtain predictive information about the object due to experiments [1].

A predictive model, as a term in prognostics – is a forecasting model, the study of which allows you to obtain information about possible future object states and (or) ways to achieve these states [2]. Getting information about the future object states, and not just general information about it, is the predictive model target.

The methods of developing and verifying the predictive models adequacy are quite peculiar, since the check should be related to the future object states. Therefore, it is impossible to perform the model's compliance direct check with the original. Such object future states cannot be known in advance, especially in conditions where the object itself does not yet exist (for example, it is still being designed).

It is necessary to know the possible models classes to develop a predictive model. The most interesting for technical and economic fields of science are predictive models, describing technical processes, production processes, research development processes and economic patterns.

The most typical for the above areas are:

- functional models;
- physical processes models;
- economic models;
- procedural ones.

As a rule, functional models, are compiled at the very beginning of the system study. They are used for description of the functions, performed by the main system components.

The physical process model defines mathematical dependencies between the variables of the physical production process. As a rule, these are the technological parameters of the process.

Economic models, as the title implies, determine relationship between various economic indicators.

Procedural models are needed to describe the order and content of managerial actions.

It should be noted that there are many classifications of predictive models due to the fact that classifications are made according to different aspects.

Modern models are presented in the form of [3]:

- verbal description;
- graphical representation;
- flowcharts or decision matrices;
- mathematical description;

- program description.

The forms of graphical representation and mathematical description are mostly widespread among predictive models.

It is also necessary to know the following requirements for models in order to develop a predictive model:

1. The model must be sufficiently complete, meet the adaptability and evolutionarity requirements.
2. The model should be sufficiently abstract to vary a large number of variables. But it should be taken into account that doubts about the reliability and practical usefulness of the results may arise with excessive abstraction.
3. The model must meet the conditions limiting the problem solving time.
4. The model must correspond to the level of technical development, i.e. it must be physically feasible at this level of technology development.
5. The model should provide useful information about the object in the research task terms.
6. The model should be constructed with the use of established terminology.
7. The model should be able to verify the truth of compliance with the original.

In order to study the process of developing complex objects in more detail, it is necessary to consider the basic principles and rules defining this process. The general properties that a model should have are determined by the principles. The ways of getting the desired model properties are determined by the rules, which follow from principles.

The basic principles defining the model are:

1. There must be a compromise between the expected accuracy of the simulation results and the model complexity.
2. It is necessary to maintain a balance of accuracy, i.e. different errors must be in balance with each other.
3. The model should consist of various elements.
4. The model should be understandable and convenient both for the researcher and the consumer.
5. The model should be presented in the form of some blocks, i.e. divided into blocks in order to its further simplifying by removing non-essential blocks.
6. It is necessary to use relatively small conditional submodels, which are designed to analyze the system functioning in a narrow range.

Rules following from the listed principles:

1. It is necessary to aim at parallel modeling of the projected system competing variations with an assessment of the difference or the corresponding indicators ratio.

2. It is necessary to ensure the minimum possible exchange of information between the blocks.

3. Blocks with little effect on the accepted output criterion for interpreting simulation results should be considered insignificant and deleted.

4. When deleting the end blocks, making up the description of interaction with the consumer, it is necessary to reflect the interests of the consumer in relation to the criterion formation for interpreting the simulation results.

5. The model block that affects the system studied part, in general, can be replaced by a set of simplified equivalents that do not depend on the studied part. Modeling takes place in several variants for each simplified equivalent.

6. When simplifying the block affecting the system investigated part, it is necessary to compare the possibilities [4]:

- direct simplification of the closed loop without breaking the feedback;
- construction of a probabilistic equivalent with an assessment of its statistical characteristics by an autonomous study of the simplified block;
- replacing the block with the worst interactions in relation to the studied part of the system.

7. It is necessary to try to construct conditional submodels equivalent to the complete model in typical situations for the designed system, and to compare these submodels and the model being tested in these situations in order to verify the submodel conformity and the complete model.

8. The conformity verification of a specific model and the complete model of the original should be based on the convergence of the results obtained on increasing complexity models.

9. It is necessary to calculate margins according to the simplest model, that includes all the inaccurate description parameters.

Predictive modeling methods can be used to solve a variety of technical problems. Due to the “Big Data” and cheaper computing resources, the applicability of forecasting methods based on statistical data is increasing in industrial sectors. At the moment, predictive analysis is an actual direction of modeling systems, and the resulting predictive models are the product of rational mathematical methods applied to data.

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# OVERVIEW OF ADVANTAGES AND DISADVANTAGES OF DIFFERENT GAME ENGINES

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**Abstract**. The gaming industry develops at an incredible rate every year. The demand for games is growing, which is why developers are thinking about choosing the right game engine to save time and money. This article provides an overview of the advantages and disadvantages of different game engines.

**Keywords**: game engine, review, Unity, Unreal Engine, CryEngine, Corona SDK, Hero Engine.

# ОБЗОР ПРЕИМУЩЕСТВ И НЕДОСТАТКОВ РАЗНЫХ ИГРОВЫХ ДВИЖКОВ

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**Аннотация**. Каждый год игровая индустрия развивается с невероятной скоростью. Спрос на игры растет, из-за этого разработчики задумываются о выборе подходящего игрового движка, чтобы сохранить время и деньги. В данной статье представлен обзор преимуществ и недостатков разных игровых движков.

**Ключевые слова**: игровой движок, обзор, Unity, Unreal Engine, CryEngine, Corona SDK, Hero Engine.

A game engine is a piece of software that simplifies game development by providing you with the set of tools you need to develop.

The gaming industry develops at an incredible rate every year. The demand is increasing, there is a need to create more and more games. In this regard, the developer has a question about choosing a suitable game engine. In most cases, ready-made development tools are selected.

Deciding on a game engine means building the right strategy for developing and maintaining an application [1]. This article will look at the pros and cons of popular engines.

Unity is a cross-platform game engine. It is a full-fledged environment for developing computer games, which includes various software tools for creating software – a compiler, a text editor, a debugger, etc. [2]. This engine is used by both large developers and independent studios, for many of which it became the door to the world of game development.

Unity is also the most popular game engine in the world, with a 45% market share and affecting over 600 million gamers worldwide. A weighty argument in favor of choosing this engine is its free distribution model for projects with a turnover of no more than $ 100 thousand over the past 12 months. With a component-based approach, Unity enables developers with minimal experience in the game to create games.

Unity also has a large developer community, a huge library of assets and plugins, which speeds up the development process. With the help of the engine, you can develop games on all current gaming platforms and port them without much difficulty. This fact means that the GaaS project is available on a large number of platforms.

DirectX and OpenGL support can provide not only flexibility in customizing an application's graphics, but also access to the latest technologies such as real-time ray tracing. Using the engine, you can customize the physics of objects, create complex animations. Unity has support for 2D and 3D projects.

However, Unity has its downsides. Building complex games requires a good C # programmer on the development team to write scripts and components. The engine is quite difficult to learn, novice developers can very painfully transfer the first stages of development. Integration of mobile APIs (Application Programming Interface is a set of methods and rules by which various programs communicate with each other and exchange data), advertising, etc. is more challenging than other engines. The engine also shows itself badly with a drop in FPS (FPS – the number of frames per second) in large-scale scenes with many components and simultaneously present players.

Unreal Engine (UE) is one of the most popular big-budget game development engines. Since March 2, 2015, it has become a free engine, provided that the quarterly profit of the project is less than three thousand dollars, otherwise it is required to transfer 5 % of the profits to Epic Games.

The engine is cross-platform, projects created with its help can be transferred to all current gaming platforms. UE also has a large developer

community with many tutorials and an asset store to speed up the development of the project. In this engine, support tools and a project update mechanism are well implemented.

UE has built-in visual programming system Blueprints, which significantly lowers the threshold for entering the development process. The basis for writing code to work in the engine is C ++, which is perfectly implemented using Blueprints [3]. Writing C ++ code is the best choice for developing large projects because of the complex management in Blueprints that degrades performance.

UE is actively developed by Epic Games. Each update adds new functionality and optimization tools.

Originally designed for games with a large number of players on the map, UE is great for realizing online games. However, developing with the engine requires a productive system, which is not always available to independent studios. However, the convenience of project support negates this disadvantage. With UE, you can create games with the best graphics on the market, due to the support for DirectX 12 and the excellent work of the integrated graphics engine. Also, with the help of optimization tools, UE is able to deliver high FPS even in loaded scenes.

Also, from the minuses, it can be noted that C ++ development is an order of magnitude more difficult than programming in C # or Javascript, so more resources will be spent.

CryEngine (officially styled as CRYENGINE) is a game engine developed by the German game developer Crytek. CryEngine (CE) has had a major impact on the development of open world games.

Like the previous examples, CE is distributed under a free model, but in cases of project income of more than $ 5 thousand, it requires payment of 5% of the income.

Incorporating the most advanced technologies such as DirectX 12, Vulkan API, VR, as well as an advanced lighting and ray tracing system, the engine allows you to create games with almost photorealistic graphics. Scripts in this engine are written in C #, which is convenient for developers who have switched from Unity.

However, there are some drawbacks to using CE. The main one is the presence of a large number of bugs in all aspects of the editor. CE does not shine with a large developer community, which, combined with a meager set of assets, as well as a lack of good technical support (even paid), leads to a long development process. The need to rewrite the source code of the engine for your project, the difficulty in solving problems by trial and error, all this will be encountered when developing the game client [4]. The engine is poorly suited for

developing online games, mainly due to the complex writing of network code (out of the box, the engine does not support more than 32 network players) and the low FPS issued by the engine in dynamic or loaded scenes with a large number of players. The engine is difficult to learn and requires a lot of experience from the developer. CE is more suitable for large experienced development teams for the long and expensive creation of a large, high-quality project.

Corona SDK is a great 2D game engine for beginners looking to create games for iOS, Android. Better yet, Corona is completely free. Applications are written in a simple Lua language with a low threshold of entry, APIs are incredibly easy to use and understand, and third-party APIs are easy to integrate if they have a partnership with Corona. Corona makes productive applications, which are, of course, inferior in speed to native ones, but subjectively they work very quickly. The result can be obtained for two popular systems at once: Android and iOS. In any case, small changes will have to be made when moving from one system to another, but they are not so global as to take a lot of time and effort. We can conclude that Corona is great for mobile gaming.

But Corona, like any engine, has a number of disadvantages. Existing books and articles on Corona quickly become outdated due to the fact that its developers make regular changes [5]. And the developer community is small. There are very few ready-made templates compared to other engines.

Hero Engine is a 3D game engine and server technology platform originally developed by the Simutronics Corporation specifically for the creation of MMO (Massively Multiplayer Online Game) games in which a large number of players interact with each other in a “permanent” game world located on a remote server). An engine developed by the authors of GemStone IV and DragonRealms for universal creation of MMO games. It supports many technologies including Vivox, PhysX, SpeedTree, FMOD, FaceGen, Wwise, and Scaleform.

The engine allows you to display a good level of graphics and maintain high FPS even in loaded scenes. Also allows you to create large “seamless” worlds. Suitable for creating complex chains within game tasks. Has a convenient support service Hero Cloud.

Hero Engine also has its drawbacks. It is a scripting engine, but its management is extremely inconvenient [6]. The engine, together with the Hero Cloud support service, is too expensive, which is not suitable for novice developers. Hero Engine also has a high entry threshold.

For ease of perception, all the pros and cons are listed in Table 1.

Table 1 – Pros and cons of game engines

| +/- | Unity | Corona SDK | Unreal Engine | CryEngine | HeroEngine |
|---|---|---|---|---|---|
| Performance | - | + | + | - | + |
| Convenient support | - | + | + | - | + |
| Convenient optimization tool | - | + | + | - | - |
| Low development cost | + | + | + | - | - |
| High level of graphics | - | - | + | + | - |
| Stable FPS in busy scenes | - | + | + | - | + |
| Large community | + | - | + | - | - |
| Asset store | + | - | + | - | - |
| Cross-platform | + | - | + | + | - |
| The choice of major developers | - | - | + | + | + |
| Independent Developer's Choice | + | + | + | - | - |
| 2D support | + | + | - | - | - |
| 3D support | + | - | + | + | + |

Ultimately, in order to make a decision, you need to look at the platforms that will support the project and how it will be monetized. Corona is a great engine if you plan to create a game on a mobile platform. HeroEngine is great if you're making an MMO game. Many good games have been developed on the CryEngine game engine, but due to its instability, its widespread use is questionable.

However, now that new consoles and devices are being built, Unity seems to support almost every new product. This is a huge advantage as using Unity allows you to release games on platforms that other engines do not support. Despite the many obstacles to learning Unit, the reward is more than worth it.

The Unreal engine seems to be the best option for games that require high graphics performance and for companies with highly experienced development teams. However, for small companies looking to target multiple platforms and monetize effectively, Unity wins the battle.

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**УДК 620.1**

# TO THE QUESTION OF THE MAIN MODERN TRENDS IN THE DEVELOPMENT OF ENERGY

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**Abstract.** Due to the growth of the Earth's population and the development of industry, agriculture, science and culture, the demand for electricity is inevitably increasing. As a result, there is a need to increase the generation of electric power to meet this demand. The article considers the trend of energy development by means of alternative energy sources.

**Keywords:** energy resources, alternative energy, fossil fuels, renewable energy sources.

# К ВОПРОСУ ОБ ОСНОВНЫХ СОВРЕМЕННЫХ ТЕНДЕНЦИЯХ РАЗВИТИЯ ЭНЕРГЕТИКИ

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**Аннотация.** В результате роста населения Земли и развития промышленности, сельского хозяйства, науки и культуры неизбежно увеличиваются потребности в электроэнергии, вследствие чего, необходимо повышать выработку электрической энергии, которая затем будет использоваться человечеством. В статье рассмотрена тенденция развития энергетики с использованием альтернативных источников энергии.

**Ключевые слова:** энергоресурсы, альтернативная энергетика, ископаемое топливо, возобновляемые источники энергии.

In order to meet the demand for electrical power significantly increased for the last decades, there is a necessity to increase the generation of primary energy resources: coal, oil, gas, uranium, solar radiation, energy resources of rivers, heat energy of Earth etc.

Efficient use of energy resources that are mostly non-renewable means to use natural resources in the way that ensures economic improvement, increasing standard of living and minimizes detrimental effect of human activities to the environment [1].

Won't the increase of utilization of such resources as coal, oil and gas get the world closer to the energy crisis? These resources are limited and non-renewable.

This question bothers wide world community from long ago. Earlier the scientists anticipated the crisis in many fields, however, the detailed analysis showed that resources supply was significantly bigger than expected and the growth pace started decreasing. World economic system is able to adapt to the changing conditions, so by sacrificing and small decreasing of the growth pace it may avoid disastrous crises. Scientific and technological development encourages more efficient resources utilization and postpones the deadlines of full depletion of non-renewable resources. This gives more time to create alternative substitution for resources, which are under the threat of soonest depletion. This phenomenon can be especially observed in the energy field where the critical situations came first. The analysis shows that along with traditional non-renewable resources there are other ones, which are practically unlimited and renewable, for example solar energy.

Nowadays world energy market grows comparably slow and its regulation is still on the initial stage. This can be explained by various reasons: power has significant role for each country and the governments have cautious attitude to any intergovernmental interference to this sphere; the countries which export and import energy resources have completely different interests; focused influence on the fuel and energy complex is quite problematic; some important aspects of the field is very specific.

The situation that looked dead ended at the beginning of 70s now turned into the problem of economic optimization for the development strategies, into the problem of the acknowledged ways of balanced development, which is slowing down but anyway striving to the high level in the future. It will lead to the crucial changes in the structure of global energy balance in the nearest 50 – 60 years. During this period the following changes are expected:

a) power consumption growth;

b) the increase of power generation from renewable energy resources like nuclear or maybe even thermonuclear energy, solar radiation etc;

c) implementation of global power supply systems instead of national ones;

d) more efficient energy consumption and more important part of electric power in the global energy balance.

During many centuries the main energy resources used by people were chemical energy of wood, potential energy of water, kinetic wind energy and solar power. However, in XIX century the list of top energy resources was headed by different kinds of fuel: coal, oil and natural gas. The fast increase of energy consumption caused many issues, so the humanity had to think about new energy resources [2].

Nowadays there is a huge interest in the clearer kinds of energy, for instance, solar power, geothermic energy, wind power and the power of thermonuclear process. Energy consumption always affects the economy: the increase of GNP inevitably leads to the increase of energy consumption.

Last century is commonly called “the century of oil”. Since 1970s oil industry experienced very fast growth and price fluctuation. Regarding the price fluctuation, this century does not differ too much: the price for the oil grows and falls very rapidly and this significantly affects the economy of the developing and developed countries. This is one more reason why the developed countries get more interests in alternative energy resources. These are renewable natural resources and municipal solid waste. Considering the fact that the oil and other fuel deposits are limited, the interest to the renewable energy resources will continue growing.

Let’s consider the existing energy resources, paying more attention to the fuels. There are three main types of fuel: coal, oil and natural gas.

Oil: oil is produced in 80 countries in the world; the biggest producers are Saudi Arabia, USA, Russia, China and UAE. It is quite difficult to predict how much time the humanity has before the oil deposits get depleted. Even assuming that the industrial reserves may increase, the scientists expect that 80 % of all oil deposits will be depleted by 2035.

Natural gas: high consumer performance, low production and transport fees, wide implication zone in various fields allow natural gas to take very important role in the fuel, energy, raw material base.

Coal: coal reserves are easier to assess. Three fourths of world deposits are in the countries of ex-USSR, USA and PRC. The coal plays significant role in the regions, which suffer from the lack of alternative energy resources. Comparably low price makes coal important especially for the developing Asian countries. Coal is the most wide spread energy resource in the world, it takes 24 % of world energy system.

Nuclear energy: this type of energy is used not only for power generation but also for the production of new nuclear fuel. Wide spread uranium isotope U-235 is used for that. The forecasts suggest that with the help of breeder reactors the uranium deposits can be used for more than 6000 years. However, this type of energy has its own peculiarities: it is still impossible to create the environment for safe thermonuclear process for now.

Along with traditional energy resources, there are alternative ones.

Nowadays the scientists are making researches for various alternative energy resources and for now, the solar power shows the strongest potential.

The solar power has two strong advantages. The first one is that it is renewable and practically not limited. The second is that its generation process does not cause any damage to the environment. However, even such promising energy type has its disadvantage: high energy production requires wide collector surface [3, 4]. Apart from that, the generation process is not stable since it depends on weather conditions and time of the day. This causes the necessity to use special devices to accumulate the power. That is why there are three main goals that the solar power is mostly used for: for heating system, hot water supply and air conditioning system; for direct conversion to the electrical power; for large-scale electrical power generation based on the thermal cycle system.

Geothermal energy is the heat energy of Earth's interior. This type of energy is already used in such countries like Iceland, Russia, Italy and New Zealand. The heat of the Earth’s interior in most cases is the result of the radioactive decay in the Earth core. However, the resources for geothermal energy are localized and limited and this is one of the main disadvantages of this type of energy.

Waterpower generates significant part of all electrical power in the world – almost one third. The key point of it is the potential water energy accumulated with the help of dams. At the base of dams there are hydraulic turbines which rotate the rotors of electric generators.

Marine power is the type of energy resource that used the water level difference during the tides. To generate the power the coast basin should be separated with the help of low dam, which retains the water. The principle is the same as for hydro-electric power stations: the hydraulic turbines installed at the base of dam are rotated by the water power.

Wind power: wind is one of the form of solar power conversion since the reason of the wind is differential heating of the Earth’s atmosphere. Further development of the wind power system is possible only because of average annual wind frequency and the persistent winds for different regions.

Solid waste and biomass. Biomass in power system can be used in several directions [5]:

a) direct combustion;
b) biomethanation;
c) pure alcohol production.

The renewable energy resources have their own advantages and disadvantages. The advantages are that they can be used in wide range of fields, the potential of renewable energy resources are much bigger than current demand of the regions; the renewable resources are practically equally spread and are available almost everywhere in one form or another. Moreover, they are exhaustless and eco-friendly: they do not emit hazardous substances and do not encourage thermal pollution of the environment.

The main disadvantages of renewable energy resources are lack of stability and low density of energy flows. Consequently, the humanity now is in so-called transition period from the power system based on limited fossil organic fuel to the power system, which uses renewable resources for power generation [6]. As a conclusion, it is worth mentioning that our country has huge deposits of natural resources for comparably low price, that's why alternative energy most probably won't reach its potential on the market in the nearest future. The focus should be applied to the aspects of small alternative energy to create the fundament for future development of the field.

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**УДК 677**

# THE ANALYSIS OF 3D TECHNOLOGIES IN FASHION

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**Abstract.** In the design of clothing virtual can replace the real reality and generate augmented reality. The article explores modern types of 3D technologies in the fashion industry used in design, production and sales. The positive and negative impact of new technologies is analyzed, including the environmental impact. The shift from traditional technologies to innovative ones is mentioned.

**Keywords:** 3D technologies, virtual fitting room, virtual mirror, 3D scanner, avatar.

# АНАЛИЗ 3D-ТЕХНОЛОГИЙ В МОДЕ

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**Аннотация.** В дизайне одежды виртуальное может замещать реальную действительность и создавать дополненную реальность. В статье рассмотрены современные виды 3D-технологий в индустрии моды, применяемые в дизайне, производстве и продажах. Проанализированы положительные и отрицательные последствия внедрения новых технологий, в том числе на окружающую среду. Отмечается важность перехода от традиционных технологий к инновационным.

**Ключевые слова:** 3D-технологии, виртуальная примерочная, умное зеркало, 3D-сканер, аватар.

With the popularization of 3D technology, it has been introduced in most industries. These are specialized programs that simulate physical clothing: behavior of the fabric, fit of the product, general appearance. 3D technology is

used in various forms such as 3D scanners, magic mirror virtual fitting systems, virtual fitting services, and digital fashion shows.

The emergence of virtual clothing changes the production cycle of clothing, excluding the long stage of model development, the production of samples, and the representation of goods. A lot of brands already present their collections on avatars in virtual showrooms and displays. It also allows reducing material use and the number of activities in the production process.

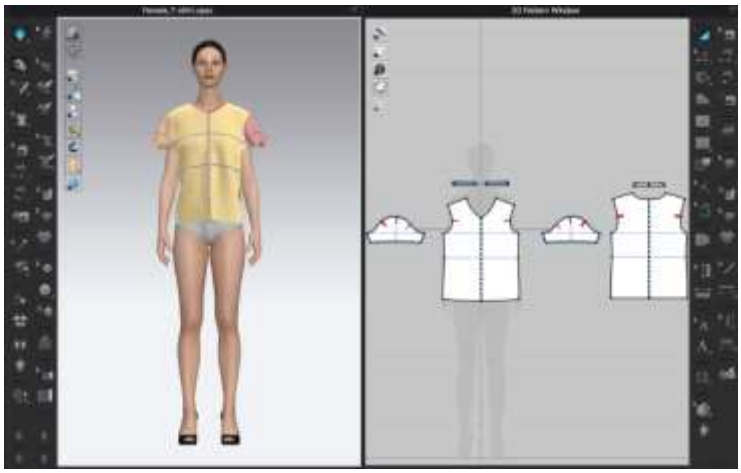

Figure 1. Software 3D CLO – 3D and 2D window

There are a number of programs for both general consumers and for professionals (CLO 3D, Marvelous Designer, Browzwear, i-Designer, etc.). Special instruments, like 3D scanners, are used to scan the texture and person for realistic images. The development of patterns is carried out in a 2D window on the right, and we can see an avatar and a sewn piece of clothing on the left (Fig. 1).

3D Scanners allow anyone to create a digital avatar (Fig. 2). This will help customers select the right style and size when shopping for clothes online. This leads to both better experience for customers and lower returns for retailers. Sizing studies based on primary scan data allow brands to plan smarter, i.e. to reduce lead time and waste. This data can further empower design teams to turn to the design of 3D models at once and check the garment fit virtually basing on the existing database of 3D models.

The software combines several million points into a complete, highly accurate 3D model while providing results quickly and with minimal resources. At the same time, it preserves edges, shades, and textures and realistically transmits facial expression, hair and clothes. To scan complex hairstyles, for example, hair with dark, shiny or very thin elements, we use the best sensors on the market. Even the complex details of clothes will look real, and the proportions will remain natural. After scanning is completed, a 3D copy can be integrated into various services such as AR/VR systems or virtual fitting rooms.

Figure 2. 3D scanner Texel Portal BX

The development of VR and AR technologies opens up new ways to communicate with consumers, and one of them is virtual fitting rooms. Stores install so-called “smart mirrors” or “magic mirrors” and, using a scanner and neural network technology, to dress a customer on the screen is a matter of seconds. The system takes into account the recommended color and size of clothing for a customer from the store's assortment. Without leaving home, by uploading your photo to the website or application, you can see yourself in the chosen bow. And if you enter the parameters of your body, the website will give recommendations on the size of clothes (Fig. 3).

It seems to be realistic to establish an online atelier using 3D programs for making clothes and avatars, where everything from making design to fitting will take place in the digital space. And the result of the work will be both a digital model and an ability to make a 3D model.

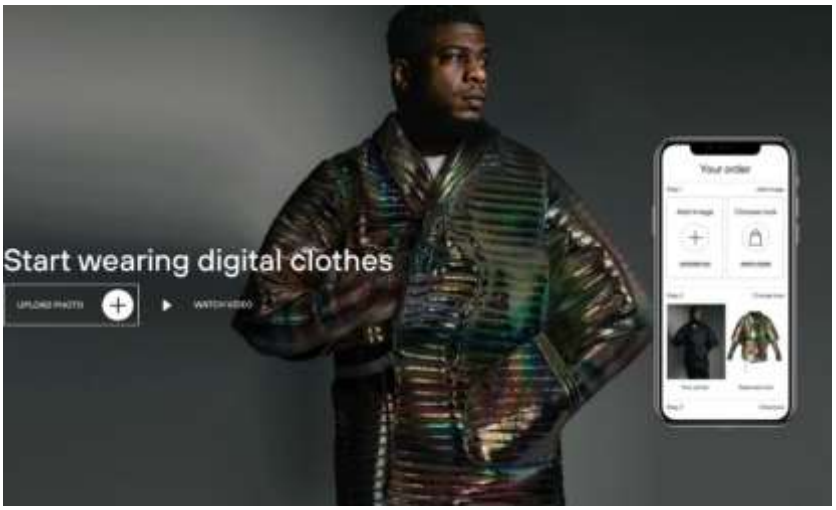


Figure 3. Dress-X company – digital clothes in-app

The magic mirror virtual fitting system is an augmented reality fitting service using 3D interactive and a system where a person stands in front of a large monitor, a camera on the monitor scans the person's body and displays it on the monitor, the clothes created in such a way fit the scanned body. The technology is fast and detects even human movement, so when it is introduced into stores, customers can wear a lot of clothes in a short time and get a preview of when they are wearing them. However, there are disadvantages, for example, it is difficult to use the system if a person is wearing comfortable clothes because the edges of the clothes are scanned instead of the body, and the shape and the pleats of the clothes are unnaturally expressed when the user moves. Currently, the magic mirror virtual fitting system is used by many companies around the world and it has already been commercialized and introduced into real clothing stores.

The 3D virtual fitting service provided by the Internet shopping mall is a system that puts clothes prepared in advance on the avatar of the customer. First, if the user feeds his/her body size and selects a face shape, skin color, and hairstyle, an individual avatar is created on the website (Fig. 4).


Figure 4. Virtual fitting serves Marks&Spencer and Texel

The clothes and shoes are prepared in advance on the website, and the user can click on the desired item to put it on the avatar and turn it through 360 degrees to check the appearance of the product.

This service has greatly relieved the anxiety of consumers who are hesitant because they can not try on clothes during internet shopping. This service was also developed as a mobile phone application, so consumers can freely coordinate

clothes images in their avatars anytime and anywhere to find out the wearing result and can choose clothes comfortably.

When developing a new fashion collection there is no need to physically sew the test clothes, a virtual fitting on a dummy in any of the design programs is enough. Digitalization of clothes design process allows to accelerate clothes development cycles and decrease wastes and time on sewing one copy.

The parameters of a virtual dummy will match real customers, rather than just being a set of "default" values in the program. Fashion designers should know what real brand customers look like. Personalization of the virtual fitting dummy will increase the quality and success of new fashion collection. The possibility to collect large data volumes about customers transforms clothing manufacturers into customer data centers. The success of new collections and the company as a whole depends on the quality of data and conclusions based on them.

Digital clothing provides an opportunity for self-expression in the online space. For a non-existent thing, it may look computerized. This is something that cannot be done in physical reality. The population is immersed in the world of technology deeply, where we find our new "me" – avatar. And each person tends to personalize the avatar, improve, add something to appearance, reward it with new qualities, or present themselves in a completely new style.

Today, each of us can escape to the virtual world from pressing problems and new technologies help us in this. In this regard, clothing brands create their collections in 3D, thereby providing a choice for avatars to dress in a way that we would never be able to do in the real world. For those who need to create unique content for media, you do not need to buy new clothes every time, it is enough to buy a virtual one Virtual clothing came to us from gaming, where players spend huge amounts of money to buy clothing for their characters. This brings income to the creators.

Only in our world there are still not many people who are ready to spend money on virtual clothes, which do not bring any benefit to them. Some brands use AR effects, for example, for masks on Instagram. Where a picture comes to life on a white T-shirt and carries a pre-laid message to followers (Fig. 5).


Figure 5. T-shirt – a present to Sberbank from the Fashion tech masters course

The print on clothes is a cue for augmented reality that is activated when you hover over the Instagram camera. The print can be set in motion with the AR effect. On hovering the camera a dynamic three-dimensional pattern will appear on the prints on the screens. It depicts Nicholas I in a futuristic suit in the middle of the city of the future (Fig. 6). We understand that this is exactly what Nicholas I saw in virtual reality glasses – the digital future, where Sberbank launches advanced technologies.

The pandemic has given a strong impetus to the development of 3D technology and fashion. Maybe soon we all will live in the meta universes, or, at least, combine the real world with the virtual, for which the term phygital already exists.


Figure 6. Nicholas I

The digital fashion show is the application of digital clothing technology to existing fashion shows and fashion brands or fashion designers use 3D programs to hold digital fashion shows and make them as videos.

There are advantages and disadvantages of using 3D technologies in the closing field. 3D technology is widely used in the fashion field, and the magic mirror virtual fitting system has a disadvantage. It does not accurately represent the feel of the actual clothes, instead reflecting the user's actions because it utilizes an image transformation method rather than a 2D pattern. In addition, the virtual fitting system provided by the shopping mall has the disadvantage of that the use of 3D makes the actual clothes and the clothes implemented in 3D almost identical.

Digital fashion shows utilize pre-made 2D patterns to accurately express clothes. In this case, spectators can see the physical properties of the fabric, the material and the shape of the clothes when the person moves. But it takes a long time to implement the simulation. It is necessary to develop additional technology to make virtual clothes more easily and quickly through 3D digital technology in the future and to add various detailed functions so that virtual clothes can be expressed like actual ones. There are difficulties with the implementation of virtual clothing. This is the lack of personnel, and the time spent on mastering new programs, and investments in training, the purchase of 3D programs. A restructuring of consciousness is also needed for many designers since it is necessary to create using a computer, and not a mannequin and fabric.

The advantage of 3D programs is in the fact that the changes made to the products are carried out with minimal effort than in the real development of the model, where you need to make new patterns and sew the product again. This helps garment factories keep up with the times and follow the trend of the ecosystem – reducing waste.

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**УДК 527**

# CLOSED-CYCLE GAS TURBINE PLANT AS A WAY TO COMBAT TOXIC EMISSIONS

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**Abstract.** An important problem of humanity is the pollution of the environment with toxic emissions. The solution to this problem is to use a closed-cycle gas turbine installation. This allows the exhaust gas not to be discharged into the atmosphere, but to be reused by sending it to the compressor. This prevents an increase in enthalpy in the world, which directly affects global warming.

**Keywords:** helium, nitrogen, carbon dioxide, throttling, heat capacity, gas turbine installation.

# ГАЗОТУРБИННАЯ УСТАНОВКА ЗАМКНУТОГО ЦИКЛА КАК СПОСОБ БОРЬБЫ С ТОКСИЧНЫМИ ВЫБРОСАМИ

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**Аннотация.** Важная проблема человечества – это загрязнение окружающей среды токсичными выбросами. Решение этой проблемы состоит в использовании газотурбинной установки замкнутого цикла, что позволяет отработанный газ не сбрасывать в атмосферу, а использовать его повторно, отправляя его в компрессор. Это предотвращает повышение энтальпии в мире, которая напрямую влияет на всемирное потепление.

**Ключевые слова**: гелий, азот, углекислый газ, дросселирование, теплоемкость, газотурбинная установка.

A gas turbine plant is a heat engine in which the thermal energy of a gaseous working fluid is converted into mechanical energy.

The main components are: compressor, combustion chamber and gas turbine. The electric power of gas turbine power plants ranges from tens of kW to tens of MW. The gas turbine unit can operate on both gaseous and liquid fuels.

There are open-type gas turbine installations (Fig. 1) operating in air, which emit exhaust gas into the atmosphere. However, this is inefficient because the exhaust gas temperature is high and the loss of unused heat is great, and also pollutes the environment [1].

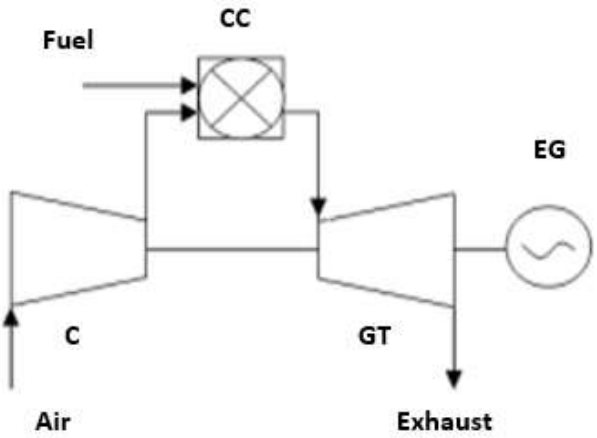


Figure.1. Open-cycle GTU scheme: GT – gas turbine; C – Compressor; CC – combustion chamber; EG – electric generator

To solve this problem, a closed-loop GTU is used (Fig. 2), which does not discharge the exhaust gas into the atmosphere, but uses it repeatedly, sending it to the compressor. This reduces the amount of toxic emissions and increases the efficiency of gas turbine installations.

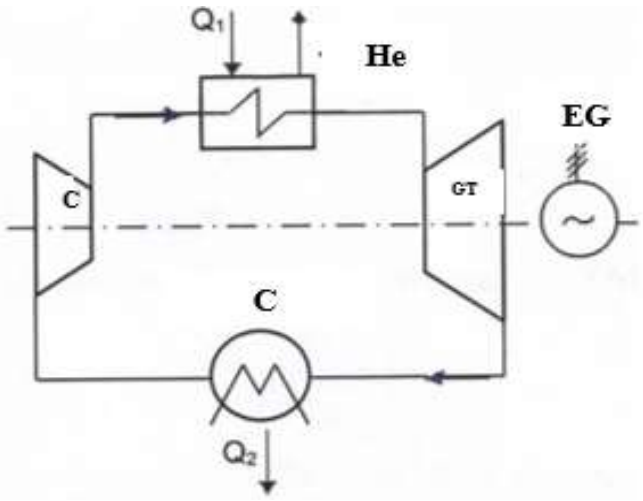


Figure 2. Closed-cycle GTU circuit: GT – gas turbine; C – Compressor; TO – heat exchanger; Coo – cooler; EG – electric generator

In closed-type GTU, the following are used as a coolant: combustion products, helium, nitrogen, carbon dioxide. However, there are peculiarities when using a gaseous working fluid [2].

The problem of carbon dioxide is the low efficiency of the cycle. This is due to the undercooling of the gas at the outlet, the temperature of which is ~ 600 K. As a result, the exhaust gas has to be cooled by ~ 300 K, because under certain parameters it is possible to accept a compression temperature of 305 – 310 K. Lowering the temperature leads to a large loss of efficiency, because part of its heat is not consumed [3].

For operation in closed-cycle gas turbine installations, helium is most often chosen. It has displacing properties, has a high RT value, due to its small molecular weight under the same conditions. The problem of helium is its small specific volume, because when it is displaced from the fuel tanks, this will be a problem. To do this, the temperature of helium is increased, which allows it to increase the specific volume.

The difference between nitrogen and helium is in their temperatures. The throttling process is accompanied by an increase in the temperature of helium, and nitrogen has the opposite effect, enhanced cooling occurs. The use of a closed gas turbine installation and the use of helium as a working fluid will ensure relatively small dimensions of the equipment [4].

How many times helium exceeds air, we can see if we compare two gas turbine installations – helium and air. Let's identify the correspondence between the degree of pressure increase (Fig. 3):

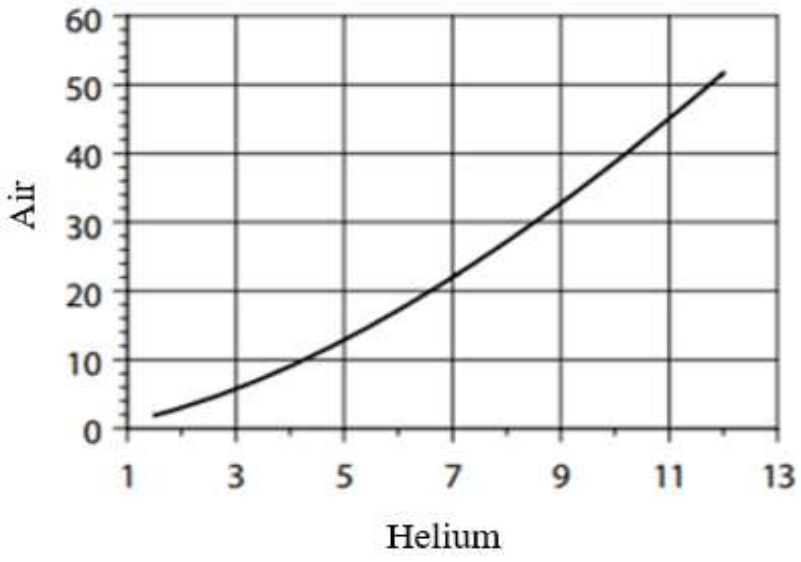


Figure 3. Correspondence between the degree of pressure increase of helium and air

Since the heat capacity of helium is $C_{p\,He}$ = 5,194, and air $C_{p\,в}$ = 1,144, then their ratio $\frac{C_{p\,He}}{C_{p\,в}} = \frac{5,194}{1,144} = 4,54$ shows that in the stage of the helium installation, the enthalpy drop will be triggered 4.54 times more than in the air stage.

Accordingly, from these conditions, we can say that the ratio of pressures and the ratio of densities in a helium installation will be less than in an air one. Therefore, if the initial temperatures and pressures are equal, the initial density of helium will be less than that of air.

Having considered the working bodies that are used in closed-cycle gas turbine installations, we can say that helium is the most promising [5].

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**УДК 004.42**

# THE MAIN FUNCTIONS AND FEATURES OF THE ANSYS SOFTWARE

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**Abstract.** Currently, modern technologies allow solving problems in different areas remotely. This is very convenient, because often when studying the compositions of different materials, the materials and laboratories themselves are needed to conduct research, and modern software packages allow research to be carried out virtually. A huge plus is the fact that such a study does not require funding, because all that is needed is a personal computer with installed software. One such leading software today is ANSYS. This paper contains information about the ANSYS software package, presents the main functions and capabilities.

**Keywords:** software, design, programming languages, analysis.

# ОСНОВНЫЕ ФУНКЦИИ И ВОЗМОЖНОСТИ ПРОГРАММНОГО ОБЕСПЕЧЕНИЯ ANSYS

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**Аннотация.** В настоящее время современные технологии позволяют решать задачи в разных областях удаленно. Это очень удобно, потому что часто при исследовании составов разных материалов нужны сами материалы и лаборатории для проведения исследований, а современные программные пакеты позволяют провести исследования виртуально. Огромным плюсом является тот факт, что для подобного исследования не требуется финансирование, ведь все, что нужно – это персональный компьютер с установленным программным обеспечением. Одним из таких лидирующих программных обеспечений сегодня является ANSYS. В данной работе содержится информация о программном пакете ANSYS, представлены основные функции и возможности.

**Ключевые слова:** программное обеспечение, проектирование, языки программирования, анализ.

Currently, modern technologies allow solving problems in various fields remotely. This is very convenient, because often when studying the compositions of different materials, the materials themselves and laboratories are needed to conduct research, and modern software packages allow you to conduct research virtually. A huge plus is the fact that such a study does not require funding, because all you need is a personal computer with installed software. One of such leading software today is ANSYS.

ANSYS is a software system of finite element analysis that allows engineers and designers to modify and analyze a project (Fig. 1). ANSYS has been leading in the field of computer engineering for the past 50 years.

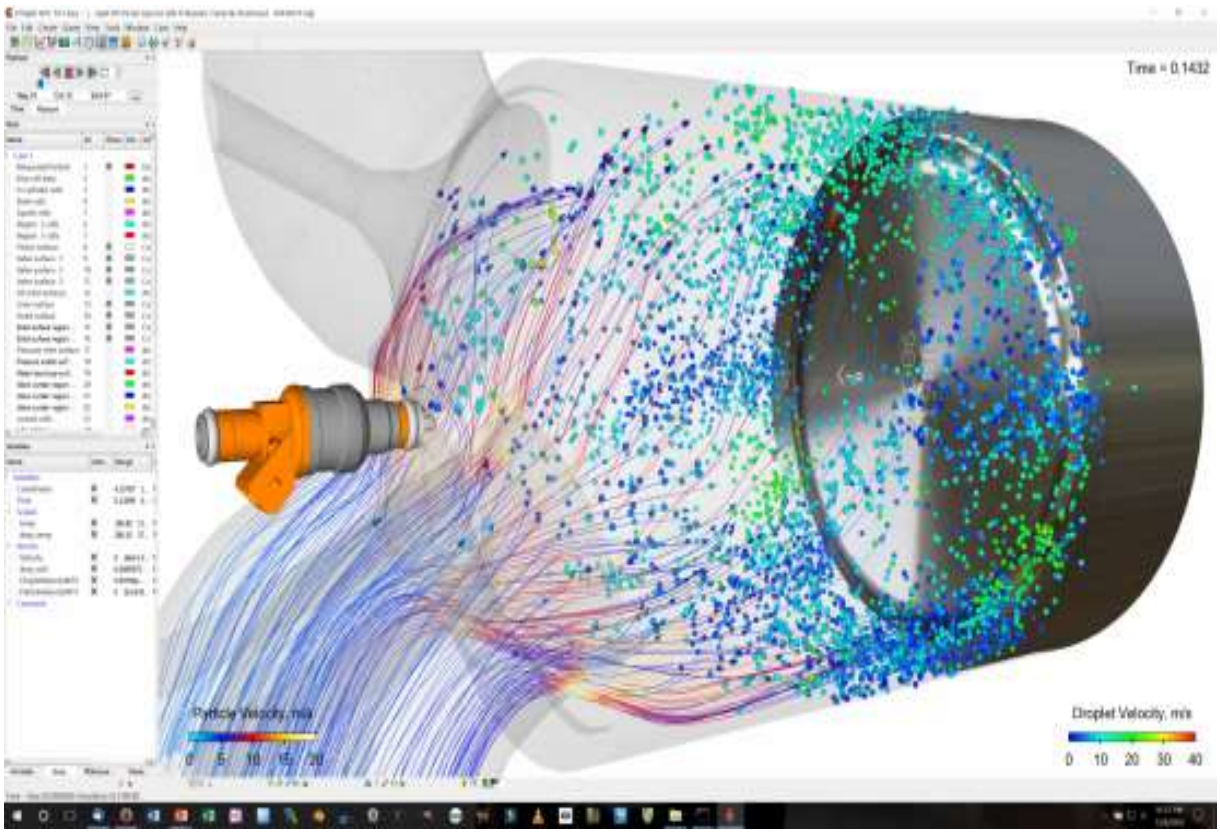


Figure 1. Multidisciplinary engineering analysis based on ANSYS solutions

This research CAE system is capable of providing two-way exchange with many CAE/CAM/CAD systems. Several programming languages are supported in ANSYS: APDL, C++, C#, XML and Javascript. Certified by ANSYS according to international standards: ISO 9000, Lloyd's Register, NAFEMS, etc. [1].

The tools of this software are formed on the basis of a modular structure consisting of specialized programs. Consider the following ANSYS tools [2].

1. ANSYS Multiphisics. This tool provides structural, thermal and dynamic analyses.

2. ANSYS Mechanical. It allows you to develop projects, research and optimize them, solve problems on the analysis of structural strength, acoustics and heat transfer. ANSYS Mechanical is a part of the ANSYS Multiphisics software package.

3. ANSYS Structural. This tool is needed for accurate modeling of large and complex projects, for strength analysis of models. ANSYS Structural is a part of the ANSYS Mechanical software package.

4. ANSYS Termal. This is an ANSYS Mechanical element that helps to perform various calculations.

5. ANSYS Emag. A tool that allows you to simulate electromagnetic fields.

6. ANSYS LS-DYNA. A program aimed at analyzing emergency situations.

7. ANSYS Parallel Performance. This module of parallel calculations is able to solve problems using clusters.

8. ANSYS Workbench. A new generation of software products based on an object-oriented approach to engineering research. Here, engineering analysis provides great integration capabilities with CAD systems.

One of the main features of ANSYS is analysis. Let's consider different types of analysis:

1. Static analysis – it is necessary to determine the load and change the shape of the body in conditions of static load of the structure.

2. Dynamic analysis – allows you to calculate the frequencies of natural vibrations of the structure by the Lanczos method. This is necessary under dynamic load and when simulating vibrations.

3. Dynamic harmonic analysis – it is necessary to determine the response of the structure to loads that change according to the harmonic law over time, ignoring nonlinear effects and characteristics of materials.

4. Transient dynamic analysis is similar to harmonic analysis, but the loads here vary arbitrarily. It allows you to take into account inertia, attenuation and contact with surfaces.

5. Interdisciplinary analysis – allows you to solve problems related to the simultaneous course of physical changes depending on nature, associated with induction heating, ultrasonic transducer, etc. There are two ways to solve problems: sequential and joint. With sequential, the results are transmitted from the output of one calculation module to the input of another, and with joint, certain

finite element calculations are required that take into account all types of loads. With strong nonlinearities, a joint method is always used, since a sequential method does not give accurate results.

The analysis consists of several stages. The first stage is preprocessing preparation. At this stage, the calculation type, model construction and load distribution are selected. When constructing, it is necessary to select coordinate systems and finite elements, specify the properties of materials, create a model and generate a grid of finite elements. There are three ways to build a geometric model: by importing a model from a CAD system, modeling, and creating a finite element model interactively [3].

The next stage is the application of loads and getting the result. This stage consists of load analysis and running a finite element task. The type of analysis is selected based on the load and response of the system. The "Solve" command launches. The program accesses a huge database and performs calculations, which are recorded in a special file and in the database.

ANSYS software is a package with a very large range of functions that helps specialists in the field of modeling various processes.

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**УДК 57.024**

# BORDERLINE PERSONALITY DISORDER IN CHILDREN AND ADOLESCENTS

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**Abstract.** Borderline personality disorder is the most common variant of personality disorders and is very poorly detected among patients. The article discusses the causes of this disease at an early age.

**Keywords:** borderline personality disorder, mental health, adolescents, children.

# ПОГРАНИЧНОЕ РАССТРОЙСТВО ЛИЧНОСТИ У ДЕТЕЙ И ПОДРОСТКОВ

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**Аннотация.** Пограничное расстройство личности представляет собой наиболее распространенный вариант личностных расстройств и очень плохо выявляется среди пациентов. В статье рассматриваются причины возникновения этой болезни в раннем возрасте.

**Ключевые слова:** пограничное расстройство личности, психическое здоровье, подростки, дети.

The state of mental health of children and adolescents is a serious medical, psychological and social problem of modern society. According to the annual report, in the conditions prevailing in previous years, the trend towards deterioration in the health of children under 15 and adolescents has become stable. The unfavorable situation with the state of mental health of children and adolescents is also evidenced by the high incidence rates of mental disorders presented at the 14th Congress of Psychiatrists of Russia show that the most significant indicators of somatic and mental diseases over the past 10 years are

observed in the age group of 15 – 17 years. In connection with the above, it is necessary to strengthen the work of psychologists to preserve the mental health of children and adolescents, since the health of the younger generation determines the future health of the nation.

When analyzing the structure of mental morbidity in children and adolescents in comparison with other age groups, the predominance of borderline neuropsychiatric disorders is clearly traced.

Adolescence or the period of adulthood is usually characterized as a turning point, transitional and critical. The analysis of literary sources shows that the problems of adolescents have been the focus of attention of many scientists: psychologists, educators, cultural scientists, sociologists. Puberty covers the process of puberty from its first signs to its full completion.

The concept of borderline mental states is used to combine mild disorders bordering on a state of health and separating it from pathological manifestations accompanied by significant deviations from the norm. According to the definition of Yu. A. Alexandrovsky, borderline states are not the initial, intermediate phases or stages of major psychoses. They represent a special group of pathological manifestations that have their beginning, dynamics and outcome in clinical expression, depending on the form or type of the painful process.

Of the social factors that causally affect the socialization of a child, it is necessary to single out the parental family, which is a key condition for optimal psychosocial development of a child and most often acts as a source of age-related mental development disorders, neglect, homelessness and various mental disorders associated with these socially conditioned phenomena in a minor family member. The social situation developing in the country in recent years, on the one hand, created serious difficulties for families, especially those with many children, and on the other hand, it was accompanied by an undoubted increase in borderline mental disorders in minors, including an increase in deviant, delinquent and addictive behaviors [1].

In addition to the structure of the family, an important place in education is occupied by the nature of the relationship of parents to the child. There is a unanimous opinion in the literature about the importance of parental (primarily maternal) upbringing of a child, especially in the period up to 3 years. A child who is in conditions of insufficient emotional warmth and is not attached to the mother develops significant mental health disorders that are closely related to the persistence and duration of maternal deprivation. In the International Classification of Mental Disorders (ICD-10, 1999), they are separated into a separate category as “attachment disorders” (F93).

It is shown that the leading risk factor predisposing to the early formation of mental and behavioral abnormalities is not only maternal deprivation, but also the maladaptation of parental families in sick children in general. There are three levels of such maladaptation according to the degree of increasing severity of pathogenic effects:

- the disintegration of the family and the transfer of the child's upbringing to relatives and other persons;
- the presence of conflicting family relationships that prevent the implementation of normal educational functions;
- antisocial maladaptation of parental families.

Thus, in the works of many researchers, the following psychotraumatic factors of the microenvironment affecting the mental health of children have been identified and presented:

- conflict situations in the relationship of parents with each other (29,6 %);
- alcoholism of parents (27,4 %);
- increased demands from parents bordering on despotism (18,3 %), etc.

Borderline disorder, is a serious mental health disorder of children. No matter how old the child is, it is quite difficult to maintain a relationship with him. This disorder is difficult to diagnose, especially at an early age, for this reason, parents, most often, do not correlate their child's behavioral problems with any deviation in the development of his psyche.

Meanwhile, the symptoms of personality disorders in a child manifest themselves from a fairly early age, by about four years old, it is already possible to notice a certain kind of distortion; self-image, fear of rejection, extreme and sudden mood swings, stormy relationships, complex relationships combined with gullibility and naivety. While the child is small, parents consider certain oddities in his behavior to be age-related features. You can often hear that a child was born with a special character. When a child gets older, his behavioral features are more noticeable, but parents still do not attribute the characteristics of the child's character to any violation of personality development. But the real problems often do not begin until the beginning of adulthood.

By “borderline mental disorders” we mean a far heterogeneous set of mental disorders in their manifestations and mechanism of origin, which occupies an intermediate position between “mental illness”, “psychosis” and “mental health”. Moreover, borderline disorders are considered not as a “bridge” between mental illness and mental health, but as a kind of group of nonspecific symptom complexes similar in the degree of severity of their manifestations and limited to the “neurotic level” (“neurotic register”) of mental disorders. The group of

borderline disorders in children and adolescents usually includes neurotic and pathoharacterological reactions, neuroses and pathoharacterological developments, psychopathies, neurosis-like and psychopathic states, as well as borderline forms of intellectual disability and other, less common disorders [2].

When a child becomes an adult, it is much more difficult to help him learn how to manage the symptoms of a mental health disorder. Behavioral and emotional problems affect not only those who have a similar diagnosis, but also have a profound impact on the lives of people around them. Parents of children with borderline personality disorder often feel helpless because they do not know how to help their child, do not know how to communicate with them, do not know how to properly educate them, how to teach them how to interact with other people, help them learn how to manage their symptoms of the disorder and live a more successful life.

Trying to help an adult child with borderline personality disorder is not an easy thing. He, as a rule, refuses any help offered by his parents, since he does not see the need for it. Helping a child or teenager is much easier than helping an adult with borderline personality disorder.

Some parents claim that they noticed signs of borderline disorder in their child even in infancy. The baby was restless, in the senior preschool and primary school age, they faced learning difficulties, numerous episodes of frustration and aggression, with behavioral problems.

Children and adolescents undergo many developmental changes, and sometimes it may seem that the symptoms of one disorder can turn into a completely different one. Behavioral problems may be a sign of a deeper disorder, or they may simply be a certain phase of growing up that children outgrow.

Some of the most distinctive features of borderline personality disorder in children include problems with personal relationships and extreme and unjustified fear of rejection and waiver. This can lead to the fact that the child has to change schools, as it is difficult for him to manage his emotions. In communication with other children, there is an idealization of relationships, and a quick disappointment in them. Identity confusion often occurs, and in adolescents this can manifest itself in gender confusion or take other forms [3].

Borderline personality disorder is one of the most difficult disorders to treat

To help the patient, the doctor uses a set of methods. But the only form of work with scientifically proven effectiveness so far is dialectical behavioral therapy [4].

The method was created by Marsha Linehan, an American psychologist, in the late 80s to treat people with borderline personality disorder. As a result of

therapy, a person realizes that there are many views on the situation, which he sees as unbearable and hopeless. Thanks to this, the patient learns to objectively evaluate the pros and cons and adhere to the point of view on the problem that allows using the behavior model that is most beneficial for him.

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**УДК 620.9**

# MINI-TPP AND ITS ADVANTAGES IN GENERATING YOUR OWN ELECTRICITY

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**Abstract.** The mini-thermal power plant is considered in the article. The types and the main advantages of this thermal power plant are analyzed. The methods for obtaining own electricity are described.

**Keywords:** mini-thermal power plant, cogenerating, small power, fuel, energy resources.

# МИНИ-ТЭС И ЕЕ ПРЕИМУЩЕСТВА В ВЫРАБОТКЕ СОБСТВЕННОГО ЭЛЕКТРИЧЕСТВА

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**Аннотация.** В статье рассматривается мини-теплоэлектростанция. Проанализированы типы и основные преимущества данной тепловой электростанции. Описаны способы получения собственного электричества.

**Ключевые слова:** мини-теплоэлектростанция, когенерация, малая энергетика, топливо, энергоресурсы.

One of the main tasks of ensuring the stable operation of an industrial enterprise is its continuous supply of electric and thermal energy.

The solution to this problem is the construction of your own mini-TPP (mini-thermal power plant).

Mini-TPP is a practical application of two technologies: small energy and cogenerating. Small-scale energy is energy that allows you not to depend on centralized power supply and its condition. Such technologies find a place in industrially developed areas with different climates. Cogenerating is the joint production of electrical and thermal energy. The efficiency of fuel use with this

method is 80 – 90 %. At the moment, in modern cogenerating plants, the role of mechanisms that convert natural energy resources into mechanical work can be performed by: steam turbines, steam-gas turbines, steam-screw turbines, piston turbines, gas turbines and microturbines [1].

Mini-TPPs differ from each other by several factors, one of which is the type of fuel used.

Solid fuel – wood and fuel briquettes derived from its waste, organic waste and fuel briquettes made from them.

Liquid fuel – oil, fuel oil, diesel fuel.

Gaseous fuel – natural gas trunk, liquefied, associated gases of hydrocarbon deposits [2].

The choice of the power plant, the main part of the mini-TPP, depends on the type of fuel. There are various types of power plants.

1. Piston. The power plant responsible for generating electricity due to the combustion of the main fuel is present in any TPP. But there are units in which the internal combustion engine performs the universal function of converting thermal energy. These are plants that work with almost any type of fuel. This can include both traditional liquid and gas, as well as solid-state fuels. Energy-efficient mini-TPP running on biofuels are also being distributed. Pellets, granular materials and even some types of industrial waste are used for such installations.

2. Gas turbine. The very idea of autonomous power plants determines their independence from the main sources of energy supply. The most economical in operation are gas-fired thermal power plants that are connected to the central gas pipeline. This solution is the least expensive, safe and effective in terms of maintaining performance. If there is no possibility of connecting to the main line, then you can use cylinders filled with liquefied gas. Such models work on the principle of converting the heat released during fuel combustion into mechanical and electrical energy. Thanks to the addition of a turbine generator, mini-thermal power plants on gas can generate large amounts of energy. While maintaining the small size of the structure, the plant is capable of servicing industrial equipment that requires the connection of considerable energy resources under high voltage.

3. Steam. The features of steam power plants include low power, environmental friendliness, a high level of safety and savings in operation. In this case, the source of energy generating for conversion is water, which, as a result of high heating, turns into steam, and then into condensate. The main disadvantage that a mini-steam TPP has is the complexity of its structural device. The plant is a complex consisting of several separate components. Steam installations are composed of a boiler, which performs the function of a vaporizer. Also, the connection with the generator set is formed through a network of pipes that

circulate water and steam. But the inconveniences of using the design are practically compensated by the lack of fuel material costs [3].

The construction of a mini-TPP for a specific consumer in close proximity to it provides a number of advantages, unlike the construction of large central TPPs and other power plants.

1. Quality and stability of energy supply. Mini-TPP provides uninterrupted power supply with a constant voltage level and heat supply with specified parameters.

2. Joint production of electricity and heat. The solution of two major problems of the facility operation at once is an example of a modern approach to business.

3. Low cost of generated energy. With an average consumption per hour of 0,3 $м^3$ gas consumers can get 1 kW of electricity and about 2 kW of heat per hour, while saving a significant amount on connecting to the traditional power grid [1].

4. Environmental friendliness. The production of two types of energy at once at mini-thermal power plants reduces the impact on the environment in comparison with the separate generating of electricity and thermal energy at boiler plants. If necessary, cold can be obtained from heat for centralized ventilation and air conditioning systems, for example, in the summer. The use of gas fuel further increases environmental friendliness.

5. Fast payback and high energy resource. The construction of a mini-thermal power plant pays off in 2 – 3 years. As part of a mini-TPP, up to twelve electric units can operate, each with a capacity of 1000 – 9000 kW.

6. Savings on communications (due to proximity to the power supply facility). Issues of maintenance and repair of heating networks do not concern users of mini-thermal power plants.

7. Compactness. Small dimensions make it convenient to place mini-thermal power plants inside already built buildings or next to them – for example, on the territories of industrial, shopping and entertainment, hotel complexes [4].

8. Efficiency of commissioning. The construction time of the mini-TPP ranges from three months to a year and depends on the choice of fuel, the power of the power units and the final configuration of the plant. The life cycle of the equipment reaches 20 – 25 years.

9. Significant savings. The financial dependence of the consumer on the growth of electricity and heat tariffs is reduced. The savings on the electricity bill reaches two or more times.

10. Simplicity and convenience of operation. The operation of the mini-TPP is fully automated.

11. Reliability. Power supply companies cannot always guarantee the reliability of energy supply, while you fully control your own mini-TPP.

To date, the main barrier to the development of small-scale energy in Russia is insufficient attention to this industry. The spontaneity, the lack of a unified plan, in contrast to large-scale energy, interferes.

Thus, the mini-TPP needs economic and legal support. These measures are able to provide favorable conditions for the work of independent electricity producers. Mini-TPPs should be actively developed, as it allows solving many problems of the country's electricity supply.

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# DESIGN PROJECTS INTENDED TO HELP PEOPLE IN THE ERA OF THE PANDEMIC

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**Abstract.** The article discusses design projects designed specifically for use in the conditions of the coronavirus pandemic, and also analyzes the relevance of each of them for this situation. The article clearly shows the ways of applying each of the concepts being developed and tells how existing products can be improved so that they significantly reduce the risk of infection.

**Keywords:** design, pandemic, coronavirus, design project.

# ДИЗАЙН-ПРОЕКТЫ, ПРИЗВАННЫЕ ПОМОЧЬ ЛЮДЯМ В ЭПОХУ ПАНДЕМИИ

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**Аннотация**. В статье рассматриваются дизайн-проекты, предназначенные специально для пользования в условиях пандемии коронавируса, а также анализируется актуальность каждого из них для данной ситуации. Статья наглядно показывает способы применения каждого из разрабатываемых концептов и рассказывает о том, как уже существующие продукты можно улучшить, чтобы они значительно снижали риск заражения.

**Ключевые слова:** дизайн, пандемия, коронавирус, дизайн-проект.

The coronavirus took the whole world by surprise, so humanity has become very limited in its actions. During the period of complete self-isolation, it was necessary to refrain even from going to the store. People have adapted enough to such a situation in the world, but this does not mean that it is not critical and does

not require solutions. We must not forget the fact that a pandemic can last for many years, so it will not be possible to endure this period, people will have to learn to live in these conditions. Today, a lot depends on the work of designers, because they are the ones who are able to develop such a project that will ensure the safety of the user during the pandemic. We can already observe the introduction of new projects and new design solutions for existing devices. But what are the prospects for this activity?

*Projects aimed at helping people function normally in the coronavirus pandemic.* The first project was developed by the architectural studio The Manser Practice. This is the concept of a whole contactless hotel, where guests do not meet with the staff. The key focus of future hotel rooms will be cleanliness and the reduction of unnecessary contacts – something that is difficult to achieve in common areas with a rapid turnover of guests. Such hotels will be adapted to minimize the interaction between staff and guests: administrators will be replaced by contactless registration with temperature check, and doors will be opened using a smartphone (Fig. 1).

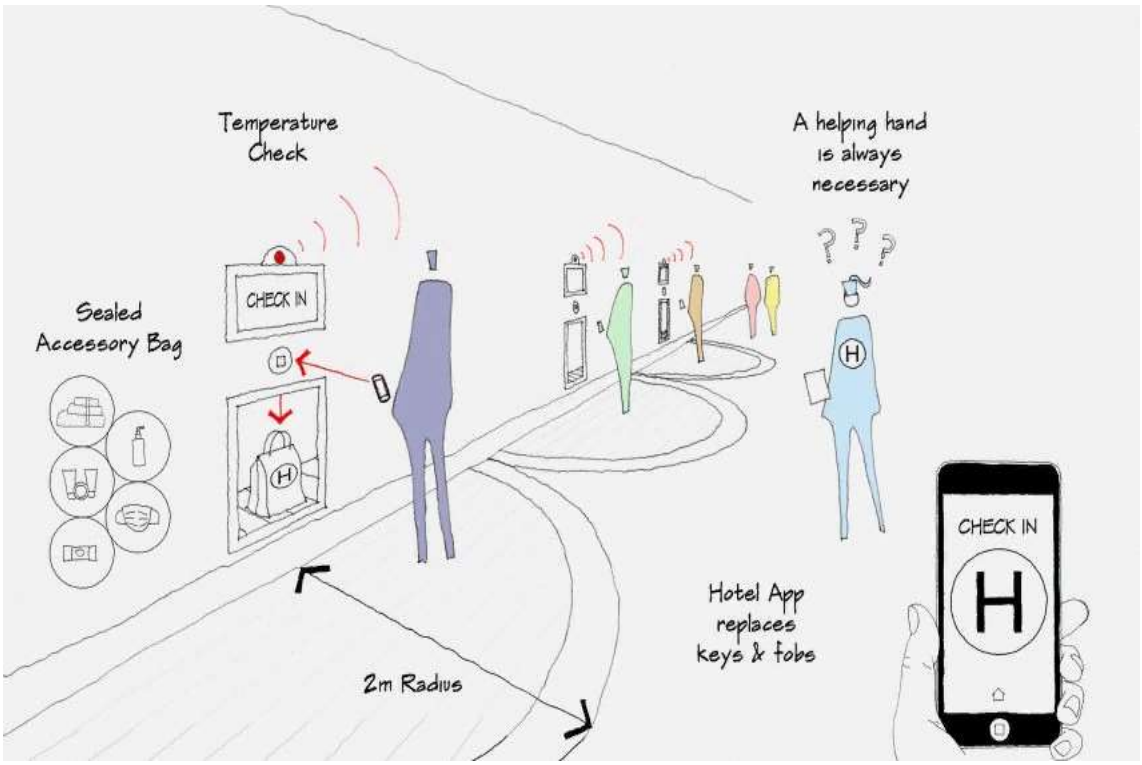


Figure 1. Contactless registration scheme

The internal spatial arrangement in the hotel buildings can change to one-way systems, thereby minimizing the points of intersection of guests in narrow corridors (Fig. 2).

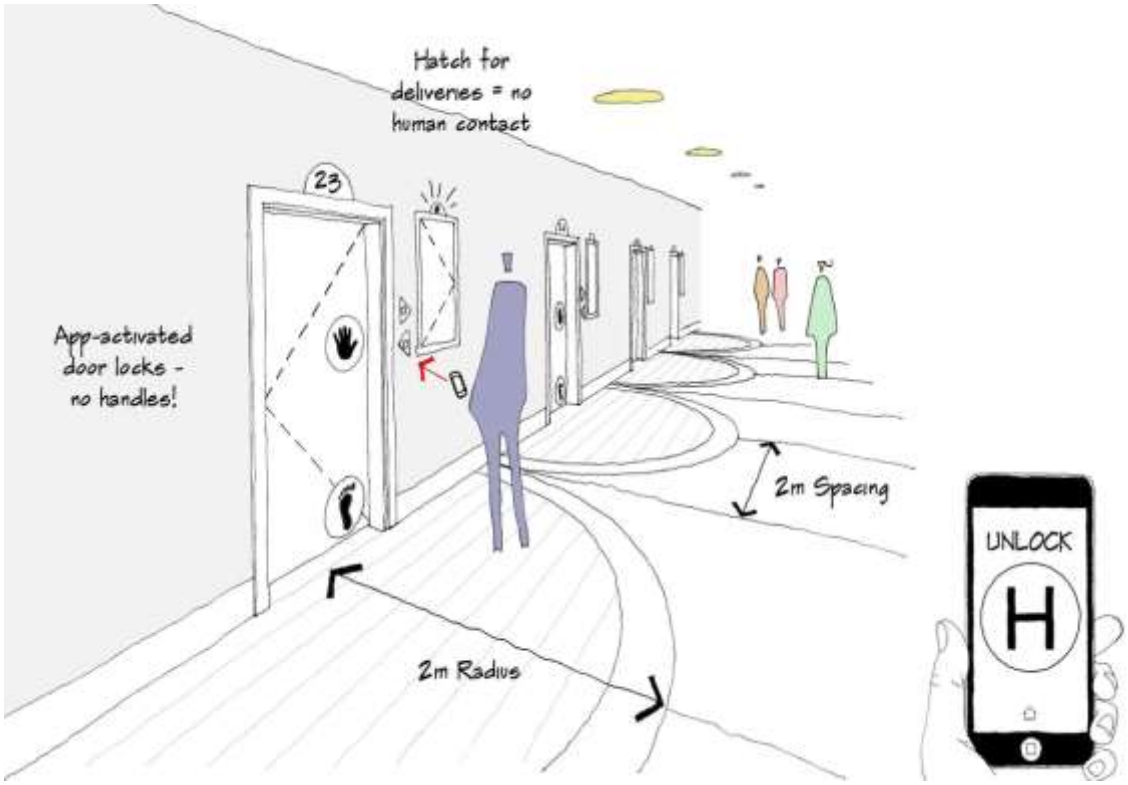


Figure 2. The scheme of contactless hotels

The pandemic situation will certainly affect the distribution of space in hotels, so spacious rooms and reduce the amount of equipment will be a priority (Fig. 3).


Figure 3. Extra space for sports in the rooms

Thanks to such hotels, people will be able to travel and relax in hotels without problems in the conditions of a pandemic, while reducing the risk of infection as much as possible [1].

Lu Xu and Zihan Zhang, studio Above, have developed masks called “Buckle” with a built-in filter that changes color in the spectrum from white to black as it absorbs dust and bacteria (Fig. 4). When the mask expires, it turns black, you can get rid of this outer layer by pulling the green latch at the bottom of the mask before replacing it with another one.


Figure 4. Mask “Buckle” with a filter

This improvement in the design of conventional face masks solves two main problems: their service life, as well as the recycling process. With the new mask design, a person can know exactly when he should change the layer so that the mask is useful again [1, 2].

Designer Andrea Ponti has developed a tram project called the “Island” (Fig. 5). The idea of this concept is social distancing. This autonomous transport option assumes the complete absence of a car driver, which allows you to optimize the interior space as much as possible to create the necessary social distance between the seats, which are made in the form of rings and placed in the center of the cabin [1, 3].

Figure 5. Design project of the trawm “Island”

Frank Chow's lamp (Fig. 6). Ideally, it should stand in the hallway just before the exit, so that a person uses it immediately after coming home. Such a lamp sterilizes objects due to ultraviolet radiation. It is designed to become a part of everyday life.

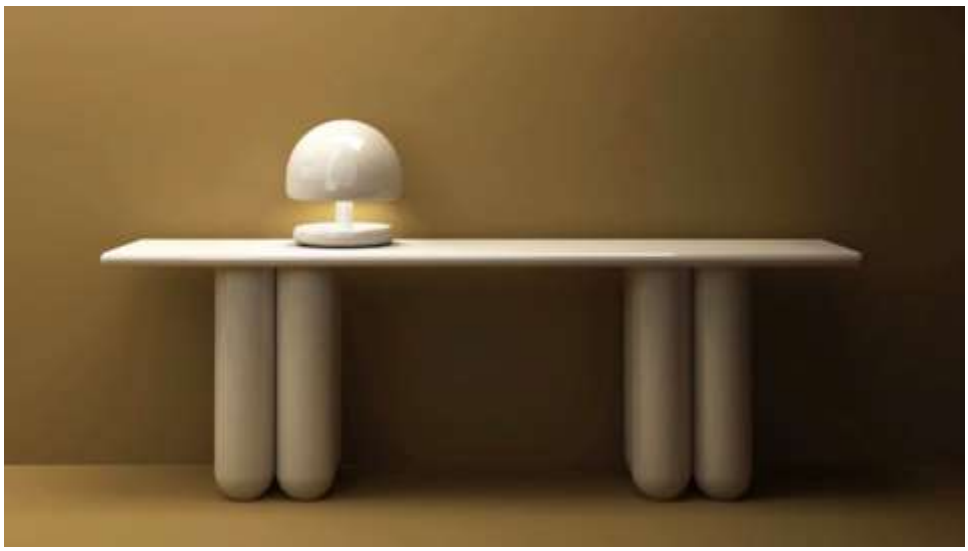

Figure 6. Frank Chow's Lamp

The base in the form of a tray is designed for small things that people carry with them on the street almost always: mobile phone, wallet, keys, etc – when you press the case, the light is activated, and the rounded lid is lowered, covering the objects to disinfect them. Disinfection takes exactly one minute. A lamp with such a design is practical, and can also easily fit into any interior [2, 4].

The pandemic has burst into the lives of all of us, causing inconvenience to everyone, not to mention the danger of infection. But they were followed by implementations that solve these problems – projects aimed at helping a person in such a difficult time. The task of creating such concepts, of course, fell on the shoulders of designers. Despite the fact that people are already using products created specifically for more convenient functioning in the era of the pandemic, there are still prospects for this activity. Moreover, this direction has every chance to open a new era in design. Of course, some of the concepts being designed are too futuristic and seem impossible to implement, but besides them there are many really useful and possible design projects.

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**УДК 620.92**

# THE NEGATIVE IMPACT OF GEOTHERMAL ENERGY ON THE ENVIRONMENT

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**Abstract.** The article discusses the principle of operation of geothermal plants. As well as environmental problems caused by this branch of alternative energy.

**Keywords:** ecology, geothermal energy, alternative power engineering, ecological problems.

# НЕГАТИВНОЕ ВОЗДЕЙСТВИЕ ГЕОТЕРМАЛЬНОЙ ЭНЕРГЕТИКИ НА ОКРУЖАЮЩУЮ СРЕДУ

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**Аннотация.** В статье рассматривается принцип работы геотермальных станций. А также экологические проблемы, вызываемые данной отраслью альтернативной энергетики.

**Ключевые слова:** экология, геотермальная энергетика, альтернативная энергетика, экологические проблемы.

Geothermal energy is an alternative energy source that uses renewable energy resources. This area of energy is based on the use of thermal energy of the Earth's interior to produce electricity in geothermal power plants, or to supply heating.

Wells are drilled to produce heat. It is brought to the surface in the form of steam or hot water. Thermal regions are located in many parts of the world. They are usually found in areas of high seismic activity, where tectonic plates collide

or rupture. The areas around the edges of continental plates are the best places to build geothermal plants because the crust in such areas is much thinner. In the most favorable cases, temperatures can be so high that surface waters are heated to the desired temperature. Geysers and hot springs are examples of such cases. Below the earth's crust is a layer of hot and molten rock called magma. Heat arises there primarily from the decay of naturally occurring radioactive elements, such as uranium and potassium [1].

There are two main ways of using geothermal energy: direct use of heat and electricity generation. Direct use of heat is the simplest and therefore the most common way. The practice of direct use of heat is widespread in high latitudes at the borders of tectonic plates, for example in Iceland and Japan. In such cases, water is installed directly into deep wells. The resulting hot water is used to heat roads, dry clothes and heat greenhouses and residential buildings. The way of producing electricity from geothermal energy is very similar to the way of direct use. The only difference is the need for a higher temperature.

Three of the most common options are used to generate electricity with underground heat.

*1. Geothermal steam electric station.*

Dry steam is fed from the production well to the turbine, rotating it, the torque is transferred to the generator, which generates electricity. The condensate from the turbine is pumped back into the geothermal layer through the neighboring injection well (Fig.1).

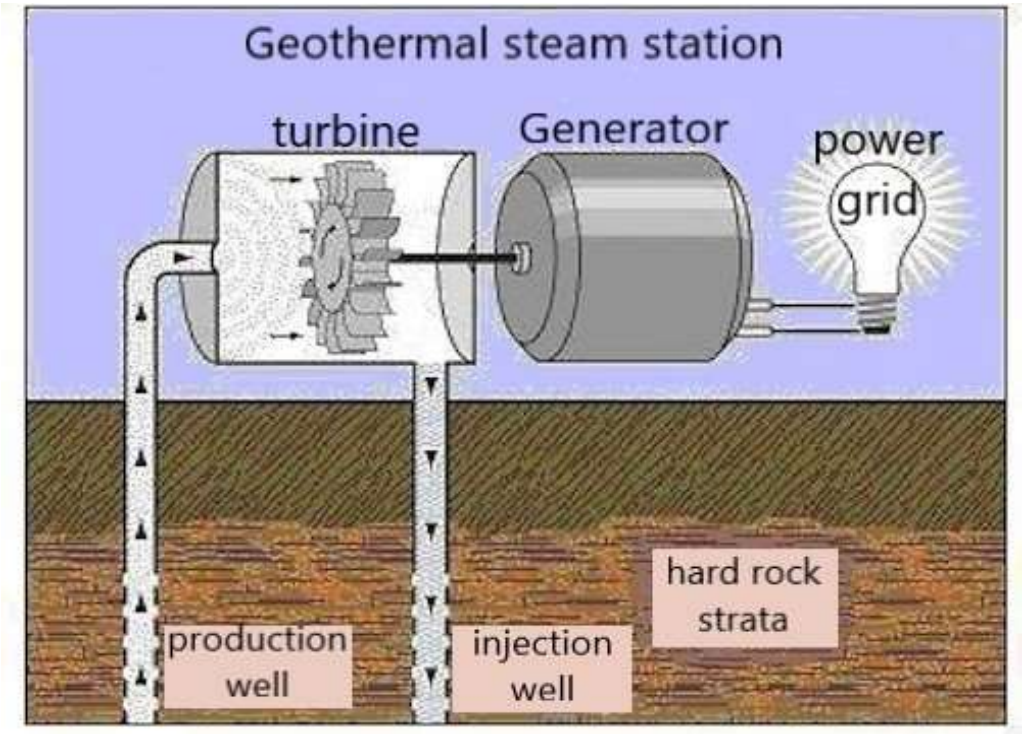


Figure 1. Geothermal steam electric station

*2. Hydrothermal electric station.*

A heated solution is fed from the production well to the vaporizer chamber, which is pressurized in the chamber, and the vapors are fed to the turbine. The torque is transferred to the generator, which converts it into electricity. The condensate from the turbine is pumped back underground through the injection well (Fig. 2).

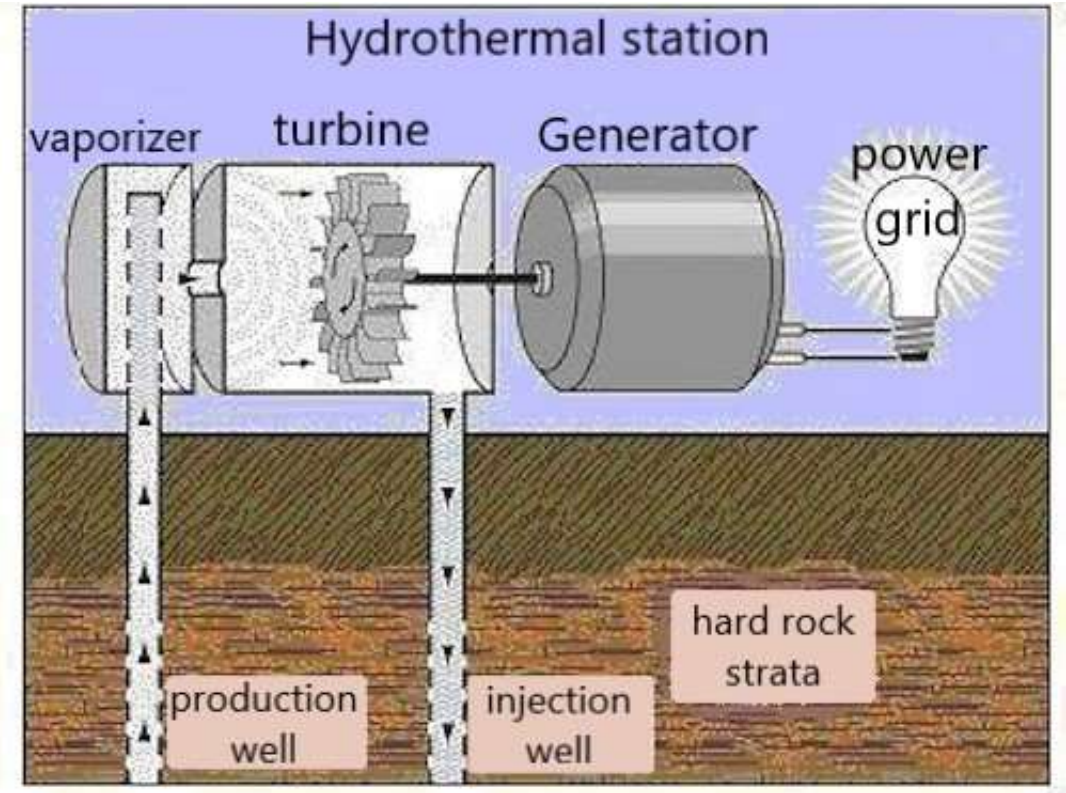


Figure 2. Hydrothermal electric station

*3. Geothermal electric station with binary cycle.*

From the production well, the solution enters the heat exchanger, where the heat is transferred to a liquid with a lower boiling point. The steam is fed to the turbine and the torque is transferred to the generator, where electricity is converted. The condensate is injected into the hard rock strata through the injection well (Fig.3).

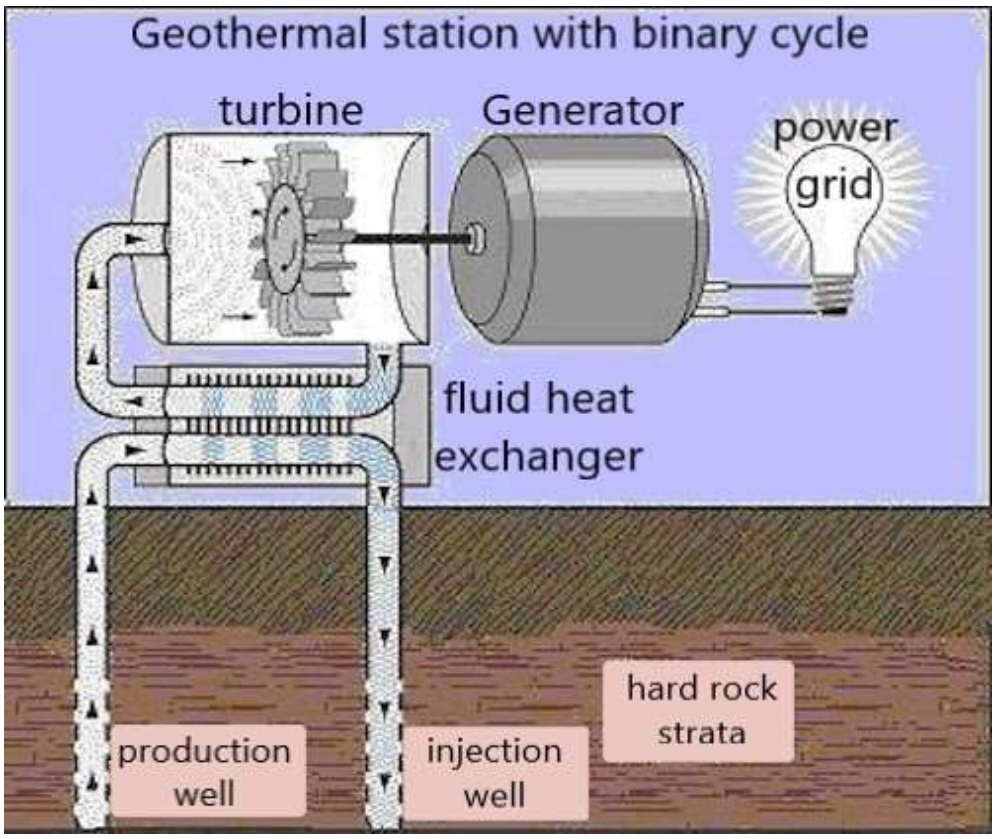

Figure 3. Geothermal electric station with binary cycle

The specific option depends on what state the geothermal medium is in water or steam [2].

Geothermal energy is not a perfect way to produce energy. There are many problems caused by this industry. One of them is the environmental problem.

*The first problem* is high heat loss. After all, the sources that naturally come to the surface are not enough to obtain the necessary temperature. Several artificial wells have to be drilled for the station. Not 100 % of the energy obtained from the well is consumed to obtain electricity. Part of the heat energy is released outside into the atmosphere, which leads to local climate changes. This negatively affects certain species of animals and plants living in those habitats. Of course, in some cases species can adapt to the changes. But the altered climate can also affect their life cycle.

*The second problem* is the depletion of the geothermal source, which leads to changes in the geology. The withdrawal of large amounts of water from the aquifers leads to subsidence of the soil. The landscape is changed, the surface layer of the soil is disturbed.

*The third problem* is the accidental leakage of toxic substances to the surface. During unforeseen circumstances, gases can be released into the atmosphere. Gases such as methane, hydrogen, nitrogen, ammonia, and hydrogen

sulfide are released to the surface. It is impossible to predict the exact concentration, so it is impossible to make a complete analysis of gas release. But unambiguously these substances are harmful to living organisms.

*The fourth problem* is the accidental release of brine into the aquifer. Brine is the working fluid during geothermal energy extraction. This fluid can also get into surface water bodies and cause poisoning of living organisms. The brine can contain, for example, substances such as arsenic, cadmium, zinc, lead and boron. These are the main substances in its composition. It is not possible to give exact concentrations, so, like with gases, it is not possible to carry out a complete analysis.

*The fifth problem* is the impact on the earth's crust leads to seismic motion. Even during the exploration of territories, wells are being drilled. Since the most promising places for mining are in seismically active areas, artificial interference can provoke local earthquakes. This leads to changes in the landscape and disturbance of the surface layer of soil [3, 4, 5].

Precise calculations cannot yet be made due to the fact that the earth's crust is poorly understood. There are also many factors influencing geothermal energy from nature.

Like all energy sources this type has its disadvantages. But if you can competently study its nature, geothermal energy will reach a decent level. After all, to obtain energy in this way uses replenishable resources, which within the limits of our planet means its inexhaustibility. It remains only to solve the considered environmental problems.

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**УДК 66.074.51**

# NEUTRALIZATION OF FOUL-SMELLING GAS PRODUCTS DURING SULFATE COOKING

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**Abstract.** This article discusses methods for neutralizing foul-smelling gas products during sulfate cooking. During the study of this issue, an analysis of the comparison of means and methods of neutralization of gases was carried out. The method of circular alkali balance was presented, and it was also shown how the degree of regeneration is calculated to determine the consumption and loss of alkali.

**Keywords:** sulfate, alkali, foul-smelling gas, highly concentrated, low-concentrated, incineration.

# ОБЕЗВРЕЖИВАНИЕ ДУРНОПАХНУЩИХ ГАЗОВЫХ СРЕДСТВ ПРИ СУЛЬФАТНОЙ ВАРКЕ

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**Аннотация.** В данной статье речь идет о методах обезвреживания дурнопахнущих газовых средств при сульфатной варке. В ходе изучения данного вопроса был произведен анализ сравнения средств и методов обезвреживания газов. Был представлен метод кругового баланса щелочи, а также было показано, как рассчитывается степень регенерации для определения расхода и потери щелочи.

**Ключевые слова:** сульфат, щелочь, дурнопахнущий газ, высококонцентрированные, низкоконцентрированные, сжигание.

The production of sulfate pulp is a process with a closed chemical regeneration system. After the end of the causticization process, the active alkali spent on cooking is returned to the process in the form of white alkali. However, the entire volume of alkali does not enter production, as part is lost. To compensate for the losses, fresh chemicals are added – sulfate ($Na_2SO_4$) and soda ($Na_2CO_3$) [1].

There are losses at each of the stages of cooking alkali (Table 1). In the presence of effective trapping equipment, losses range from 20 to 40 kilograms (kg) of $Na_2SO_4$ per ton (t) of pulp.

Table 1 – Alkali losses at the cooking stages

| | |
|---|---|
| When rinsing | 8-10 kg $Na_2SO_4$/t |
| When removing soap | 10 kg $Na_2SO_4$/t |
| During evaporation | 1,2 kg $Na_2SO_4$/t |
| With removal from sodo-regeneration boiler | 5-8 kg $Na_2SO_4$/t |
| When causticizing | 7-10 kg $Na_2SO_4$/t |

Alkali losses with sulfate soap can be reduced provided that the sulfate soap is decomposed by sulfuric acid in the factory. Using this method allows a significant part of the losses to be returned to the alkali tanks before evaporation. In addition, alkali losses can be minimized by installing electrofilters. The scheme of the electrofilter is shown in Fig. 1.

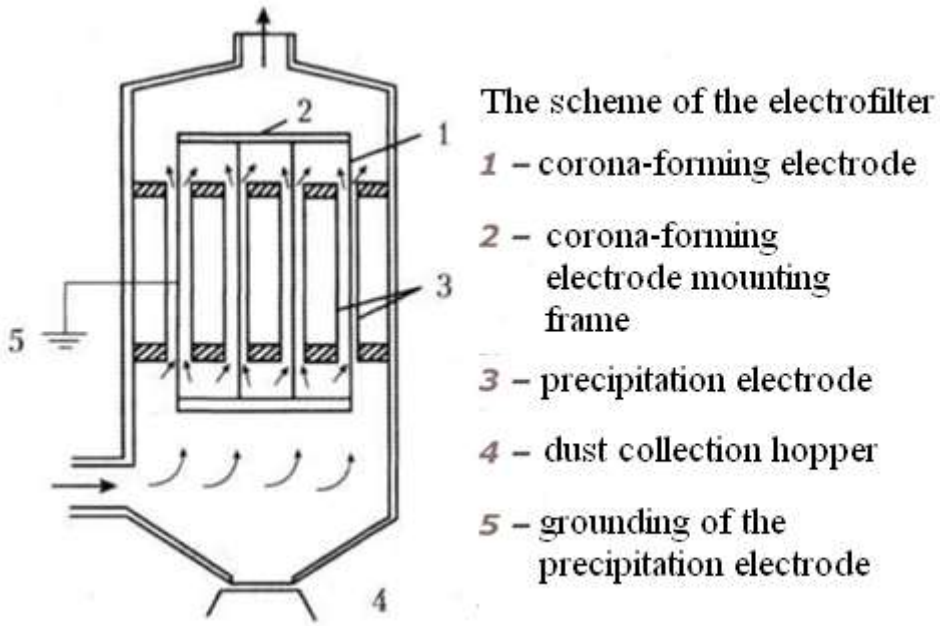


Figure 1. The scheme of the electrofilter

During the production process, the alkali is in a closed processing cycle, so a circular alkali balance was compiled. It is designed for 1 ton of cellulose per kilogram of total $Na_2O$. This balance shows not only irretrievable losses, but also the entire volume of circulating alkali. The circular balance for the production of medium hardness alkali is shown in fig. 2.

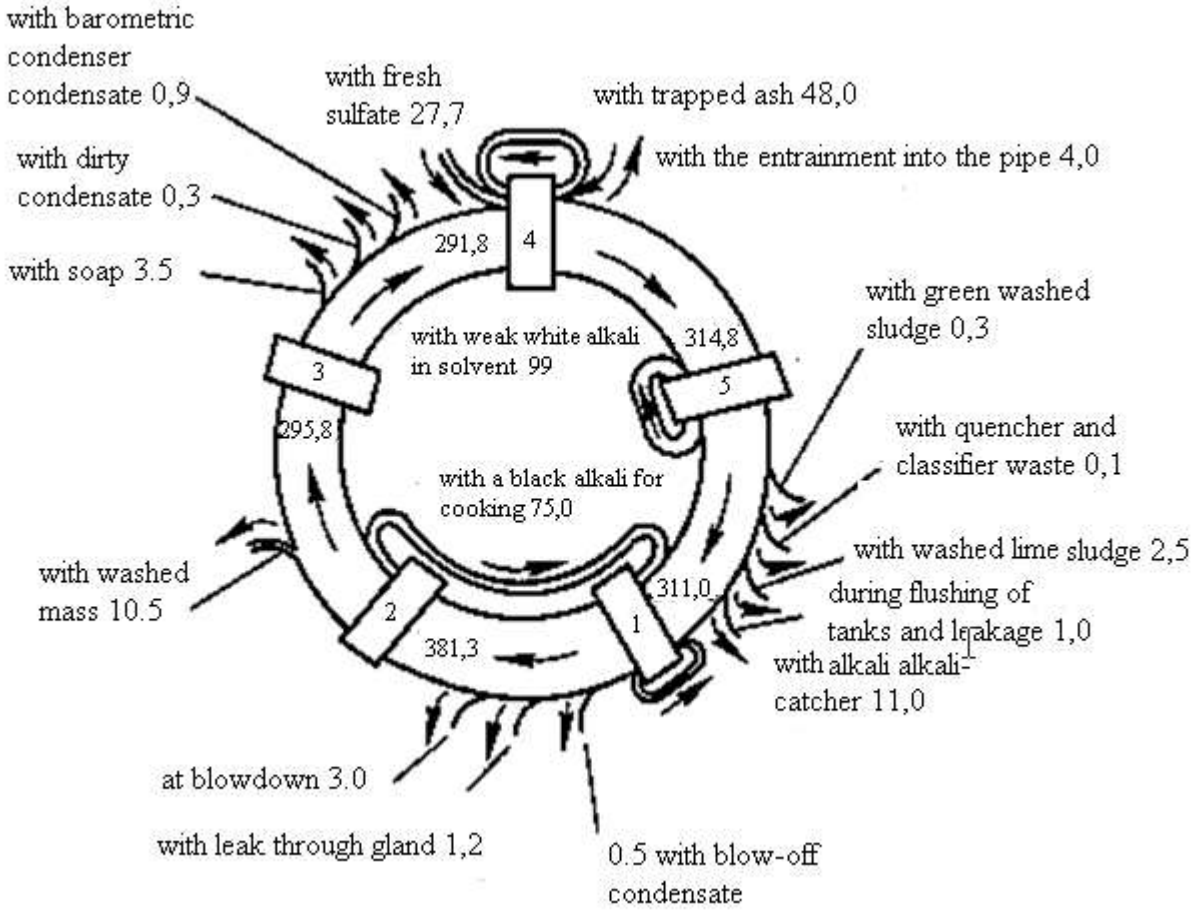


Figure 2. The circular balance for the production of medium hardness alkali.
1– cooking; 2 – flushing; 3 – evaporating; 4 – sodo-regeneration;
5 – causticized

Losses and consumption of alkali of fresh chemicals are determined by the degree of regeneration of alkali:

$$R_A = 100 - \frac{n}{N} * 100;$$

Where $R_A$ – is the degree of alkali regeneration in %,
n – is the number of alkali losses and the consumption of fresh chemicals, kg of total Na2O/t;
N – is the amount of alkali entering the boiler with white alkali, kg of total Na2O/t.

At modern enterprises, the degree of alkali regeneration is about 92 – 97 %. In the balance sheet, the minimum alkali loss is about 27.7 kg Na2O/t. And in the

production of medium hardness pulp from softwood with white alkali, about 311 kg of Na2O/t are supplied to the boiler. Based on this, the degree of alkali regeneration can be calculated:

$$R_A = 100 - \frac{n}{N} * 100 = 100 - \frac{27,7}{311} * 100 = 91,1\%$$

Then the specific consumption of 95% sulfate will be:

$$311 * (100 - 91,1) \div 100 * (142 \div 62) * (100 \div 95) \approx 67 kg/t$$ [1]

After delivery and unloading, the sulfate it enters the sodo-regeneration department. It is delivered using a conveyor belt. For the storage of sulfate, a warehouse is being built, which is designed for a stock volume of at least two months. Large and whole pieces of sulfate are passed through a crusher, giving it the appearance of a white powder. When using it, weight accounting is strictly observed, since the specific consumption at the enterprise is the main indicator that characterizes the effectiveness of further alkali regeneration.

As it burns, the organic component of the dry substance of the black liquor burns, turning into gaseous products, for example: $CO_2$, $H_2O$, etc., and the mineral component turns into a molten residue – podzol. There are no sulfur compounds in the composition of the dry soda liquor substance, and no sulfate is added to the furnace during its combustion. Instead of sulfate, soda is added during the caustic process, allowing to compensate for the loss of alkali [2].

Foul-smelling gases (FSG) released in sulfate production contain up to 20 % of biological oxygen consumption ($BOC_5$) and about 30 % of toxic substances from the total discharge of common drains of the enterprises. Discharges are a highly concentrated, low-volume waste stream that is subject to further processing. FSGs are highly explosive in the presence of air. The concentration range of these compounds is shown in Table 2. FSGs can ignite spontaneously if their temperature rises to 210 °C, after which sparks or flames appear.

Table 2 – Concentration range of DPG compounds in a mixture with air

| **Chemical compound** | **Explosive concentration of compounds in mixture with air, %** |
|---|---|
| $H_2S$ | 4,3…45,5 |
| $CH_3SH$ | 2,2…9,2 |
| $CH_3SCH_3$ | 3,9…21,8 |
| $CH_3SSCH_3$ | - |
| Turpentine ($C_{10}H_{16}$) | 0,8 |

To eliminate the formation and emissions of sulfur in the form of $H_2S$, $CH_3SH$, $CH_3SSCH_3$, a method of modifying sodium sulfide of white liquor into semi-sulfides and sulfur compounds containing acid by oxidation of $Na_2S$ is used. Oxidation products increase the yield and quality of cellulose, while not formation sulfur emissions in the departments of the enterprise. [3]

At the moment, there are three ways to reduce emissions of foul-smelling gases (FSG) at the enterprise:

1. Collection of highly-concentrated foul-smelling gases (HCFSG);
2. Collection of low-concentrated foul-smelling gases (LCFSG);
3. Waste gas from the distillation column.

Also, FSG decline can be achieved by treatment with chlorine, hydrochloric acid solutions, air-oxidation, absorption water, lye, etc.

Chlorine water and bleach solutions destroy sulfur compounds, but frequent use this method in enterprises leads to a high level of toxicity, and therefore they have a low demand. FSG is also well absorbed by black alkali, white alkali, and an aqueous solution of NaOH. An aqueous solution of NaOH is the most effective of them, since when it is used, unlike white and black alkali, hydrogen sulfide is not released.

There is also a method of combustion FSG in:

1. Sodo-regeneration boiler (SRB);
2. Lime-regenerating furnace (LRF);
3. A special furnace for non-condensable gases equipped with a wet scrubber to remove $SO_x$.

After combustion, sulfur compounds turn into sulfur gas – $SO_2$. The absorption of sulfur gas in the scrubber with an alkaline solution allows the sulfur to be returned to the regeneration system. This often leads to an increase in the sulfidity of white liquor, as a result of which, for regulation, it is necessary to partially replace sodium sulfate with soda products.

Lime-generating furnaces used for combustion in a HCFSG have an advantage in comparison with an autonomous furnace, since the investment of capital is significantly less. The heat released during the combustion of fuel allows you to save fuel. As a result of the combustion of emissions in the lime-regenerating furnace at the plants for the production of sulfate cellulose, gas emissions can be reduced by collecting and combustion sulfur-organic compounds by more than 90 %. About 10 – 15 % of the fuel used in the LRF can be replaced by combustion concentrated foul-smelling gases.

Lime-regeneration furnace used for combustion a HCFSG have an advantage in comparison with an autonomous furnace, since the investment of capital is significantly less. The heat released during the combustion of fuel allows you to save fuel. This method allows you to significantly reduce gas emissions by up to 90 %, through the combustion and collection of organosulfur compounds. About 10 – 15 % of the fuel used in the LRF can be replaced by combusting concentrated foul-smelling gases [4].

It can be concluded that the combustion of FSG in a soda-generating boiler is applicable for low-concentrated gases, while combustion in a lime-regenerating furnace is applicable for highly concentrated gases, but this method can lead to problems in the operation of the LRF. At the moment, the most optimal method of neutralization of FSG is the combustion of emissions in a special furnace equipped with a scrubber for $SO_2$ capture. This method of neutralization ensures stable combustion of gases and does not depend on the operation of SRB and LRF.

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**УДК 620.3**

# WIND POWER AS AN INEFFICIENT METHOD OF GENERATING ENERGY

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**Abstract.** The article discusses wind power installations, provides arguments about the low efficiency of these installations in Russia at this point in time. The authors set out the main barriers to obtaining electricity through the use of wind energy.

**Keywords:** wind power plant, alternative energy, average annual wind speed, electricity from the air, barriers.

# ВЕТРОЭНЕРГЕТИКА КАК НЕЭФФЕКТИВНЫЙ МЕТОД ПОЛУЧЕНИЯ ЭНЕРГИИ

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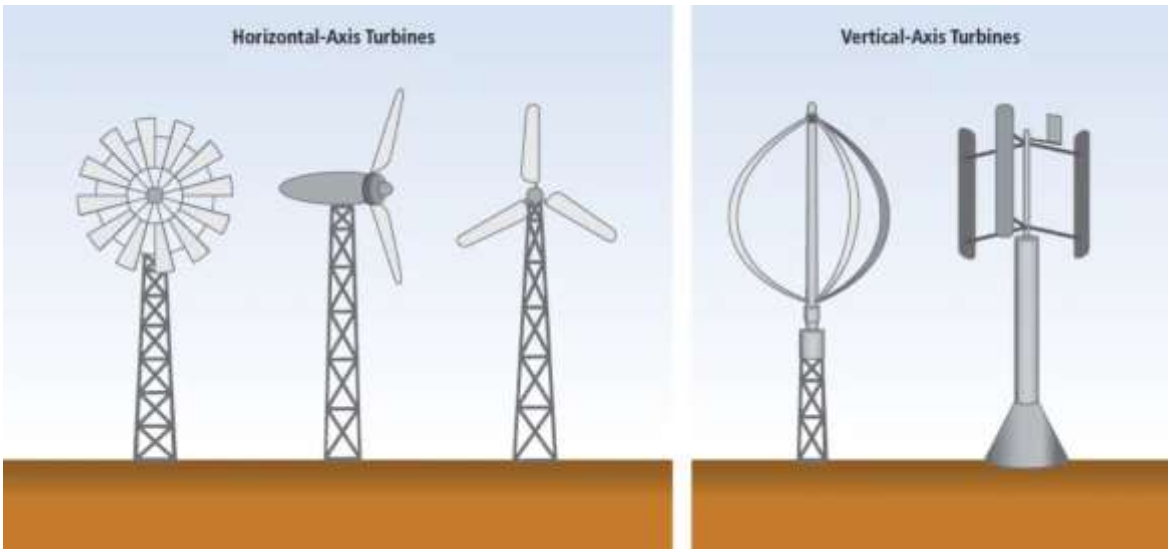
**Аннотация.** В статье рассматриваются ветроэнергетические установки, приводятся аргументы о низкой эффективности этих установок в России на данный момент времени. Авторами изложены основные барьеры получения электроэнергии путем использования энергии ветра.

**Ключевые слова:** ветроэлектрическая установка, альтернативная энергия, среднегодовая скорость ветра, электричество из воздуха, барьеры.

It is known that the bulk of electricity in our time is generated with the help of three main types of power plants: nuclear, thermal and hydraulic. All alternative energy sources in Russia account for about 3 percent. Despite this, unconventional energy is developing and spreading throughout the world. Wind power is one of the alternative energy sources. Over the past decade, wind energy

has begun to develop more actively. Conversion of kinetic wind energy into electrical energy is considered environmentally friendly. In addition, some countries do not have enough energy resources for their own energy needs, so they depend on energy imports, and due to political instability and armed conflicts in the supplying countries, there are risks for the importing countries. These factors are driving the development of wind energy in the world. Wind power has come a long way from the 18th century to the present day. For the most efficient efficiencies, even innovative bladed wind turbines generate electricity and require speeds in excess of six meters per second. Wind power on the territory of the Russian Federation, as it was already accepted, did not gain widespread use also because the developers of wind power plants initially chose an unpromising way of creating active blade wind turbines of an air flow, based on the aerodynamics of aircraft. Wind turbines can be divided into two categories: industrial and private use. There are also two types of wind turbines: with a horizontal rotor and a vertical rotor (Fig. 1).

The first type is the most common. It has a high efficiency (40 – 50 %), but has a high level of noise and vibration. In addition, it requires a large free space and a high mast to install. However, a more significant disadvantage is the need for a weather vane to constantly search for the direction of the wind. In addition, when turning, the wind speed decreases, which reduces its efficiency. Generators with a vertical rotor are less energy efficient: the efficiency is almost 3 times lower than that of horizontal ones. This is explained by the fact that the half-cylinder blades work only in a quarter of a turn, and they seem to slow down the rest of the rotation with their rotation movement. Their advantages include only ease of installation and structural reliability [1].




a b

Figure 1. Wind turbines with horizontal (a) and vertical (b) axis

Modern bladed wind turbines that generate electricity operate at an average annual wind speed of more than 7 m/s. At that time, at a wind speed of 3,5 – 7 m/s, wind turbine designs are inapplicable and ineffective. As can be seen from the map of wind energy resources of Russia (Fig. 2), the average values of wind speeds limit the use of wind turbines, since they depend on geographic location, weather conditions, time of year and even time of day. This disadvantage allows the use of wind turbines in a certain region of the planet.

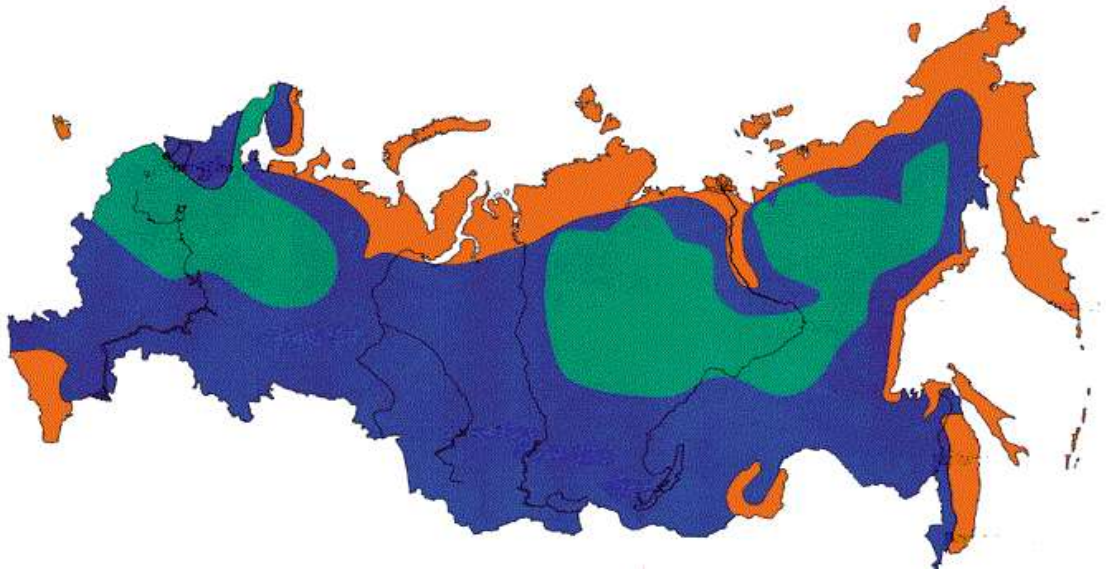


Figure 2. Map of wind energy resources of Russia.
The numbers indicate the zones with average annual wind speeds:
orange – above 7 m/s; blue – from 3,5 to 6 m/s; green – up to 3,5 m/s

When constructing powerful power plants, significant land plots are required, which must be excluded from the total turnover of land, which is a colossal problem for a number of regions. However, as you know, wind speed is the most important indicator in the design and operation of wind turbines. The power generated is proportional to the wind speed to the third power. This means that when the wind speed doubles, the possible generated power will increase 8 times. Therefore, in order to increase the generation of electricity, it is necessary to somehow increase the wind speed. Even a slight increase in it leads to a noticeable increase in power. The higher the height of the wind turbine tower, the more stable and stronger the wind force. If the height of the wind turbine is increased from 80 to 120 meters, then in order to assess the energy potential of the wind speed, at the height of the proposed installation of wind turbines, it is necessary to recalculate the speed using the approximation dependence: $\mathrm{v}_{\mathrm{a}v_{120}} = \mathrm{v}_{\mathrm{av}_{80}} \cdot \left(\frac{120}{80}\right)^{0,2}$, where $\boldsymbol{v}_{\mathrm{av}_{80}} = \boldsymbol{v}_{\mathrm{av}_{10}} \cdot \left(\frac{80}{10}\right)^{0,2}$ – the average wind speed at an altitude of 80 m, which is easily determined, knowing the average speed at

an altitude of 10 meters (at this altitude, anemometers are installed at meteorological stations – devices that measure the wind speed). Let us assume that the average annual wind speed at a height of 10 meters will be 5 m/s (at this speed, it is possible to use wind turbines). Then $\boldsymbol{v}_{\mathrm{av}_{80}}$ = 7,58 m/s, and $\boldsymbol{v}_{\mathrm{av}_{120}}$ = 8,22 m/s. Fig. 3 shows how the generated energy changes from the total height of the wind turbine [2].

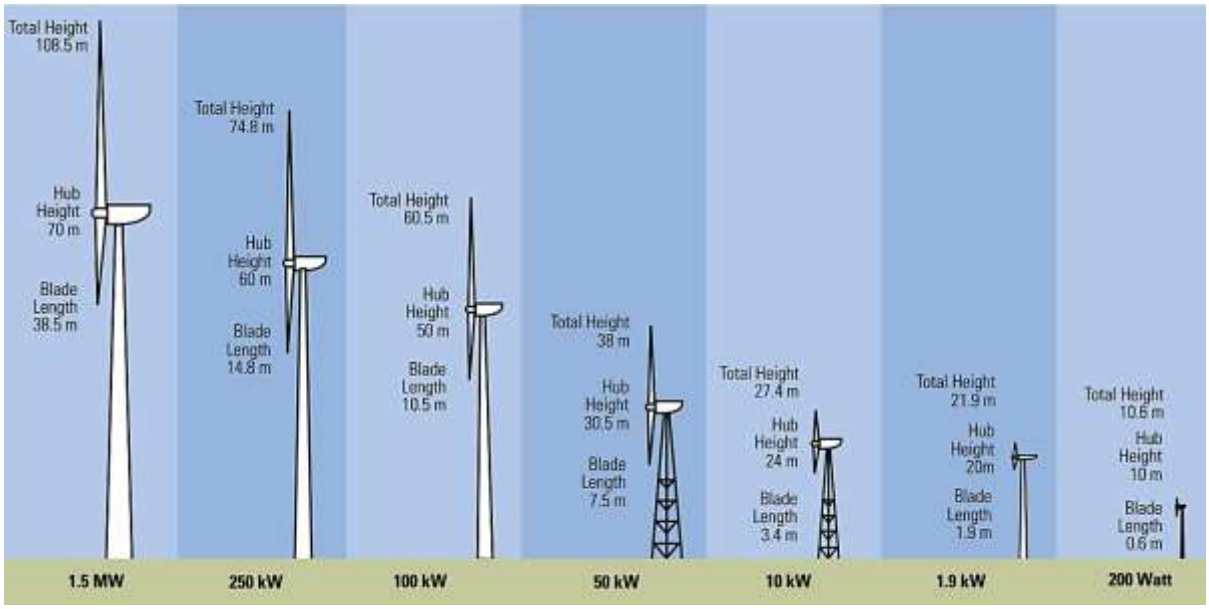


Figure 3. Dependence of the generated energy on the height of the wind turbine

However, the installation and procurement of higher installations will require a higher upfront cost, which implies an investment in the industry at an early stage of development. Therefore, an additional barrier in the sale of wind energy is a financial barrier. Such a barrier includes the macroeconomic situation in Russia, a lack of investment in this industry, and weak government support in isolated regions. These problems require a comprehensive solution and depend on the current economic situation in the country [3]. In this context, import substitution is a profitable mechanism, since the costs of purchasing expensive equipment from abroad are reduced. The next barrier is the infrastructure barriers of the wholesale market, where the complexity of technical connection to the energy system prevails, in addition, the complexity of interaction in the network and the strong difficulty in obtaining land for the implementation of projects as such. To overcome the existing problems, measures are proposed for the state planning of territories, the design of methods for regulating wind power systems in the network. An obstacle in Russia is a large number of regulatory and legal barriers in the design of a RES facility, which is associated with the lack of practice in the design and operation of large wind farms. In addition, for

companies producing wind turbines, there is a conflict of standards when recreating the foundations of wind turbines. In addition to the above, the impact of wind turbines on wildlife is a barrier to wind energy. When assessing the environmental impact of wind energy, the number of wind turbines in a power plant and its length should be taken into account, since the adaptive capacity differs among different groups of birds [4].

When hit by huge wind farms, birds become disoriented, which leads to an increase in the number of victims. More than 90 % of birds found near wind turbines showed signs of internal hemorrhage. Wind turbines can exert an “alarm factor” on migratory forms, causing them to change their route of constant movement. At the same time, an increase in the area of wind farms may lead to a change in the migration route. Under the influence of “anxiety factor”, many animals leave their habitats, which, given the area of wind farms, can lead to a decrease in biodiversity over vast areas. The sensitivity of many representatives of the animal world to noise and vibration is much higher than that of humans. Wind turbines generate aerodynamic noise that can cause discomfort to people.

For this reason, in some European countries, a law has been adopted according to which the distance from the wind turbine to residential buildings should not be less than 300 meters, and the noise level should not exceed 45 dB during the day and 35 dB at night. Moreover, the range of sound frequencies perceived by animals, in many cases, differs from that of humans. The assessment of the impact of wind turbines on animals in terms of parameters applicable to humans is incorrect. In order to fully reflect the level of animal exposure to wind turbines, the assessment should be carried out in accordance with specific parameters applicable within the species. The final barrier is the high difficulty of recycling generator blades made of composite materials, which is an important problem in wind power. Several solutions to this problem are being considered abroad. The first solution is reuse. For example, companies specializing in the restoration of rotor blades are already opening in Germany [5].

In their opinion, regenerated blades are not inferior in strength to new ones, moreover, the estimated service life is at least 20 years. However, such a solution is still under development. The second option for solving the problem is the creation of highly efficient technologies for separating components – which may turn out to be economically inexpedient. For example, separating fiberglass from epoxy resin can be carried out by pyrolysis, but this process requires furnaces that take into account the design of the blades, which must also be manufactured. Therefore, a third option is proposed – the technology of crushing the blades into small granules – recirculation. This product serves as a filler in the production of plastics or advanced fiber composites. Since this does not completely solve the

problem of blade recycling (since the share of recycled materials in newer products should not exceed 40 %), you can additionally use a technology that thermally utilizes materials mixed with recycling. Unfortunately, to date, the described methods are under development, and the methods used (for example, mechanical grinding, pyrolysis and combustion) have a number of disadvantages, which does not make it possible to declare a solution to the problem of processing blades in full [6].

According to some studies, the deployment of wind power to at least 33 % of the current global electricity generation will lead to worse climate impacts than doubling the carbon dioxide content in the atmosphere. Meanwhile, according to modern scientific concepts, a doubling of the carbon dioxide content in the atmosphere will inevitably cause truly catastrophic climate changes and mass extinction of species. The fact is that each wind turbine creates a "wind shadow" directly behind it – an area in which the air is slowed down in comparison with its natural speed in the area. That is why wind turbines at wind farms are placed with significant "gaps": otherwise, too close neighbors will reduce the efficiency of each other. If the entire Earth were "covered" with wind turbines, the researchers believe, such a power system "could generate huge amounts of energy, much more than 100 TW, but at this point, as climate modeling suggests, its effect on global winds and, therefore, the climate became would be very harsh [7].

In short, theoretically, too rapid development of wind energy can lead to an increase in average temperatures in summer and a drop in winter. This means an ecological catastrophe on a planetary scale. Dependence on external conditions at a particular moment: the wind may be strong, or it may not be there at all. To ensure a continuous supply of electricity to the consumer in such variable conditions, a system for storing electricity of significant capacity is required. In addition, infrastructure is required to transfer this energy. Considering the technical as well as environmental aspects and all of the above barriers, it can be concluded that wind power in Russia, at the moment, is an ineffective method of generating electricity on an industrial scale.

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**УДК 004.934**

# CONVERSION OF INDIAN SIGN LANGUAGE INTO TEXT USING GESTURE RECOGNITION METHOD

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**Abstract.** Although Indian Sign Language is still far behind other developed countries, many inquiries and issues have come to the fore in recent years through new research related to this matter. As a result, it is becoming easier to create static and dynamic datasets to develop Indian Sign Language-related mobile and web applications. Our focus is on the conversion of Indian Sign Language into text. To accomplish our goal, the implementation of gesture recognition methods is necessary. In this article, our proposed approach, methodology, experiments, and further planning have been outlined.

**Keywords:** Indian Sign Language, gesture-to-text translation, gesture recognition, deep learning, dataset.

# ПРЕОБРАЗОВАНИЕ ИНДИЙСКОГО ЯЗЫКА ЖЕСТОВ В ТЕКСТ С ИСПОЛЬЗОВАНИЕМ МЕТОДА РАСПОЗНАВАНИЯ ЖЕСТОВ

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**Аннотация.** Хотя индийский язык жестов все еще сильно отстает от других развитых стран, в последние годы многие вопросы и проблемы вышли на первый план благодаря новым исследованиям, связанным с этим вопросом. В результате становится проще создавать статические и динамические датасеты для разработки мобильных и веб-приложений, связанных с индийским жестовым языком. Наше внимание сосредоточено

на преобразовании индийского языка жестов в текст. Для достижения нашей цели необходима реализация методов распознавания жестов. В этой статье изложены предлагаемый нами подход, методология, эксперименты и дальнейшее планирование.

**Ключевые слова:** индийский жестовый язык, перевод жестов в текст, распознавание жестов, глубокое обучение, датасет.

*Introduction.* The goal of the research about Indian Sign Language includes the conversion of Indian Sign Language into text, which requires development of static datasets using image processing, creation of video datasets for dynamic signs, CNN (Convolutional neural network), deep learning, machine learning, and the basic knowledge of programming languages. Recently, various studies and the implementation of the translation of gestures into text have been carried out. But understanding the analysis and research of the literature showed an insufficient degree of knowledge about Indian Sign Language, mainly its true status in India, which is one of the most significant reasons for the preparation of many parts of the research to improve its usage for the betterment of the society.

*Gesture recognition system using Image Processing.* The gesture recognition system is designed to develop human-computer interaction with the objective of interpreting human gestures via mathematical algorithms [1]. Early methods included the use of radiofrequency gloves to solve communication problems. But the use of electronic equipment has become less popular after the development of advanced image processing algorithms [2]. Now with automatic gesture recognition, human-machine interaction is gaining in popularity because of some reasons like minimal usage of electronic equipment, advanced image processing algorithms, high accuracy, etc. though in the dynamic type of hand gesture, the sequence of posture for communication requires more computational complexity than other methods [3].

Gesture recognition can be simply explained as interpreting human gestures via mathematical algorithms to communicate, control devices, applications, etc. [3].

*Methodology.* For converting Indian Sign Language to text at first the focus is on only on static signs. The projecticts includes four main steps, Creating the dataset, Verifying the Dataset, Training a CNN on the captured dataset, and Predicting the data [4].

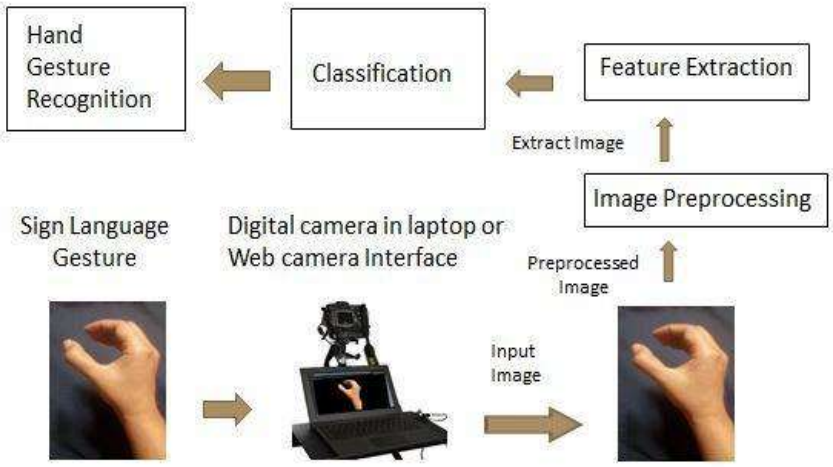


Figure 1**.** Vision-based hand gesture recognition system's step by step flowchart [3]

*Indian Sign Language (ISL).* Experts in India believe in an urgent shortage of special schools for people with hearing impairment. Very few schools accept sign language as a teaching tool. This leads to inadequate communication and language skills for children with hearing impairment, which negatively affects literacy in the deaf community. The reality is that schools for the deaf practically do not use ISL, and almost 5 % of deaf people [5, 6, 7] attend Deaf schools. The use of ISL is limited to professional programs and short-term courses only.

Figure 2 shows the static one-handed gestures of Indian Sign Language representing certain numbers. The gestures denoting the numbers 1 – 5 are very similar to the gestures from the Russian sign language.

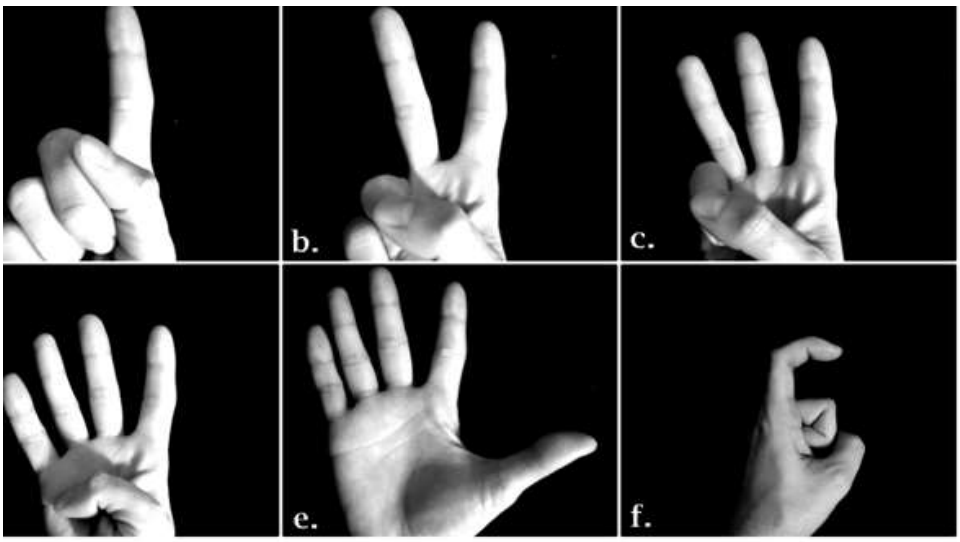


Figure 2. Numbers in Indian Sign Language (a – 1, b – 2, c – 3, d – 4, e – 5, f – 7)

Banerjee [8] compared the gestures used in some schools for the deaf in West Bengal and parts of Assam, and concluded that the gestures used in each school were not the same. Madan Vasishta [9] in 1975 sent out questionnaires to the leaders of over one hundred schools for the deaf in India. Almost all respondents agreed that ISL does not exist. A similar survey was conducted again 20 years later using questionnaires sent to schools for the deaf. Some of the answers reveal the same misconceptions about sign language: that gestures are "spoken-based," or "English-based," or "difficult to find a gesture for every word spoken." Subsequently, increased awareness of the nature of sign languages has been confirmed [10].

*Development of the dataset.* Collecting accurate signs for Indian Sign Language and developing the image dataset needs verification and participation of Sign Language Experts. A unique dataset of more than six hundred images has been created to experiment the classification results. Along with the process of collecting accurate dynamic and static gestures, it is necessary to focus on the technical part of the project.

*Training the Dataset.* It is possible to perform experiments with a basic convolutional neural network model for an image dataset. The base model can provide the minimum performance against which all other models can be compared, as well as the model architecture that will be used can work as a basis for learning and improving. There are many CNN methods to train dataset and image classification. Among them VGG19 showed very effective results with the dataset. To use the VGG19 network, some characteristics were taken into account to improve the accuracy. Static images were used to train the model, and to perform the image classification.

*Classification Accuracy.* The following experiment shows the accuracy of classifying random images of Indian Sign Language in the VGG19 model.

Table 1 – The accuracy of classifying images in the VGG19 model

| **VGG19 Model** | **Accuracy** |
|---|---|
| Epoch 1/10 | 0.4038 |
| Epoch 2/10 | 0.9615 |
| Epoch 3/10 | 1 |
| Epoch 4/10 | 1 |

| | |
|---|---|
| Epoch 5/10 | 1 |
| Epoch 6/10 | 1 |
| Epoch 7/10 | 1 |
| Epoch 8/10 | 1 |
| Epoch 9/10 | 1 |
| Epoch 10/10 | 1 |
| Average | 0.93653 |

*Experiment Results:*

- The image classification results show an average accuracy of 0,93653.
- The experiment shows very low accuracy for some of the results, for example just 0,4038.
- The image set contains imprecise gestures.

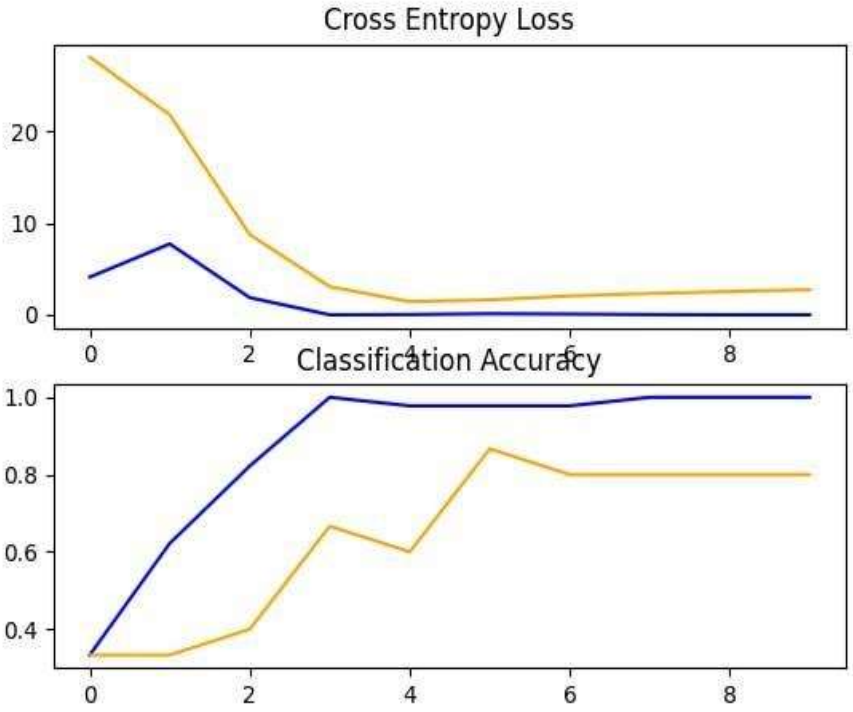


Figure 3**.** Accuracy of classification of Indian Sign Language using VGG19 Model (Random Signs)

*Sign or Gesture Recognition.* The pre-trained network is run on the data set at once to extract the features required for the classification. The resulting properties are given as input to fully connected layers for classification, followed by fine-tuning, which is done only in the final layers to prevent excess fitting, with new data with a gradual learning rate [11]. After the training process, the dataset of images has been evaluated and it showed more than 90 % accuracy.

*Further Work.* Several gesture recognition techniques are available, such as gesture recognition using image processing, feature extraction, machine learning, etc. The approach can be implemented in a variety of ways. It depends entirely on the type of input. For further work, the focus will be on deep learning methods, and usage of dynamic signs. The conversion of Indian sign language into text, is a complex project and it demands more experiments and improvements of the present status of the work.

*Conclusion.* The importance of Sign language for the betterment of the society is undoubtable. The development of Indian Sign Language depends on the call of more research in this field, teachers training, awareness, technology-oriented teaching method, development of a sign-to-text and vice-versa translator, real-life surveys among a larger population, and initiatives for official recognition. In future, more experiments, and results of both static and dynamic signs can help in the process of conversion of Indian sign language to text.

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**УДК 398.3**

# BRANDED STYLE USING FOLK UDMURT ORNAMENT

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**Abstract.** This work is devoted to the study of corporate identity using folk Udmurt ornament based on its characteristic features of artistic expressiveness. The questions of design, branding, corporate style, the ethnic history of the Udmurt Republic, the evolution of the Tolese pattern over time to the present day are touched upon. The Tolese sign is considered as a meta-subject basis of the image.

**Keywords:** design, corporate identity, brand, ornament, Udmurtia.

# ФИРМЕННЫЙ СТИЛЬ С ПРИМЕНЕНИЕМ НАРОДНОГО УДМУРТСКОГО ОРНАМЕНТА

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**Аннотация.** Данная работа посвящена изучению фирменного стиля с применением народного удмуртского орнамента на основе его характерных особенностей художественной выразительности. Затрагиваются вопросы дизайн-проектирования, брендинга, корпоративного стиля, этническая история Удмуртской Республики, эволюция узора Толезе на протяжении времени до наших дней. Знак Толезе рассматривается как метапредметная основа образа.

**Ключевые слова:** дизайн, фирменный стиль, бренд, орнамент, Удмуртия.

## *Introduction*

Udmurt folk art is a reflection of the history of the republic. M. Gorky wrote: “The people are not only a force that creates all material values, they are the only and inexhaustible source of spiritual values, the first philosopher and poet

in time, beauty and genius of creativity, who created all the great poems, all the tragedies of the earth and the greatest of them – history of world culture" [1, p. 26]. The centuries-old experience of humankind in a variety of creative activities over time has become a multifaceted system of traditional folk culture.

Folk culture is the basis of traditional ethnic consciousness: habits, preferences, models of upbringing, stereotypes of behavior and ideological attitudes. Thus, through the products of traditional culture: embroidery, ornaments, carvings and others, the connection between generations is manifested. In addition, culture contains the entire historical experience of the people, and its individual elements are of a universal human nature, and therefore allow maintaining and encouraging mutual understanding of different peoples, countering ethnic and religious hatred, violence, thereby supporting modern civil society. Traditional art is not only a powerful means of aesthetic development of all art and art education, but also an inexhaustible source of ideas for implementation in professional practice.

Ornamental art is one of the elements of the national culture. This is a vivid "time marker" in art, since the process of the formation of the ornament took place inseparably with the formation and development of ethno cultural and national traditions.

The purpose of this article is to study corporate styles with the use of ornament, the connection between generations through ornamental art.

Tasks are defined by the goal and are formulated as follows:

- Explore the relationship between design and traditional art;
- Consider the corporate identity as a component of the brand's advertising campaign;
- Investigate the influence of the brand's advertising campaign on the consumer by means of design;
- Consider the Udmurt ornament as a basis for creating a corporate identity;

The relevance of the topic of the article is associated with the high interest of both consumers and manufacturers, in particular, designers, to ornamental art. This article will be useful both for established designers – they will find new motives for their creativity, and for students of art universities, as an education in the topic of ornamental art. In addition, the article introduces the Udmurt art, the works of which are little known in the modern world.

The art of ornament continues to live now, it develops in all its wide variety. Let us recall, for example, the ancient craft of Pavlovsky Posad near Moscow – the creation of scarves. This piece of decorative and applied art is found in the modern world as a fashionable women's headdress. Designers of the XX – XXI

centuries also turn to the famous Gzhel – Gzhel ornaments attract the attention of Cavalli and Valentino. Silk and satin, selected for the basis of the 2013 Cavalli collection, emphasized the sophistication of folk patterns and the charm of cobalt. And the collection 2015 – 2016 from Valentino is also a unique work, because the print on the fabric was not applied with paints, it is embroidered, which makes it seem that the dress is two-layer, and its second layer is made of guipure.

In addition, traditional ornaments are found in interior design. They bring living creatures into the room, support the plasticity of objects and set the mood for the entire interior. In addition, the styles of boho, kitsch, African and many others, by default, include a combination of many ornaments in the interior.

*The rise of graphic design*

Popular culture echoes also show up in graphic design. In the modern world, this is an area of design that covers almost all spheres of society. To the traditional types of book and poster design, the solution of packaging, labels, the development of brand signs and styles, fonts, the communicative branch was first added (in the interiors of buildings, on the spaces of settlements and roads). Later – screensavers, commercials, web design [2, p. 13].

As a form of creativity, design is the result of the expansion of the scope of art, the transition from single to mass production. For many years before the advent of design, traditional art was preparing its arrival. The knowledge accumulated in the traditional art, artistic techniques poured into design creativity. There was an interchange, traditional art opened up artistic possibilities for design, and that, in turn, improved the technology.

*Form style*

In the 21st century, the world cannot be imagined without advertising, a modern engine of commerce. A well-designed advertising campaign is a complex process, one of the most important elements of which is graphic design [3, p. 111].

The creation of a corporate identity or branding is the most important stage of working on an advertising campaign. L. Podorozhnaya calls corporate identity "one of the most modern and relevant types of advertising", noting that "many researchers consider it as an important special type of marketing communications" [4, p. 22]. In a broader sense, it is a set of systematically organized constants: font, color, video and others, which provide visual and semantic unity, individuality of the entire external design of the company's goods and services.

Corporate style allows companies to acquire an individual image that will not only evoke positive emotions and suitable associations in the client, but will also be able to influence a person on an intuitive level, which will strengthen the

bond between the client and the company. Therefore, in the process of designing corporate identity elements, it is necessary to take into account a number of factors that affect the positive result of the work. Emotional expressiveness, uniqueness and originality of the image is the strongest advertising tool. In addition, corporate symbols can tell a potential consumer about the taste, the chosen direction of activity, the competence of the company and become the last argument in favor of buying the company's goods and services.

The most important elements of corporate identity design are the trademark and logo, font, corporate color and the image of the hero, if required. That is, the main task of the designer in this case is an integrated approach, since all elements must be competently combined with each other, carry a single message. Each detail should become part of the whole – corporate identity, which in turn should have its own character, image, individuality, that is, be a complete work of graphic art [5, p. 60].

*Traditional ornament in modern branding*

In the modern world, a number of stereotypes have been formed that are widespread among the broad masses of people, following which, an entrepreneur will receive more benefits from his product. Different cultures have their own product stereotypes: Swiss watches, Tula gingerbread and more. Therefore, the packaging of this product should be designed taking into account ethno cultural traditions. The same applies to the entire advertising campaign of the product. In addition, this technique can be used to emphasize environmental safety, traditional technology, local production and more. Therefore, in an advertising campaign for services, goods and products related to traditional culture: literature, art, music, decoration of holidays and other events, it is appropriate to use a traditional ornament. In addition, it solves the problem of preserving and developing traditional culture through the formation of aesthetic taste among the population. An example of such a corporate identity is the corporate identity of the Belarusian Products company. The consumer sees recognizable colors (red and green), folk ornament, which forms a positive attitude towards the brand.

Researchers are still discussing the possibility of transferring the sacred meaning through ornamentation, so Yu. Ya. Gerchuk believes that the symbolic element is completely absent in the traditional ornament: "The loss of the symbolic meaning ... is not terrible for the ornament. On the contrary, exactly where the symbolism is absent, even suppressed, degenerated, has become insignificant, the ornamental motif fully reveals for us its qualities of the pattern – the subject of plotless and disinterested admiration ... its meaning" [6, p. 64].

Thus, the perception of an ornament only as a “decoration” testifies to the cultural transformation of society, when there is a gradual change in the understanding of a specific element of a particular ornament, the formation of a new information space. However, even with this perception, the ornament continues to carry hidden information. Therefore, a certain ornament can carry information about the history of the people, its traditions and customs, and more.

*Udmurt ornament as the basis of corporate identity*

To study ornament as a graphic element in branding, Udmurt traditional ornaments and their elements were chosen. Such ornaments are found directly on the territory of the Udmurt Republic, the cradle of the Udmurt people. We see decorative elements everywhere here: from food packaging to the decoration of national holidays.

The Udmurt ornament arose under the influence of the neighboring peoples of the Kama region, Siberia and the South Urals. The main motive of the Udmurt patterns is the reflection of natural processes. Ornamental symbols embroidered on the costume spoke of social status, marital status and age. The main colors were white, black and red.

Ornaments often carried a secret, deep meaning associated with the religious ideas of the people. Therefore, for example, the top of the clothes reflected the connection of a person with the sky, and since the soul, according to the ideas of this people, was on the chest, this place was closed from magical influences. To do this, embroidered ornaments Rainbow, Svetets, Heavenly dew and various amulets.

One of the examples of the modern use of elements of the Udmurt ornament is the design of the corporate identity of the brands “Udmurtia invites” and “Made in Udmurtia” (Fig. 1). Here we see modular thematic and ornamental pictograms based on elements of traditional ornament. In addition, the Udmurtia invites logo (Fig. 2) was developed on the basis of the Tolese solar sign, one of the main Udmurt symbols. The eight-pointed star “Tolese” appears in the 9th – 13th centuries. We see its first image on a bone spindle from the Kushman settlement. Tolese means fertility and well-being, it is one of the most important and popular symbols in the Udmurt art of the 19th – 20th centuries. This sign is present in the patterns of clothing, as a talisman, as well as on the bottoms of spinning wheels, in carved shutters.

Figure 1. Products with elements of the corporate identity “Udmurtia invites”


Figure 2. Udmurtia invites logo

In the branding of these companies, we also see traditional Udmurt colors – black, white and red. Among the Udmurts, these colors symbolize the fertile land, sky and people. This is due to the mythology of the people, according to which Inmar, the creator of the world, divides it into three parts: the sky, subject to him, the earth and the afterlife [7, p. 29].

In the design of “Centenary of Udmurtia” there are also traditional symbols, stylized and simplified for ease of perception. Here we see the Tolese solar sign, the Vukaran dragonfly, and the Pityres circles (Fig. 3).

Figure 3. Products with elements of the corporate identity "Century of Udmurtia"

This example illustrates the use of ornament symbols without endowing them with a sacred meaning, which confirms the words of Yu. Ya. Gerchuk about the absence of a symbolic element in traditional ornament. However, these elements remain recognizable by the society as traditional symbols of the people. The site “Centenary of Udmurtia” is designed in the same style (Fig. 4). Here we clearly see a combination of modern web design trends: minimalism, typography, full-page with elements of the old Udmurt ornament. This allows us to trace the connection between generations: the elements of the ornament remain recognizable through the centuries. It also proves the relevance of the chosen topic – the symbols do not just decorate the site, they underlie its design and the entire design concept of the “Century of Udmurtia”.


Figure 4. Website “Centenary of Udmurtia”

Logos of various organizations are also a striking example of the use of ornamental elements. For example, the coat of arms of the Alnash District is a rectangular shield divided horizontally into two colors. In the lower part there is a silver letter “A” with an arrow-shaped bridge. Above it we see a white figure of a man-swan, as on the coat of arms of the Udmurt Republics, in the center of this figure there is a solar sign (Fig. 5). And the flag of the Balezinsky District, although not made in the traditional colors of Udmurtia, consists of three horizontal stripes: white, black and blue, but there is a solar sign in its center. This speaks of the belief of the Udmurts in amulets, which was passed on to them through hundreds of generations.

Figure 5. Coat of arms of the municipality “Alnash district”

Now Tolese is found in the symbols of most municipal institutions, both the capital of Udmurtia and its other parts. For a long time, the symbol of the National Library of the Udmurt Republic was an open blue-blue book, in the center of which was the Tolese sign (Fig. 6). In 2018, the library celebrated its 100th anniversary, and in honor of this event, it was decided to change the logo. The new symbol for the library was developed by an employee of the institution and approved by a commission of experts. Now the logo is a solar sign that turns into a bookmark (Fig. 7).


Figure 6. The previous symbol of the national library
of the Udmurt Republic


Figure 7. Symbol of the national library of the Udmurt Republic

Summing up, I would like to note that cultural trends associated with an appeal to national roots and self-determination are also manifested in graphic design. The use of traditional folk ornaments by designers, their stylization emphasizes the interest of society in the history of their culture. The ornament, which carries the history of the people, its customs and traditions, in the modern world has the ability to visually communicate with the consumer who unconsciously perceives this information.

The study of corporate identity using traditional elements has shown that designers strive to simplify forms, stylize them for ease of perception. Ornaments no longer carry the sacred meaning that was laid in it earlier, but they remain recognizable elements of culture.

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**УДК 620.003.1**

# N**EGATIVE ECONOMIC EFFECT OF GEOTHERMAL ENERGY**

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**Abstract.** The article discusses the negative aspects of the use of geothermal energy, the upcoming economic risks, as well as the analysis and comparison of the efficiency of geothermal power plants with other types of power plants. The main causes of these investment risks and ways to overcome them are identified. The influence of economic costs on the feasibility of the construction of geothermal power stationis shown: the cost of their construction can be much higher than coal, oil and gas power plants. Most of these costs relate to exploration and drilling of geothermal energy resources.

**Keywords:** geothermal energy, geothermal power station, renewable energy, geothermal resources, alternative energy.

# ОТРИЦАТЕЛЬНЫЙ ЭКОНОМИЧЕСКИЙ ЭФФЕКТ ГЕОТЕРМАЛЬНОЙ ЭНЕРГЕТИКИ

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**Аннотация.** В статье рассматриваются негативные аспекты использования геотермальной энергетики, предстоящие экономические риски, а также проведен анализ и сопоставление КПД ГеоТЭС с другими видами электростанций. Выявлены основные причины названных инвестиционных рисков и способы их преодоления. Показано влияние экономических расходов на целесообразность строения ГеоТЭЦ: стоимость их строительства может быть намного выше, чем угольных, нефтяных и газовых электростанций. Большая часть этих затрат касается разведки и бурения геотермальных энергетических ресурсов.

**Ключевые слова:** геотермальная энергетика, ГеоТЭС, возобновления энергетика, геотермальные ресурсы, альтернативная энергетика.

Geothermal energy is a branch of energy based on the use of thermal energy from the bowels of the Earth for the production of electric energy at geothermal power plants, or directly for heating or hot water supply [1]. The power of Earth's geothermal waters is an alternative energy source. This method of energy production is used in regions where geothermal sources come to the surface or are located in places of easy reach. Before the construction of the station on the site of the sources, the perimeter is evaluated from the point of view of engineering and economic feasibility, and most importantly – safety. The turbines of geothermal plants drive steam, which is released by geysers and volcanoes. It follows that geothermal sources are usually located in unstable seismic zones, which means that safety is a matter of paramount importance [2].

As with any source of alternative energy, geothermal energy has its economically unprofitable sides. Let’s look at them and make a conclusion about the rationality of using this type of energy.

1. The origin and essence of geothermal energy and, as a consequence, unsafe and economically unprofitable construction of geothermal power plants.

The origin of energy is the main disadvantage since the stations are built in seismically active zones. The main problem is the inability to predict the awakening of a volcano, an earthquake or the movement of soils. The construction of a station in such places is always a risk. And taking into account the fact that the construction of geothermal power plants is a costly matter, the question arises about the expediency of using the power of geothermal waters of the Earth.

2. High costs for the construction of geothermal systems.

Investment costs for the construction of geothermal systems vary in a very wide range – from $ 200 to $ 5,000 per 1 kW of installed capacity, that is, the cheapest options are comparable to the cost of building a thermal power plant. They depend, first of all, on the conditions of occurrence of thermal waters, their composition, the design of the system. Drilling to a great depth, creating a closed system with two wells, the need for water purification can multiply the cost. So, for example, for normal operation, the water should warm up to 200 – 300 C. Mathematics shows us that to get such a temperature on the territory, you will have to dig and drill a well 7 – 10 kilometers deep. And it’s not just expensive, but very expensive. High drilling price (exponential growth with depth): 10 km – (1 – 2) billion rubles. This is more than 60 % of the total capital expenditures. The record-breaking Kola well has a depth of only 12 km, which is the limit of the

capabilities of modern drilling technologies. The depth of wells for geothermal plants rarely exceeds 3 km.

Hence the conclusion – they can not be installed everywhere, but where there is already the right temperature at a shallow depth (Fig. 1) [3].


Figure 1. The temperature of thermal waters and the dry rocks containing them increases with depth

3. Comparison of the cost of geothermal energy with other types of energy.

On average, the cost of 1 kWh of geothermal energy is comparable to that for thermal power plants (in Russian conditions – about 1 rub/1 kWh) and ten times higher than the cost of generating electricity at HPPs (5 – 10 kopecks/1 kWh).

Part of the reason for the high cost is that, unlike thermal and hydraulic power plants, geothermal power plants have a relatively small capacity. In addition, it is necessary to compare systems located in the same region and in similar conditions.

Indicators of the economic efficiency of the geothermal system depend, for example, on whether it is necessary to dispose of waste water and in what ways this is done, whether combined use of the resource is possible [4].

4. Economically complex maintenance of geothermal plants suitable for environmental protection requirements.

There are no energy systems that do not have an impact on the environment. The problem associated with the content of undesirable mineral salts in steam condensate or in water from deposits with wet steam that has not turned into steam has traditionally been solved by dumping such waters into a nearby reservoir. This

usually caused significant chemical and thermal pollution of surface waters, which has now become unacceptable according to the standards adopted in many countries.

The demand of geothermal power plants for cooling water (per 1 kWh of electricity) is 4 – 5 times higher than thermal power plants, due to lower efficiency. The discharge of waste water and condensate for cooling into reservoirs can cause their thermal pollution, as well as an increase in the concentration of salts, including sodium chloride, ammonia, silica, and elements such as boron, arsenic, mercury, rubidium, caesium, potassium, fluorine, sodium, bromine, iodine, although in small quantities. With the growth of well depths, an increase in these revenues is possible.

A pipeline breakthrough is dangerous, as a result of which large amounts of brines can enter the ground.

Geothermal power plants, having an efficiency 2 – 3 times less than nuclear power plants and thermal power plants, produce 2 – 3 times more thermal emissions into the atmosphere.

Recently, there has been a tendency to solve the problem of dumping pollutants into the environment by pumping the resulting condensate and excess water with all gases and mineral salts dissolved in them into the productive formation through unproductive or specially drilled wells. At the same time, almost all chemical pollutants are again underground without the possibility of their getting into surface waters. However, this requires additional costs and is associated with the risk of blockage of the rock by particles or sediment contained in the injected water near the injection well. It is worth recalling that drilling is very expensive and, according to approximate calculations, amounts to 300 – 600 million rubles if we take into account the depth of the well equal to 3 km.

5. The use of expensive corrosion-resistant materials.

Corrosion, sediment bursting and blockage of drilling equipment, casing pipes and pipe systems on the surface are also serious problems when extracting hot solutions from deposits. Until chemical methods are developed to eliminate these problems, it will be necessary to use expensive corrosion-resistant materials for the structures of the ground part of the system and periodically close wells for cleaning or replacing equipment.

6. The use of investment-unprofitable exploration methods.

The problems associated with determining the location and estimating reserves of natural steam deposits are similar to the corresponding problems in oil and natural gas exploration, and are solved using similar geological and geophysical methods in combination with geochemical and hydrological studies, as well as the study of heat transfer, However, less is known about natural steam

and hot water deposits than about oil and gas fields. In particular, it is unclear how to correlate the data on geological structures and the results of ground surveys and aerial photography with the presence of underground pools of steam and hot water. Drilling remains the main and decisive, although expensive, method of exploration.

Drilling remains the most effective method of exploration, evaluation of reserves, development and use of geothermal deposits. With the exception of cases when there is a danger of encountering high-temperature heat carriers, exploration drilling is carried out by traditional methods, and therefore, the development of appropriate equipment and methods will mainly consist in reducing the cost of drilling exploration wells of small diameter and wells without casing.

Drilling productive wells is associated with special difficulties, mainly due to the presence of fragile rocks, high temperatures, pressures and high costs of heat carriers that cause corrosion.

Drilling productive wells in existing steam and hot water fields is currently carried out using more or less traditional methods, but the drilling process itself turns out to be difficult, expensive and dangerous, and very often-drilling equipment fails before the planned depth of the well is reached. Consequently, the development and creation of new drilling methods and more advanced equipment are highly desirable for the exploration, development and use of geothermal deposits [5].

In our article about alternative energy, graphs were presented, according to which it is clear that, according to forecasts, gas will be one of the main energy sources by 2040, and the remaining clean energy sources in the aggregate will lag behind (Fig. 2).

Thus, the construction and further operation of geothermal power plants are quite difficult to implement and have many economic nuances. Only at the initial stages of the project creation should attention be paid to such costs as drilling to a great depth, creating a closed system with two wells, the need for water purification, the use of corrosion-resistant materials, and others. At the same time, the efficiency of this station may correspond to or be inferior to the efficiency of stations of other types of energy. It cannot be said that geothermal power plants are very efficient, since their efficiency is only 7 – 10 percent.

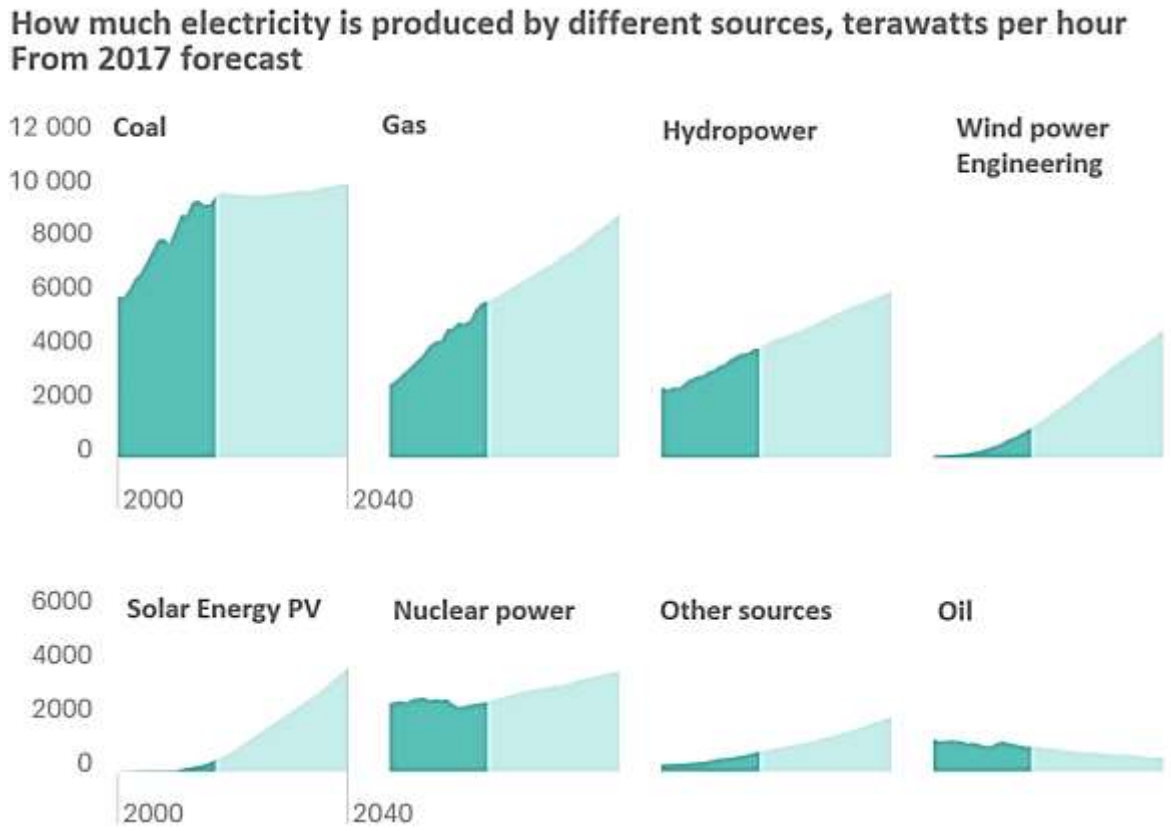


Figure 2. Electricity generation in the future

This is very small in comparison with objects where energy is extracted from burning fuel. That's why you can't just dig a hole, put a pipe in it and go to rest. The system must be highly efficient and use several cycles for greater productivity, otherwise the energy received will not even be enough to operate the pumps used to deliver the liquid to the surface. But most importantly, no matter how hard scientists try to predict the appearance of seismic activity, it is impossible to guarantee that all investments will suddenly lose their value and the geothermal power plant will decline. Therefore, it can be concluded that investing money in the development of geothermal energy is very unreliable and doubtful. Our technologies in alternative energy are not yet ready for large-scale decarbonization (transition to a low-carbon economy). It is necessary to invest primarily in the development of technologies, and not in the introduction of existing ones into the global energy system.

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# OPTIMIZATION OF THE EXTRACTION PARAMETERS OF CAROTENOIDS IN MICROALGAE FROM THE BALTIC SEA CHLORELLA VUL. AND ARTROSPIRA PL. AND STUDY OF THEIR ANTI-OXIDATIVE ACTIVITY

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**Abstract.** Microalgae of the Baltic Sea not only may use as an energy resource but as a carotenoid source. Researchers could have a bulk quantity of carotenoids if they used optimal extraction conditions. In this article, researchers optimized an extraction condition for two microalgae – Chlorella vul. and Artrospira pl. Extracts, that have the largest quantity of carotenoids have been determined the anti-oxidative activity.

**Keywords:** microalgae of the Baltic Sea, carotenoids, anti-oxidative activity, Chlorella vulgaris, Artrospira pl.

# ОПТИМИЗАЦИЯ ПАРАМЕТРОВ ЭКСТРАКЦИИ КАРОТИНОИДОВ МИКРОВОДОРОСЛЕЙ БАЛТИЙСКОГО МОРЯ CHLORELLA VUL. И ARTROSPIRA PL. И ИССЛЕДОВАНИЕ ИХ АНТИОКСИДАНТНОЙ АКТИВНОСТИ

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**Аннотация.** Микроводоросли Балтийского моря могут использоваться не только в энергетической промышленности, но и как источник каротиноидов. Исследователи могут получить большое количество каротиноидов, оптимизируя условия экстракции. В данной

статье исследователи оптимизировали условия экстракции для двух микроводорослей – Chlorella vul. и Artrospira pl. После того, как были выбраны лучшие параметры для экстракции, полученные образцы были изучены на антиоксидантную активность.

**Ключевые слова:** микроводоросли Балтийского моря, каротиноиды, антиоксидантная активность, Chlorella vul., Artrospira pl.

*1. Introduction*

Blue-green algae, or microalgae – Chlorella vul. and Artrospira pl. are populated in the Baltic Sea [1, p. 2], [2, p. 395]. Microalgae have a lot of healthsome properties, for example, they have higher anti-oxidative activity, because chemical matter, that compound in microalgae, has a carbon chain, porphyrin ring, and conjugated double bond [3, p. 36]. Among the antioxidant substances produced by microalgae, the most interesting are carotenoids. Microalgae are the source of a wide variety of carotenoids: fucoxanthin, astaxanthin, violaxanthin, zeaxanthin, canthaxanthin, auroxanthin, neoxanthin, β-cryptoxanthin, saproxanthin, lutein, lycopene, β-carotene. Microalgae are useful as a carotenoids source because they have simple conditions of cultivation, ecology perseverance, quick reproducibility, and accommodation capability in environmental conditions [4, p. 203]. The biosynthesis of carotenoids in microalgae can be induced either by modification of cultivation conditions or by genetic engineering methods. In this article, we have optimized the methodic extraction conditions for microalgae from the Baltic Sea (*Chlorella vul.* and *Artrospira pl*) and then researched the anti-oxidative activity of these microalgae's extracts.

*2. Material and methods*

*2.1. Optimization nature of solvents*

We needed to optimize the methodic to the production of total carotenoids from microalgae. We studied 4 parameters: the nature of the solvent, temperature, extraction modulus, the duration of the process. First a fall, was optimized for the nature of solvents. An extract of total carotenoids from Chlorella vul. and Artrospira platensis was obtained in the laboratory by maceration at 25 °C using 0,1 g of microalgae and 10 ml of solvent. Chloroform, hexane+acetone (50/50), dichloromethane, acetone (100 %), ethanol (70 %) [5, p. 30] being different solvents and extracts were remained for 4 hours at a 25°C temperature in an incubator shaker. After 4 hours, extracts (10 ml) were centrifuged at 5000 g 15 minutes. Then absorbance of extracts was measured at spectrophotometer Shimadzu UV-3600 at 480 nm and 730 nm. Total carotenoids were counted by

the special total-carotenoids formula [6, p. 8]:$C = \frac{10}{E_{1\,cm}^{1\%}} \times \frac{\Delta D_{480} \times V_{extract}}{l \times m \times (1-k)} \times 100\%$; $k = \frac{m_1 - m_2}{m_1}$,

where $m_1$ is a quantity of microalgae before drying and $m_2$ is a quantity of microalgae after drying.

*2.2. Optimization of temperature, extraction modulus, duration of the process.*

Extracts of total carotenoids from Chlorella vul. and Artrospira platensis were obtained in the laboratory by maceration at different extraction modulus (1:5, 1:10, 1:20, 1:100), different temperature (20 °C, 25 °C, 40 °C, 47 °C) and duration of the process (1, 2, 4 and 8 hours). We have used another total carotenoid methodic [7, p. 591] with the specific absorption coefficients for individual carotenoids and Chlorophylls a and b and total carotenoids (Cx+c). The special formula for total carotenoids was:

$$C_a = 11{,}75A_{662} - 2{,}35A_{645}$$
$$C_b = 18{,}61A_{645} - 3{,}96A_{662}$$
$$C_{x+c} = \frac{1000A_{470} - 2{,}27C_a - 81{,}4C_b}{227}$$

*2.3. Anti-oxidative activity of microalgae samples.*

Anti-oxidative activity has been studied by DPPH radical scavenging ability. The DPPH radical scavenging ability was tested using the method proposed by Zhang et al. (2012) [8, p. 5432]. Two milliliters of samples with different concentrations were added to 2 mL of DPPH ethanol solution (0,2 mM). The absorbance at 517 nm was recorded after 30 min of incubation in the dark. For the convenience of anti-oxidative activity was used ascorbic acid. In the capacity of the blank sample were used solutions of extractions and ascorbic acid with ethanol (96 %) instead of DPPH solution, in the capacity of control was used acetone with DPPH solution (for extraction) and water with DPPH (for an ascorbic acid).

DPPH radical scavenging activity %: $[1 - (A_{sample} - A_{blank})/A_{control}] \times 100$

where $A_{sample}$, $A_{control}$, and $A_{blank}$ were the absorbances of the sample, control, and blank, respectively.

*3. Results and discussion:*

*3.1 Optimization of nature solvent, temperature, extraction modulus, duration of the process.*

The extraction of carotenoids by different solvent for examined species are in the sequence (Table 1): Chlorella vul. – Acetone > Dichlormethane > Hexane: acetone (1:1) > Ethanol > Chloroform – Artrospira pl. – Acetone > Chloroform >

Hexane: acetone (1:1) > Ethanol > Dichlormethane. The best solvent for microalgae was acetone.

Table 1 – The average concentrations of Carotenoids in Chlorella vul. and Artrospira pl. by different solvent, μg/ml

| | **Chlorella vul** | **Artrospira pl** |
|---|---|---|
| Chloroform | 0 | 0,109 |
| Hexane+acetone (1:1) | 0,119 | 0,037 |
| Dichloromethane | 11,553 | 0 |
| Acetone (100 %) | 32,734 | 8,116 |
| Ethanol (70 %) | 0,075 | 0 |

After choosing a solvent (Acetone), were optimized an extraction modulus (Fig. 1). The best extraction modulus was 1:5 and 1:20 for Artrospira pl. and 1:20 for Chlorella vul., but for further research was chosen 1:20 extraction modulus for two microalgae.

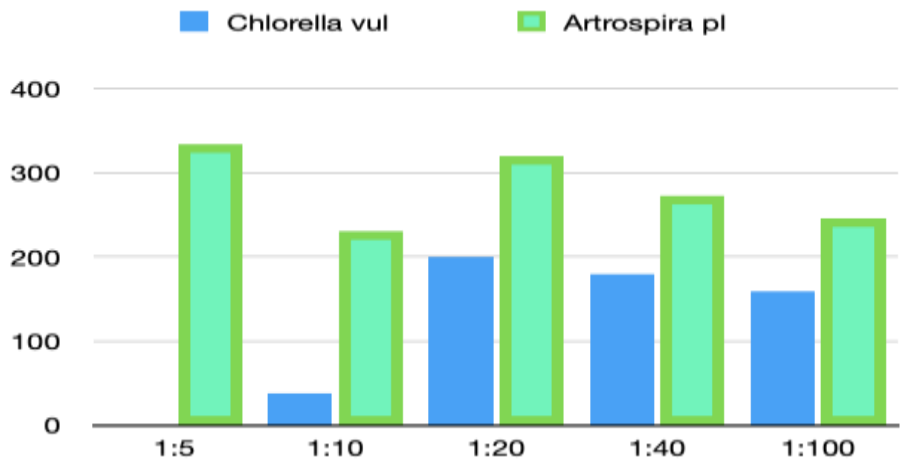


Figure 1. The average concentrations of Carotenoids at an extraction modulus (μg/ml)

After choosing an extraction modulus, the temperature was optimized. We used only acetone solvent and 1:20 an extraction modulus for Artrospira pl and Chlorella vul. extraction (Fig. 2). The best temperature was 40 °C. After 47 °C Carotenoids in microalgae have begun to collapse.

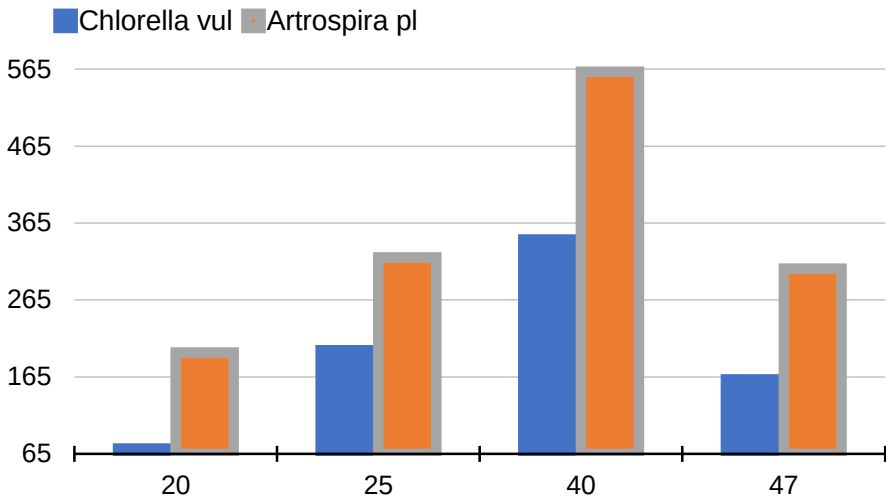


Figure 2. The average concentrations of Carotenoids at a different temperature (µg/ml)

The last point of optimization was the duration of the process. We used microalgae extracts with acetone solvent, 1:20 an extraction modulus, and 40 °C temperature of extraction. The best results were in the 4-hour duration of the extraction for two microalgae. The best results were in the 4-hour duration of the extraction for two microalgae. After 8 hours of extraction Carotenoids in microalgae have begun to collapse (Fig. 3) extraction for two microalgae.

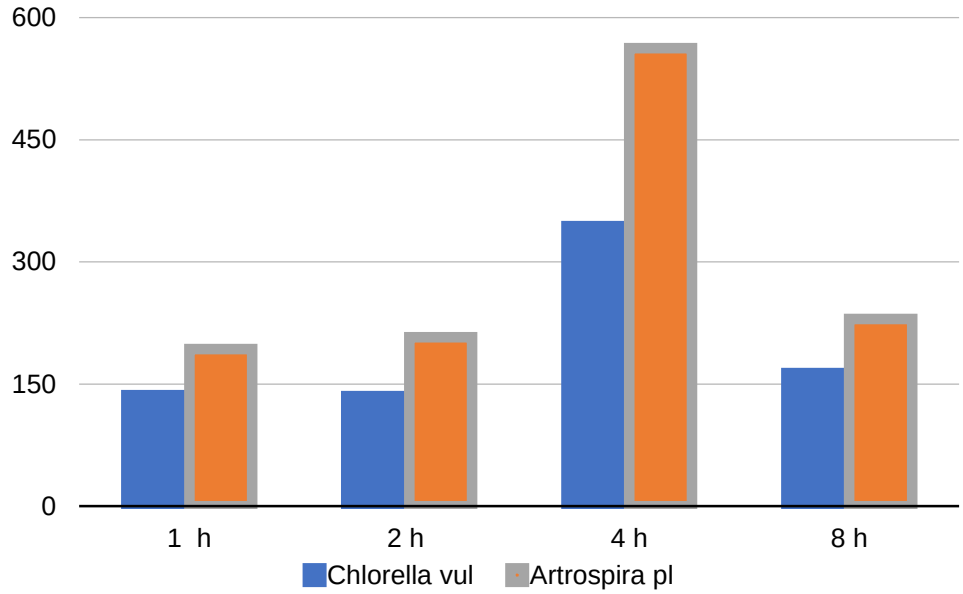


Figure 3. The average concentrations of Carotenoids at a different time of incubation (µg/ml)

*3.2 Anti-oxidative activity of microalgae samples.*

For detection of anti-oxidative activity were used extractions in conditions, which were optimized in points 2.1 and 2.2. As shown in Fig. 4, scavenging DPPH activity in extractions of Chlorella vul. and Artrospira pl. increased from 49,52 %

to 77,07 % and 43,97 % to 70,09 % with increasing of their concentrations from 3,3 to 50 mg/ml, respectively.

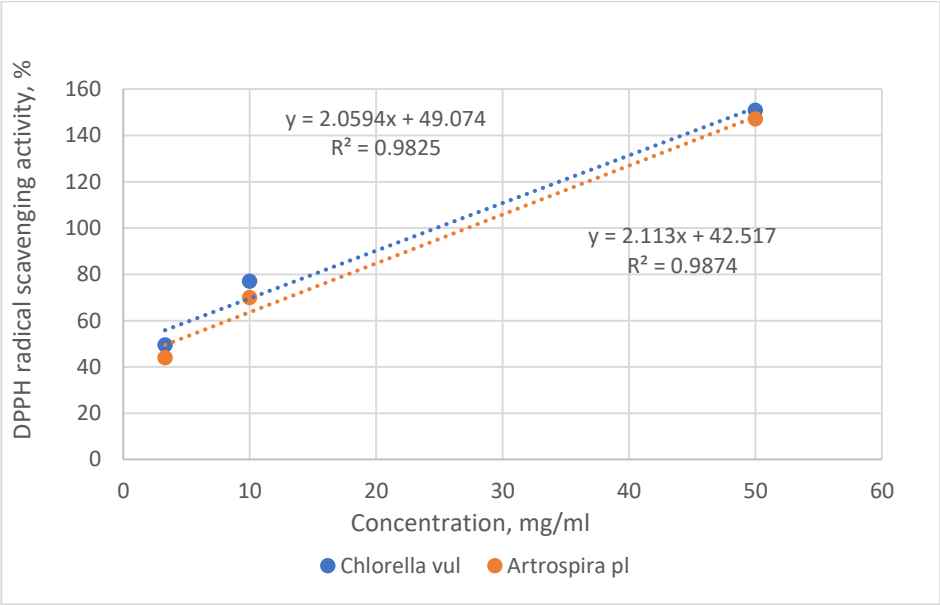


Figure 4. Anti-oxidative activity in microalgae extractions

Scavenging DPPH activity in ascorbic acid solution increased from 1,86 % to 64,49 % with increasing of their concentrations from 0,001 to 0,05 mg/ml (Fig. 5).

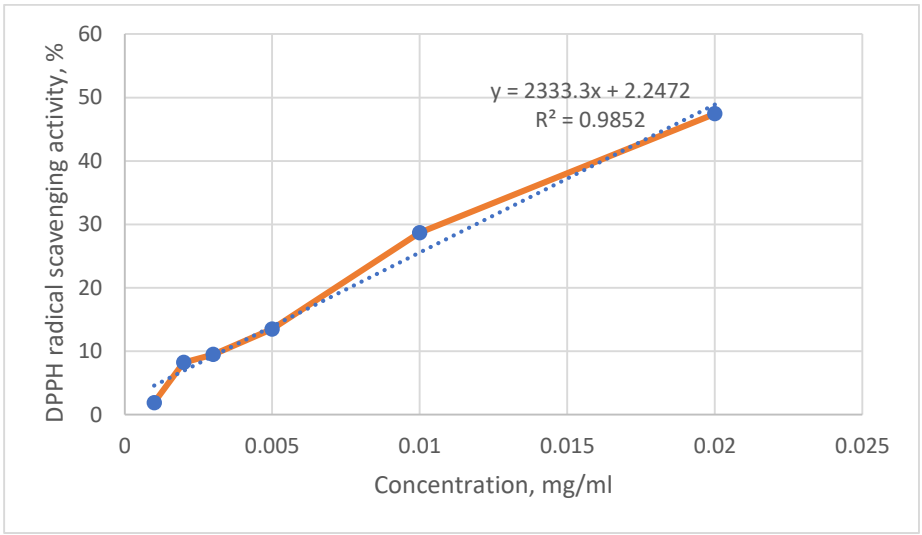


Figure 5. The anti-oxidative activity of ascorbic acid

The plot of the scavenging activity against the concentration of the sample was prepared, and the $IC_{50}$ which was the effective concentration at which 50 % of the DPPH radicals were scavenged was calculated by linear regression (Table 2).

Table 2 – $SE_{50}$ in microalgae and ascorbic acid

| **Species of microalgae and ascorbic acid** | **$SE_{50}$, mg/ml** |
|---|---|
| Artrospira pl | 3,5414 |
| Chlorella vul | 0,4496 |
| Ascorbic acid | 0,0204 |

As lower the $SE_{50}$ value as higher the anti-oxidative activity. Therefore, from among the two microalgae, the highest anti-oxidative activity has Chlorella vul. ($SE_{50}$ = 0,4496 mg/ml), and anti-oxidative activity Artrospira pl $SE_{50}$ was less high (3,5414 mg/ml). $SE_{50}$ for ascorbic acid was 0,0204 mg/ml.

*4. Conclusion*

The best conditions for microalgae extraction are acetone (100 %) as a solvent, 40 °C as a temperature in the incubator, 1:20 as an extraction modulus, and 4 hours as a time of incubation. Chlorella vul. has higher activity than Artrospira pl.

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**УДК 620.91**

# ECONOMIC BARRIERS TO THE INSTENSIVE DEVELOPMENT OF SOLAR ENERGY

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**Abstract.** The aim of this work is to identify economic barriers to the rapid development of solar energy including costly construction and maintenance. The paper also discusses methods for accumulating the produced electricity and subsequent recycling of solar panels in terms of their efficiency and cost.

**Keywords:** solar energy, solar panels, photocell, electricity, economic barriers.

# ЭКОНОМИЧЕСКИЕ БАРЬЕРЫ ДЛЯ ИНТЕНСИВНОГО РАЗВИТИЯ СОЛНЕЧНОЙ ЭНЕРГЕТИКИ

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**Аннотация.** Целью этой работы является выявление экономических барьеров для стремительного развития солнечной энергетики, к которым можно отнести значительные расходы на строительство и техническое обслуживание. Также в работе рассмотрены способы аккумулирования добытой электроэнергии и утилизации отработавших элементов с точки зрения их эффективности и стоимости.

**Ключевые слова:** солнечная энергетика, солнечные панели, фотоэлемент, электроэнергия, экономические барьеры.

Solar power is one of the main branches of green energy development based on renewable fuel sources. Its essence lies in the principle of the photocell: when light (not necessarily solar) hits the photocell, electricity is generated. Solar

energy is one of the most environmentally friendly and promising types of energy currently available. At this stage of technological development, there are a number of disadvantages that are gradually being dealt with by the scientific community. The main problems that people face are economic, technical and environmental ones, such as: costly construction, expensive repairs, short service life, high labor intensity of maintenance, dependence on natural conditions, et cetera.

The efficiency of solar power plants does not exceed 25 – 30 % due to the long chain, as inverters, storage batteries, power lines and converters are needed. Every element has its own power losses. The present work will deal with some problems related to the economic side of the issue.

One of the problems is finding the optimal location. Large areas are needed for the construction of stations. One solar panel with an area of 7 m² generates only 6 – 7 kWh/day [1]. For example, an ordinary household refrigerator consumes about 0,3 kWh. This means that it will take a considerable amount of money just to rent or buy land for the construction of a solar power plant. One also has to pay attention to the objects nearby. If a solar station is put along the road, the dust from the roads will be constantly deposited on the solar panels. Consequently, there will be expenses for maintaining them clean. In addition, over time, fine sand particles will scratch the surface of the panels, resulting in the drop of the efficiency and one will have to periodically replace the glass coating, which is rather costly.

If solar panels are moved deep into the forest, it will be necessary to cut down the trees, lay and maintain roads, just as important, poor accessibility will lead to the difficulties with electric power delivery, and new power line supports will have to be erected.

There are also problems with the operation of these stations: hail can beat the panels themselves, damaged elements will have to be replaced, repairs will cost from $10 per m² (depending on the degree of damage); semiconductor elements may overheat, thereby reducing the service life; it is necessary to increase the cross-sections of wires to reduce power losses, and wires of increased cross-section without insulation cost from $4,5 per meter; the panels need to be placed in sunny places where the temperature can be high, and the higher the temperature, the greater the resistance of the conductors, energy losses occur from this, the wires sag.

Looking at the graphs (Fig. 1, 2, 3), it is easy to notice that the load on the network follows daily and weekly cycles and is increased in winter. The work of solar power plants does not agree well with these periods: there is radiation exactly when its energy is least needed, that is during the daytime. Moreover, the sun shines brightest in summer. Consequently, there is a problem with energy

conservation. It is necessary to install storage stations, which is an additional expenditure item [2].

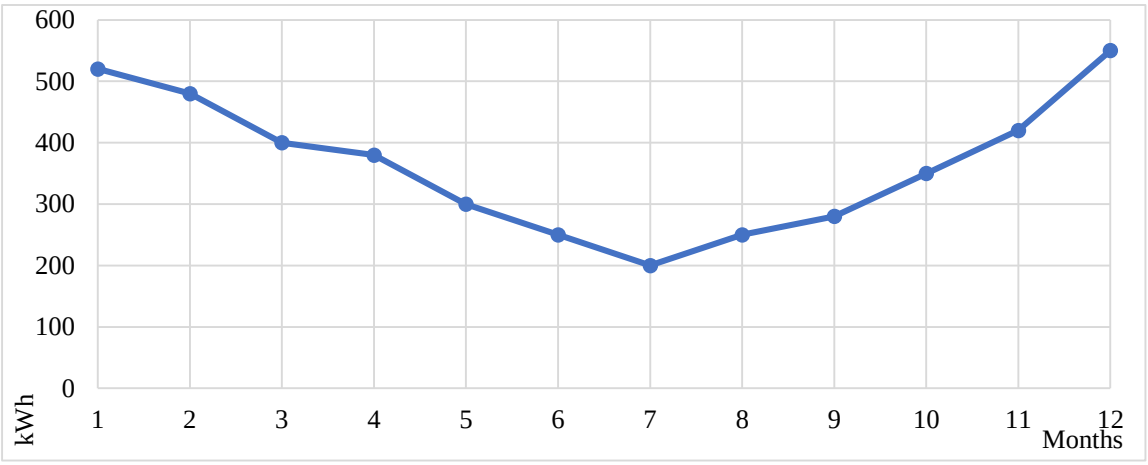


Figure 1. Graph of electricity consumption by month

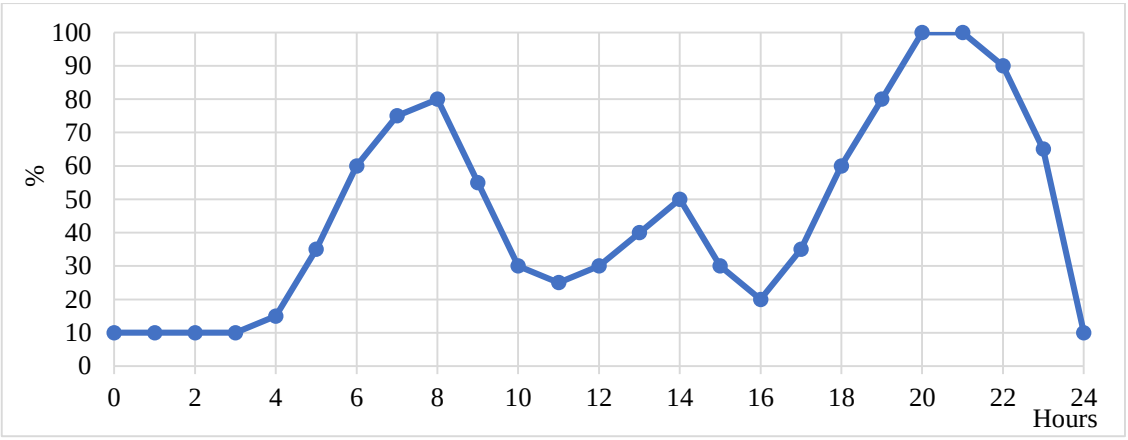


Figure 2. Graph of electricity consumption during the daytime

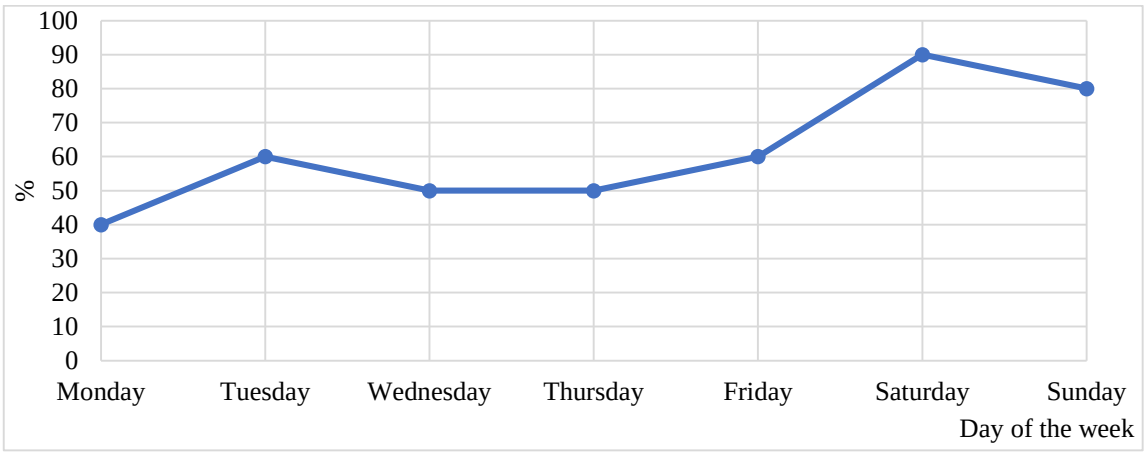


Figure 3. Graph of electricity consumption by day of the week

If the terrain allows and there are vast areas, then a pumped storage power plant (PSPP) is built. The construction of such a station will cost 70 billion rubles and its maintenance will cost 100 million rubles annually, approximately 30 % of electricity is lost due to evaporation of water and the operation of the station by this method [3]. This can also lead to flooding of arable land, a decrease in the amount of nutrients in the soil, complication of fish migration, as well as deterioration of conditions for animal survival. For example, in Russia it is possible to build a pumped storage power plant only in a small number of places.

If the terrain does not allow, a battery storage power station (BSPS) is built. This solution makes it possible to store the received energy for several days. Nevertheless, these stations are toxic, explosive and a huge amount of carbon dioxide is emitted during their activity. Batteries degrade over time, so there is a need for the disposal of spent elements and the purchase of new ones. From 10 % to 30 % of the energy (depending on the materials used) is lost at this stage due to the heating of the batteries. Therefore, BSPS is a more expensive solution [4].

It is also possible to build a solid-state storage station. For example, to supply Moscow with enough electricity, a 300-metre-high solid-state storage station will be needed with the development footprint of 1 $km^2$. Such a station will be able to supply the capital for one or two days.

There are many more storage options, but they keep electricity either for a short time at all, or in small amounts.

The next problem is decommissioning. What to do with the spent elements? It is necessary either to bury them in the soil, thereby polluting it, or to recycle them, which is another expenditure item. The construction of a processing plant will also take a lot of effort and financial resources.

Thus, the operation of solar power statins implies a very complex scheme with huge energy losses during transportation and high costs for construction, maintenance and disposal.

Taking into consideration the above-mentioned economic barriers, it can be concluded that solar energy will be beneficial to countries with long daylight hours, clear sky and low amounts of natural resources. In Russia, this industry is still underdeveloped; nevertheless, it has prospects for growth, as well as challenges to be tackled.

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# ANALYSIS OF THE CONCEPT: “GREEN SQUARE”

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**Abstract.** The principle of “Green Square” is considered in the article. Its sides, which are 4 types of power plants, are disassembled.

**Keywords:** “Green Square”, SPP, WPP, HPP, NPP, environmental impact, environmental impact.

# РАЗБОР ПРИНЦИПА: «ЗЕЛЕНЫЙ КВАДРАТ»

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**Аннотация.** В статье рассмотрен принцип «зеленого квадрата». Разобраны его стороны, в качестве которых выступают 4 вида электростанций.

**Ключевые слова:** «зеленый квадрат», СЭС, ВЭС, ГЭС, АЭС, воздействие на окружающую среду, влияние на экологию.

Humanity is now at a stage of its existence when, with the continuation of the same consumption and lifestyle, consequences may take place that we will not be able to change. Deforestation, extermination of species, burning of fuel with a large number of harmful elements, extraction of fossil resources, pollution of the atmosphere, reservoirs, soil occur in our modern world and the list does not end there. Our planet will not be able to endure this for a long time, and the result will be the extinction of our species.

Carbon dioxide will be released in large quantities during the burning of natural resources, and most of the economy is built on this. The burning of oil and gas is about 75 % of the human impact on the climate. About half are absorbed

by ocean plankton and plants, and the rest goes into the atmosphere and accumulates there. Deforestation accelerates the process even more.

One of our mistakes that can lead us to death as a species is the global consumption of one resource. That is, if the whole planet focuses on the use of one type of energy, it will undoubtedly lead to its depletion. And the negative consequences will accumulate. For example, such a form of life as microbes survived us for countless years, since each of their subspecies chose a different way of existence for themselves, and then a cycle was created.

The solution lies on the surface – it’s a balance. If we don’t get hung up on one way of generating energy, whether it's an alternative or a classic kind. And if we approach this competently, combine the efforts of all countries and make up some system with elements that complement each other and balance, this will yield results.

In 2015, an international conference was held in France, within the framework of which the ongoing climate changes were discussed. 197 countries signed an agreement, the essence of which was to keep the global temperature rise until 2050 well below two degrees Celsius and to make efforts to limit the temperature rise to 1.5 degrees.

Undoubtedly, energy plays a big role in warming, since the resources that are currently being used lead to the formation of thermal emissions and carbon dioxide. Of course, this is not the only reason, but it is quite significant.

In achieving harmony, we will be helped by a figure that is stable and equal on all sides – a square.

There is a concept of “Green Square”, which was proposed by “Rosatom” in 2017 during an international conference. It offers such an energy generation system in which carbon dioxide emissions become minimal. Let's look at the sides of the square:

the first is solar energy;

the second is wind energy;

the third is hydropower;

the fourth is atomic energy.

That is, the essence of the concept is in the accelerated development of these types of energy generation, namely solar power plants (SPP), wind power plants (WPP), hydroelectric power plants (HPP), nuclear power plants (NPP).

We adapt to various natural conditions (the sun is shining, the SPP is working, the wind has blown – WPP and HPP also helps). Now we turn to nuclear energy. Unfortunately, alternative sources do not provide us with the necessary amount of energy to meet our needs, even 50 % is not a fact that it will be collected. Therefore, we need something very powerful, but at the same time not producing carbon dioxide, nuclear power plants become the output.

Yes, the attitude towards nuclear energy is not the most positive for many people (the sad story of the Chernobyl accident scares many people), but nevertheless.

But this energy industry certainly has its disadvantages and risks, namely the production of nuclear waste, the disposal of which is not an easy process. But we can develop nuclear power and find ways to solve the problem of recycling. For example, try to close the energy cycle by combining nuclear reactions. Development in this direction will bring us into the same balance, accompanied by waste-free production. There are already solutions, afterburning of minor actinides, and then closing the fuel cycle [1].

The price for this type of energy is lower than for coal and gas by 10-20% or for solar, wind energy, the price difference is almost half less. The nuclear power plant is the key to a carbon-free future, as it is the most optimal energy option with its capacity and price.

SPP, WPP and HPP are also certainly not an ideal option, since the type of "green" energy generation is very dependent on climatic conditions and territorial features. Table 1 shows advantages and disadvantages of these types of power plants [2].

Table 1 – Advantages and disadvantages of types of power plants

| **Type of power plant** | **Advantages** | **Disadvantagies** |
|---|---|---|
| Solar power plant | 1. Environmental friendliness<br>2. Free resource<br>3. Availability<br>4. Inexhaustibility<br>5. Low losses during energy transmission | 1. The need for space<br>2. Dependence on natural conditions<br>3. High investment costs |

| | | |
|---|---|---|
| Wind power plant | 1. Cheap operation<br>2. Environmental friendliness<br>3. Free resource<br>4. Availability<br>5. Low losses during energy transmission | 1. Production depends on natural conditions<br>2. Using the landscape<br>3. High investment costs |
| Hydroelectric power plant | 1. The most inexpensive energy source<br>2. No atmospheric pollution<br>3. Creation of new reservoirs | 1. The requirement of large areas for flooding<br>2. Affecting flora and fauna |

Today, for example, in Russia, part of wind and solar energy is very small, and nuclear power plants and hydroelectric power plants occupy only 33 % of the total electricity generation. Investments are necessary for the concept "Green Square" to work. This is the main problem that the transfer of global energy to carbon-free use requires very high costs. But they are real if we set this task as the primary one [3].

It is necessary to pay attention to the idea of "Rosatom", as it helps in solving a very important task, which is paramount and determines our existence.

But, in addition, despite the fact that our civilization has made a huge step in development, there are such areas and settlements on the planet, as far as banal things have not yet reached and they live practically in the primitive age. For their development, they definitely need heat, and if we stay on the classical methods of energy extraction and build additional power plants, then the Paris Agreement will not be fulfilled exactly [4].

Thus, countries need to make efforts to develop this concept or another one that will give us warmth, without harm to our planet, which provides us with its territory.

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# TECHNICAL AND TECHNOLOGICAL ADVANTAGES OF WIND TURBINES

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**Abstract.** Recently, different types of electricity generation have been a frequent topic of debate amongst experts. Surely, wind energy is one of the frontrunners of the technological breakthroughs that might lead to more efficient energy production.

**Keywords:** wind turbines, wind power, wind, advantages of wind energy, ecology.

# ТЕХНИЧЕСКИЕ И ТЕХНОЛОГИЧЕСКИЕ ПРЕИМУЩЕСТВА ВЕТРОЭНЕРГЕТИЧЕСКИХ УСТАНОВОК

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**Аннотация.** В последнее время эксперты часто обсуждают различные виды производства электроэнергии. Несомненно, энергия ветра является одним из лидеров технологических прорывов, которые могут привести к более эффективному производству энергии.

**Ключевые слова:** ветровые турбины, ветроэнергетика, ветер, преимущества ветроэнергетики, экология.

Wind energy has been used by mankind for a long time. It is wind energy propelled sailing ships, allowing them to cross oceans, wind energy was used in mills, it was also used to irrigate fields and land drainage. And then when humanity discovered the benefits of electricity, attention was again turned to wind

energy: in the XIX wind farms for industrial production of electricity have been actively built for centuries (Fig. 1).

Currently, wind energy is one of the most dynamically developing energy industries. Wind energy is classified as a renewable energy source. All over the world, the total established the capacity of wind power plants (WPP) of all types was 591·103 MW [1].

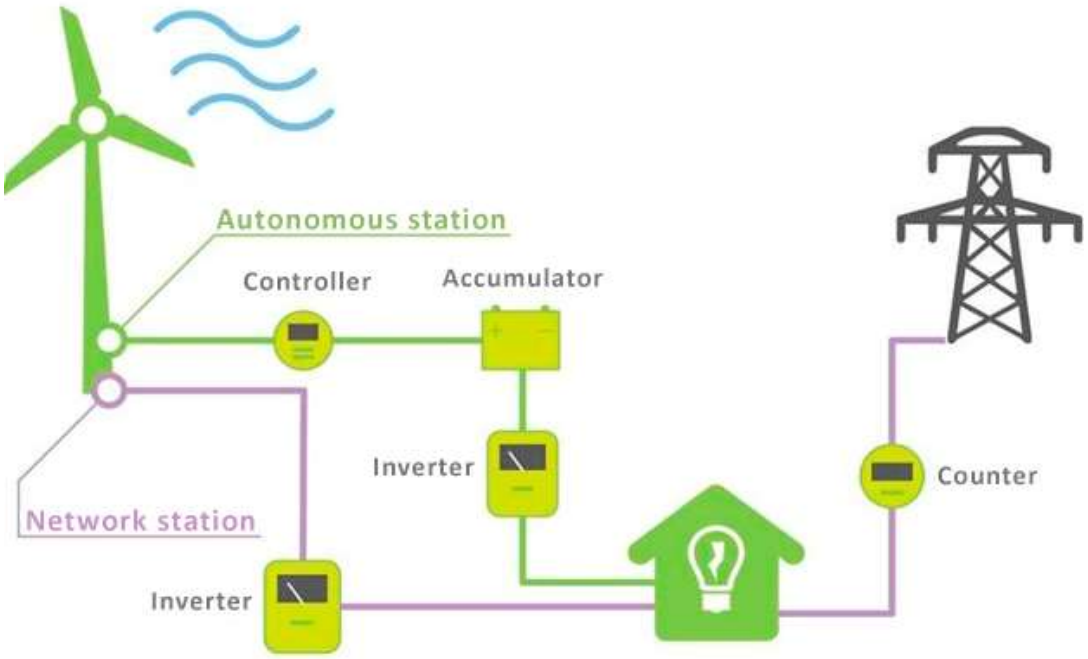


Figure 1. Wind farm operation diagram

With the help of alternative energy in the world, such problems as air pollution from greenhouse gas emissions are being solved. Gases and the limited availability of fossil fuels.

It can be noted with confidence that the largest direction in the region renewable energy in Russia has wind energy. During various research and development by Russian scientists over the past 30 years has been found that in our country there are about 300 thousand points where you can put wind turbines of various power, design and purpose

Currently only 17 % of primary energy consumption worldwide realized from renewable energy sources (wind and water energy, geothermal energy, solar energy and bioenergy), with two-thirds of non-commercial timber and other biomass, and almost one one third is wind energy. Today in the Russian Federation due to unconventional sources receive 11 % of energy, which is of course very little, but our country tries to succeed in this direction and develops more and more every day [2].

Wind power plants are complexes of equipment designed to generate, preparation and supply consumers with electric current. Since wind is a free source of energy, all the costs of generating electricity are reduced to the initial investment for the purchase (or creation) of a wind generator and related equipment and subsequent maintenance.

The wind turbines include:

- wind generator;
- battery;
- inverter;
- switching equipment, cable;
- other devices.

The principle of operation of wind turbines is based on the use of wind energy. The flow acts on the impeller blades, causing them to rotate. Rotation is transmitted to a generator that produces an electric current. The generator charges the batteries, the voltage from which is fed to the inverter, which creates an alternating current of 220 V 50 Hz, which is necessary for consumers.

There are separate windmills, feeding pumps or other simple devices that supply voltage directly to the consuming device [3]. But, in the event of abnormal situations, for example, a sudden increase in wind, the consuming device may fail due to a sharp voltage surge.

Recently, there has been a significant increase in interest in wind energy from inventors and designers. New designs are constantly appearing, which have more and more capabilities. In particular, an active search is under ways to increase the efficiency of a wind turbine, and some options have very high indicators compared to the currently used industrial designs of wind turbines.

Taking into account that the maximum use of the energy of the wind flow, according to calculations, cannot exceed 59,3 %, and the actual use is much lower and amounts to 10 %, then the possibilities for increasing the efficiency of installations are very high.

At the moment, the following technical advantages of wind energy can be distinguished [4]:

- The obvious advantage of wind energy is the actual infinity of resources: as long as the planet has an atmosphere and the sun is shining, there will be movement of air masses that can be used to generate energy. As a renewable asset, wind can never be exhausted like other regular, non-renewable assets. Winds are caused by rotation of the earth, heating of the atmosphere by the sun, and earth’s surface irregularities. We can harness wind energy and use it to generate power as long as the sun shines and the wind blows;

- The advantages of wind power plants include the speed of construction of a wind turbine: even for an industrial installation, it takes no more than two weeks, taking into account the time spent on site preparation, but a household wind generator suitable for supplying energy to a private house or cottage is installed in a matter of hours;
- Compactness. The wind turbine occupies a point position and does not require any territory to function.
- The latest advances in technology have transformed preliminary wind turbine designs into extremely efficient energy harvesters. Turbines are available in a wide range of sizes for farms, factories, and large private residences, extending the market with many different types of businesses and by individuals for use at home on larger plots and other plots of land;
- Portable wind turbines are also available and can power small mobile devices. The latest models will generate even more electricity, require less maintenance, and run more quietly and safely;
- There is no need for any fuel, the entire operation of the system is carried out completely autonomously;
- High maintainability of wind turbines, especially in comparison with traditional types of energy production;
- Energy costs are stable and predictable;
- Minimal energy losses during transmission, the possibility to install wind turbines near consumers;
- The area in the immediate vicinity can be fully used for agricultural purposes.

*Conclusions:*

1. The growth rates of wind power capacity in the world indicate that this technology is popular. Thus, the global wind energy market in 2019 grew by 39 %, adding 39,5 GW of new capacity. The main advantage of wind energy lies in cleanliness, reliability and speed of commissioning of capacities.

2. Russia has sufficient “wind” potential for the construction of air power plants.

3. The main feature of wind generation technology is determined by the physical the nature of wind as an alternative source of energy: the inconstancy of its value and low power.

4. With such significant advantages that make wind energy a very attractive industry, we can say that it can and should not only complement traditional energy, but also replace it.

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**УДК 621.548**

# ENVIROMENTAL DOWNSIDES OF WIND ENERGY

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**Abstract.** The purpose of the article is to show the aspects of negative environmental impact of the of wind power plants (WPPs) at the stages of their construction, operation and decommissioning. The relevance of this topic is dictated by the growing popularity of “green” wind energy, which requires more and more resources – land, economic and human ones.

**Keywords:** wind farms, wind power plants, environmental impact, “green” energy, renewable energy.

# ЭКОЛОГИЧЕСКИЕ НЕДОСТАТКИ ВЕТРОЭНЕРГЕТИКИ

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**Аннотация.** Цель статьи: показать, каким образом ветряные электростанции (ВЭС) оказывают отрицательное влияние на экологию на этапе их строительства, работы и вывода из эксплуатации. Актуальность этой темы диктуется нарастающей популярностью «зеленой» ветроэнергетики, которая требует все больших ресурсов – территориальных, экономических и человеческих.

**Ключевые слова:** ветряные электростанции, ВЭС, влияние на экологию, «зеленая энергетика», возобновляемые источники энергии.

A wind generator is a type of technical device, which turns kinetic wind energy into electrical energy (Fig. 1). Usually, wind generators are installed in open areas, in the fields, mountains, shallow waters and on islands, where the wind is almost always there and has the greatest strength. Such places are called wind power sations.

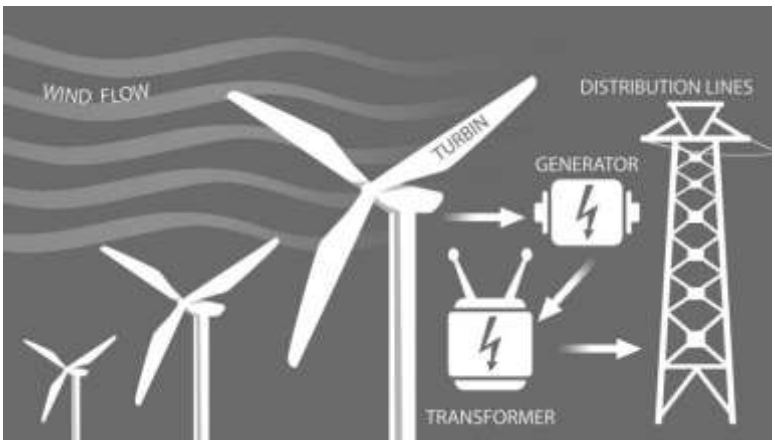

Figure 1. The principle of a wind generator

Despite all the advantages of the transition from the use of gas, gasoline and coal to the use of clean and waste-free wind energy for producing electricity, there are some controversial environmental aspects that should be borne in mind when planning a wind power plant construction. It is unprofitable to install one wind turbine, which is worth several million dollars, because it will not pay off. A wind power plant, at a cost of several hundred billion dollars, can pay off in 10 – 15 years after the completion of construction. This is the reason why companies prefer to install WPPs rather than a single wind turbine. This fact brings us to the first environmental issue of wind energy, which is the alienation of lands. The main resource required for the operation of wind farms (especially large ones) is the territory. The used territories are classified according to their location, thus WWPs are divided into onshore, offshore (located in the sea 10 – 60 km from the shore), coastal and floating (located in the sea on floating platforms 10-60 km from the shore) ones (Fig. 2 – 5). Alienation of land occurs even at the construction stage because sounds and vibrations from construction activities scare off the local fauna and make life difficult for local residents.


Figure 2. Novoazovskaya onshore WPP


Figure 3. Coastal wind farm in Denmark

Figure 4. Lillgrund offshore WPP in Sweden

Figure 5. Floating WPP in Japan 23 km from Fukushima

The larger scope of environmental problems is caused by WPPs during their operation phase. For the environment, land and coastal WPPs are the most problematic, as they force the species of animals that originally lived on the construction site to relocate. According to the research, offshore and floating WPPs do not cause any problems to marine fauna with their noise and reduced pressure around them [1].

The greatest negative impact on the environment is produced by coastal and onshore WPPs. Specifically, they harm birds and bats. Scientists have concluded that wind turbines pose the greatest threat to migrating birds and birds of prey. The most affected are members of the eagle family. In Southern Spain, such a rare species as the Spanish Royal Eagle is threatened with extinction due to the WWP located on its migration route through Gibraltar. This means that the ill-conceived location of a wind farm can lead to the birds' death or change their usual route to a longer and riskier one. Birds of prey are in greater danger because during the

hunt they fly with their heads down to track their victim. At the same time, the peculiarities of their binocular vision do not allow them to identify the rotating white blades as a moving object. However, statistics show that the harm to birds from wind farm in comparison with that from the domestic cats or windows of buildings is minimal [2] (Table 1).

Table 1 – Birds deaths statistic (According to the latest research of the United States Fish and Wildlife Service from year 2013 – 2014)

| **Reason of death** | **Victim quantities** |
|---|---|
| Wind power plants | 140 000 – 600 000 |
| Distribution lines | +- 25 000 000 |
| Cars | +- 200 000 000 |
| Buildings windows | +- 600 000 000 |
| Wild and domestics cats | 2,5 000 000 000 – 7,5 000 000 000 |

Bats suffers from WPPs too. Approaching the WPP by less than 100 meters, they fall into a low pressure zone and die from internal hemorrhage caused by a sharp expansion of the lungs. According to environmentalists' estimates, wind power plants in the United States alone annually claim the lives of about 600 – 800 thousand bats. Nevertheless, scientists began to record high mortality of bats even at wind farms, located far from their habitats, which made them conclude that bats are attracted by the turbines themselves. A possible reason for this thrust may be the light colour of the turbine blades, so as not to disturb the locals with their appearance and make them less visible. The fact is that light beige and yellowish tints attract insects that bats feed on [3, 4]. In addition to bats, the WPP also causes discomfort to other fauna that originally lived on the sites of their construction.

Another negative aspect is that windmills create constant noise. In the immediate vicinity of the axis of the wind wheel, the noise level of a sufficiently large wind turbine can exceed 100 dB, and the pain threshold of human hearing is 120 dB. The noise from one wind generator at a distance of 350 m is 35 – 45 dB, you can imagine what kind of noise background is created around a large wind farm [5].

Furthermore, wind turbines turned out to be a source of strong infrasound noise, which can influence human health. It adversely affects the nervous system and creates constant discomfort, which leads to anxiety, headaches, tachycardia, ear pressure, as well as to deterioration of vision and digestion. That is, the presence of a constant source of discomfort is undermining the whole body.

Infrasound, due to its large wavelength, freely bypasses obstacles and can propagate over long distances without significant energy losses. Therefore, infrasound can be considered as a polluting factor. Thus, if wind turbines lead to the production of infrasound, they cannot be considered a clean source of energy, since they pollute the environment. In addition, infrasound is much more difficult to filter out than ordinary sound. The installed sound filters do not allow it to be completely shielded. In practice, these factors lead to the animals and birds beginning to actively leave the territory of the wind farm and the adjacent lands, to say nothing of the people in the district, whose life has also become impossible [5].

As a specific example, let's take the case of the lawsuit against two large wind farms on the coast of Norway in Storhei and Roan in 2021. The Saami community filed a lawsuit against wind farms located near reindeer pastures, which have been there for centuries. The WWP included a total of 150 turbines with the production volume of about 1.12 billion euros per year. Despite the huge costs of creating a wind farm, the Norwegian court decided to support the community, banned the construction of the plant and the use of land for this purpose and revoked licenses for the operation of these installations. Such a decision shocked many people, and the current problem is what to do with the already built wind-powered installations (Fig. 6).

Figure 6. WPP in Norway

There is also an active movement against wind turbines in Germany. As a result, regulations appeared in the legislation prohibiting the construction of wind power plants in the immediate vicinity of residential buildings and farms. In 2020, the construction of 770 new wind turbines was approved throughout Germany –

this is 40 percent less than in 2015. In some lands, the number of permits issued has decreased by 70 and even 90 percent [6].

Finally, it should be recognized that today the most significant problem of wind energy that needs to be solved is when they are already out of service and there is a need to dispose of these white giants. The utilization of wind turbine blades made of composite materials is not that easy.

Today, two main methods of recycling are offered: mechanical and thermal recycling. The mechanical method of processing blades is quite simple and includes 3 stages: disassembly and separation into parts for easier transportation; mechanical grinding with resin extraction; separation of larger fibers from smaller fibers and granules. Currently, the thermal method of processing blades is popular. The simplest kind of it is burning. But after burning, a large amount of ash is formed (about 60 % of the burned mass), which needs disposal. A promising method is pyrolysis (heating without oxygen access at 500 º C), as a result of which the fibers of the blades can be reused and the resulting gas burned to generate electricity. Unfortunately, at the moment the proposed methods have a number of disadvantages, which do not allow us to declare a full solution to the problem of processing blades [7].

Summing up, it should be said that in the presence of some negative impact on the environment, wind generators are more environmentally friendly than the widely used technologies for generating electricity today.

Among the negative impact factors, the most noticeable one is the constant noise, the level of which is not compatible with comfortable living in the area around the WPP. Another big problem is the threat to birds and other flying creatures that fall into the blades of generators. A larger examination of the impact of the stations reveals that more global environmental changes may result, such as the forced change of routes of migratory birds.

Since the use of wind energy is one of the most efficient and environmentally sound methods of generating electricity today, the development of more advanced installations that do not have the above-mentioned negative impact on the environment continues.

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**УДК 533**

# HYDROELECTRIC POWER PLANT AS A SOURCE OF ENERGY FROM RENEWABLE RESOURCES

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**Abstract.** The article considered the technical advantages of hydroelectric power plants. A description of the types of hydroelectric power plants was presented, which gave an idea of the principles of HPP operation. Based on this, specific examples were given describing the positive aspects of the use of hydroelectric power plants in modern reality. From which it can be concluded that hydroelectric power plants based on the principle of converting the energy of water masses into electricity are a necessary “green” energy source that ensures the preservation of ecology and has many technical advantages.

**Keywords:** hydropower, PES, HPP, PSPP, specific fuel consumption.

# ГИДРОЭЛЕКТРОСТАНЦИЯ КАК ИСТОЧНИК ПОЛУЧЕНИЯ ЭНЕРГИИ ОТ ВОЗОБНОВЛЯЕМЫХ РЕСУРСОВ

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**Аннотация.** В статье рассмотрены технические преимущества ГЭС и виды гидроэлектростанций, что дало представление о принципах работы ГЭС. На основе этого были приведены конкретные примеры, описывающие положительные стороны использования гидроэлектростанций в современной действительности. Из чего можно заключить, что ГЭС, основанные на принципе преобразования энергии водных масс в электричество, – это необходимый «зеленый» источник энергии, обеспечивающий сохранение экологии и имеющий множество технических преимуществ.

**Ключевые слова**: гидроэнергия, ПЭС, ГЭС, ГАЭС, удельный расход топлива.

The topic of obtaining energy from renewable sources is more relevant than ever. According to the latest estimates of the Accounting Chamber of the Russian Federation, the known oil reserves will last for only 35 years of production. The remaining 65 % in the Russian bowels of the earth are considered difficult to recover. Statistics on gas production indicate that there will be enough gas for another 50 years. These are small numbers, our generation may even find a fuel crisis. That is why it is now important to look for alternative energy sources. One of these “green” sources is the energy of the movement of water masses, which is converted into electric power at hydroelectric power plants. Such an energy source as a hydroelectric power station can be viewed from various sides, for example, from the side of ecology, technology or economics. But we will cover a narrower topic, such as the technological advantages of hydropower [1].

Consider the classification of hydroelectric power plants.

- *Riverbed and dammed hydroelectric power plants* (Fig. 1,2). These are the most common types of hydroelectric power plants. The water pressure in them is created by installing a dam that completely blocks the river, or raises the water level in it to the required level. Such hydroelectric power plants are built on high-water plain rivers, as well as on mountain rivers, in places where the riverbed is narrower, compressed.

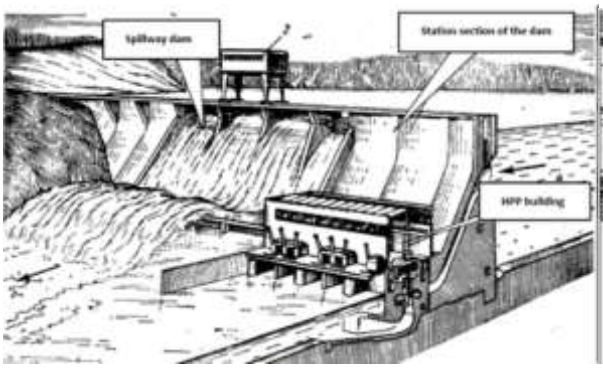


Figure 1. Scheme of the dammed hydroelectric power station (scheme of operation of the Bratskaya hydroelectric power station)

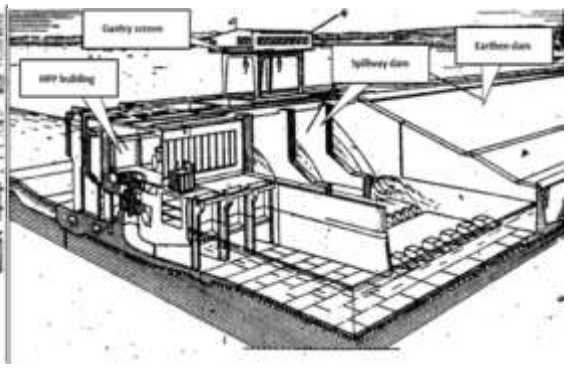


Figure 2. The scheme of the channel HPP (the scheme of operation of the Novosibirsk HPP, Irkutsk HPP, as well as all HPPs of the Volga-Kama cascade)

- *Dam hydroelectric power plants* (Fig. 3). They are built at higher water pressures. In this case, the river is completely blocked by a dam, and the hydroelectric power station building itself is located behind the dam, in its lower part. In this case, water is supplied to the turbines through special pressure tunnels, and not directly, as in channel hydroelectric power plants [2].

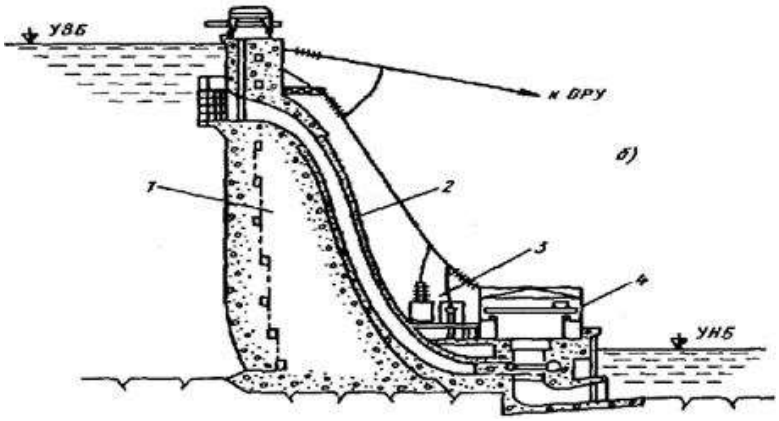


Figure 3. Dam hydroelectric power plants: 1 – dam; 2 – water conduit; 3 – high voltage electrical equipment site; 4 – the building of the hydroelectric power plant engine room

- *Tidal hydroelectric power plants* (Fig. 4). A special type of hydroelectric power station that uses the energy of tides, and in fact the kinetic energy of the Earth's rotation. Tidal power plants use the difference in water levels formed during high tide and low tide. To do this, the coastal basin is separated by a low dam, which delays tidal water at low tide. Then the water is released, and it rotates hydraulic turbines that can operate both in generator mode and in pump mode (for pumping water into the reservoir for subsequent operation in the absence of tides) [3].

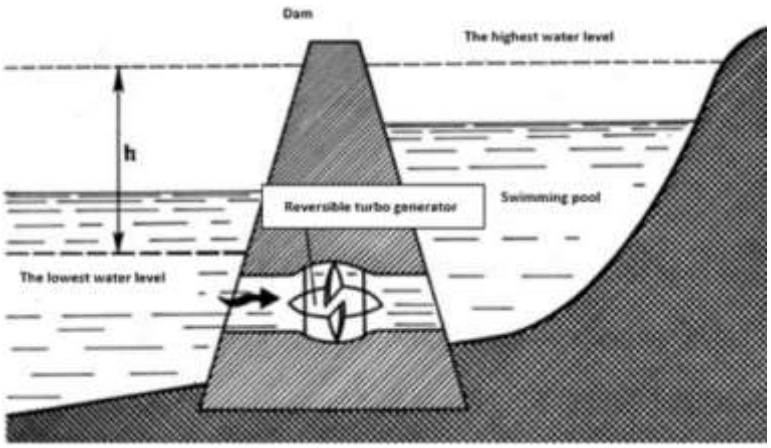


Figure 4. Scheme of tidal hydroelectric power station

One of the most important advantages of hydroelectric power station is that it is easy to control energy indicators by changing the water flow. It also allows us to regulate the amount of hydropower depending on the needs and will allow us to accumulate energy. The difference from other power plants lies in the fact that the hydroelectric power plant is able to quickly gain operating power with minimal indicators. This allows us to see high efficiency, about 95 %, and a capacity of more than 100 MW.

During the hours of reduced loads, the PSPP operates as a pumping station. It pumps water from the downstream to the upstream due to the energy consumed and creates reserves of hydropower. During the hours of maximum load, the PSPP operates as a hydroelectric power station. Water from the upstream is passed through turbines to the downstream, and the PSPP generates and supplies electricity to the power system.

Hydropower has a number of advantages over coal or nuclear fuel: – there is no need to extract, process, transport fuel for the operation of a hydroelectric power plant.

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**УДК 67.08**

# VEGETABLE OIL PRODUCTION AS A SOURCE OF NEGATIVE IMPACT ON THE ENVIRONMENT

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**Abstract.** This article examines the main types of vegetable oils and the harm to the environment caused by production. The main sources of emissions have been identified and the risks have been assessed. Solutions are given.

**Keywords:** vegetable oil, environment, impurities, harmful substances, environment, emissions, resources, production.

# ПРОИЗВОДСТВО РАСТИТЕЛЬНЫХ МАСЕЛ КАК ИСТОЧНИК НЕГАТИВНОГО ВОЗДЕЙСТВИЯ НА ОКРУЖАЮЩУЮ СРЕДУ

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**Аннотация.** В данной статье рассматриваются основные виды растительных масел и вред, наносимый окружающей среде в результате их производства. Определены основные источники выбросов и оценены риски, приведены решения.

**Ключевые слова:** растительное масло, окружающая среда, примеси, вредные вещества, окружающая среда, выбросы, ресурсы, производство.

Fats are widely used in human nutrition. It is a high-calorie product of great physiological importance. They are used in the preparation of culinary dishes, the production of canned food, in the food industry, directly in the food. Therefore, the relevance of the chosen topic is beyond doubt.

Vegetable oil is one of the main types of food fats. Vegetable oils, cleaned from impurities, bleached and thickened (mainly linseed, hemp, walnut, poppy

seeds) are used in oil painting as the main component of binding oil paints and in emulsions of tempera (casein-oil) paints. Vegetable oils are also used for thinning paints and are included in emulsion primers and oil varnishes.

Vegetable oils that dry slowly (sunflower, soybean) and oils that do not form a film in the air (castor oil) are used as additives that slow down the drying of colours on the canvas.

In medical practice liquid vegetable oils (e.g. castor oil, almond oil) are used to make oil emulsions; oils such as olive oil, almond oil, sunflower oil, linseed oil are used as the basic ingredients of ointments.

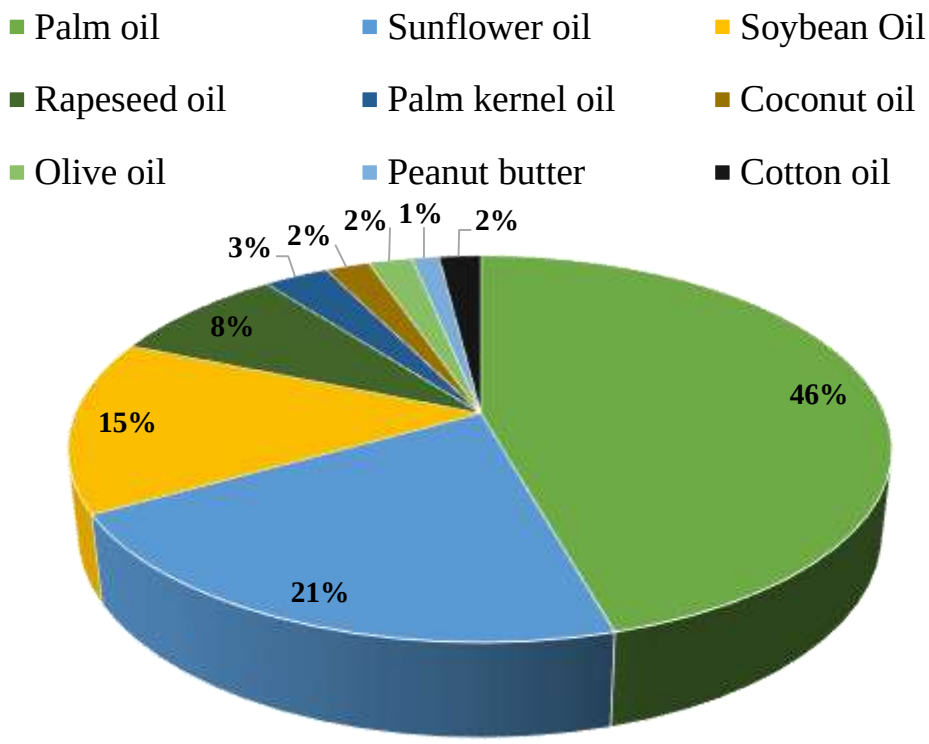


Figure 1. World oil consumption 2019

The raw material for obtaining vegetable oils is mainly the seeds and fruits of oil-bearing crops, in which fatty oils are accumulated in such quantities that industrial processing to extract oils is possible. More than 100 plants are included in the oilseed group.

Sunflower, cottonseed, soybean, flax, rapeseed, peanut, mustard, redcap, sesame seeds and others are used worldwide to produce vegetable oils. The main oil crop in our country is sunflower.

In vegetable oil production, resources such as water and chemicals are used, and gaseous, solid or liquid products are generated from the production processes.

These can be harmful to the environment and can be caused by inefficient use of materials or inefficient processes.

In the production of vegetable oils, processes that consume significant quantities of water are the extraction of unrefined oil and the refining of vegetable oil. In the production of unrefined oil, 0,2 – 12 m3 water/t oil is consumed for cooling purposes. There are certain regulations for the normal functioning of the vegetable oil production process in question.

The main sources of environmental pollution during the operation of the enterprise are organised and unorganised sources of emissions into the atmospheric air, generation of various types of waste, as well as waste water from the enterprise [1].

The main pollutants are:

- cotton dust – hazard class III;
- prop-2-ene-1-al (acrolein) – hazard class III;
- nitrogen (IV) oxide (nitrogen dioxide) – hazard class III;
- nitrogen (II) oxide (nitrogen oxide) – Hazard Class III;
- black carbon (carbon black) – Hazard Class III;
- sulphur dioxide – hazard class III;
- carbon oxide – hazard class IV;
- benz-a/pyrene (3,4-benzpyrene) – Hazard Class I;
- inorganic dust: 70 – 20 % SiO2 – Hazard Class III.

Unorganised sources include: exhausts of road transport during transportation of raw materials and removal of finished products, as well as its manoeuvring in the territory of the enterprise, belt and ring conveyors.

Organised sources include: boiler equipped with a chimney. Pollutants: nitrogen (IV) oxide (nitrogen dioxide), nitrogen (II) oxide (nitrogen oxide), black carbon (soot), sulphur dioxide, carbon oxide, benz/a/pyrene (3, 4-benzpyrene), suspended substances.

In the course of the company's activities, waste from both the main and auxiliary production facilities may be generated. The most common ones are:

- mercury lamps, fluorescent mercury-containing tubes spent and waste. FKKO code – 3533010013011. Hazard class – hazard class I waste. Is formed - 0,001100 t/year. Is given for neutralization;
- waste vegetable oils. Hazard class – hazard class IV waste. Hazard class – hazard class IV waste. Generated – 8,000000 t/year. Is given for further use in poultry farms;

- unsorted waste from household premises of organizations (excluding large-sized). The FKKO code is 9120040001004. Hazard class – hazard class IV waste. Generated – 0,900,000 t/year. Is given for disposal;
- Sunflower husk. Hazard class – hazard class V waste. Hazard class – hazard class V waste. Is formed – 130,000000 t/year. Transferred for use;
- sunflower seed cake. Hazard class – waste of the V class of hazard. Hazard class - Hazard class V waste. Generated – 1029,000000 t/year. Transferred for further use.

In the process of extraction of edible vegetable oil a rather large amount of water can be used, mainly for:

- Rinsing of raw materials;
- Use as cooling water in the production of crude oil;
- Chemical neutralisation;
- Rinsing and deodorisation;
- Cleaning of production areas;
- Steam generation.

Most of the wastewater can be treated and reused in the production process. Water abstraction or use permits usually specify the permitted volume of water abstraction, as exceeding the water abstraction may have negative consequences for the local population. If there is an increase in production, this should always be reflected in the permit.

A large volume of wastewater containing high concentrations of organic matter, organic nitrogen, oils and grease, detergents, solvents and suspended solids may be generated. The effluent may be contaminated with residual concentrations of pesticides. The main production processes associated with wastewater generation include cleaning and operation of deodorizers and boilers. Such wastewater requires treatment before it is discharged into the municipal sewer system or into the environment. A number of industries have their own wastewater treatment plants that use both mechanical and chemical treatment methods. Usually a permit is required from the local regulatory authorities that set limits for different pollutants.

In terms of intensity of negative impact of enterprises of oil and fat industry on objects of environment the leading place is occupied by water resources. Therefore, for economical and rational water consumption and drainage in oil and fat enterprises it is necessary to apply such technological processes of the main production and technological decisions at which minimum water consumption, use of circulating and sequential water supply schemes are provided [2].

Dust can occur during storage, processing and drying; aerosols are usually produced when compressed air and high-pressure water are used during cleaning.

- Workers may inhale or ingest dusts and aerosols that pose a biohazard to them in the form of a risk of occupational lung disease. Combined with high levels of humidity, this increases the risk of skin irritation and allergic reactions.

- Dust clouds consisting of flammable material can explode if: o The dust content in the air reaches an explosive concentration; o There is a source of ignition.

Dust emissions can be controlled by installing barriers around production and transport equipment, which also reduces product loss, and by installing ventilation equipment.

Depending on the type of oilseed raw material, the waste generated can be recycled almost entirely into a variety of other products, such waste is considered a by-product. For example, protein-rich oilcake and meal, fatty acids and phospholipids are raw materials in the production of food, animal feed and pharmaceuticals

Noise from equipment such as steam generators, condensers, ventilation equipment, canning and bottling lines, pneumatic equipment, and truck traffic can be a nuisance if the plant is located near residential areas and other noise-sensitive facilities. Working in noise-sensitive areas, such as near internal conveyors, conveyors, boilers, pumps, fans, steam and air leakage areas, can cause hearing loss;

Significant increases in demand for vegetable oils have led in some cases to the destruction of rainforests and displacement of indigenous people from settled areas. High temperatures can lead to heatstroke and contact burns; The following measures should be taken to reduce pollution levels at the plant [3, 4]:

- the use of air treatment facilities;

- maintaining a sanitary protection zone;

- measurements of maximum permissible concentrations of pollutants in the air in the nearby residential areas and in the territory of the enterprise shall be taken on a quarterly basis;

- agreements must be in place for the disposal of the wastes generated as a result of the enterprise's activities;

- monitoring of the acoustic impact: noise level measurements;

- control over compliance with the permissible concentrations of pollutants in the household sewage when discharging them into the sewerage network;

- improvement of the adjacent territory.

Thus, the measures taken at the enterprise contribute to the reduction of the negative impact on the environment.

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# ENERGY SAVING IN AUTOMATED VENTILATION AND AIR CONDITIONING CONTROL SYSTEMS

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**Abstract.** This article discusses ways to reduce the amount of electrical energy consumed in automated ventilation and air conditioning control systems. The description of the types of equipment used for these purposes, the principles of its operation and the conditions for successful use is given.

**Keywords:** ventilation, air conditioning, energy saving, energy efficiency, recirculation, recuperation, air heater, thermal energy.

# ЭНЕРГОСБЕРЕЖЕНИЕ В АВТОМАТИЗИРОВАННЫХ СИСТЕМАХ УПРАВЛЕНИЯ ВЕНТИЛЯЦИЕЙ И КОНДИЦИОНИРОВАНИЕМ

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**Аннотация.** В данной статье рассматриваются способы, позволяющие снизить количество потребляемой электрической энергии в автоматизированных системах управления вентиляцией и кондиционированием. Приводится описание типов используемого для данных целей оборудования, принципов его действия и условий для успешного применения.

**Ключевые слова:** вентиляция, кондиционирование, энергосбережение, энергоэффективность, рециркуляция, рекуперация, калорифер, тепловая энергия.

At the moment, automated ventilation control systems are increasingly used in the construction of new and modernization of old buildings. This is due to

several reasons. The first, and most obvious, of them is that people have begun to think more about the quality of indoor climate parameters.

The second reason is the high degree of reliability of such systems.

The third, last, but no less important reason, follows from the first two – the energy efficiency of ventilation systems.

Artificial ventilation systems consist of a variety of components powered by electricity, and are designed to process and carry large volumes of air. Accordingly, without certain solutions, a significant amount of energy will be spent on the operation of such installations.

In 2009, the Federal Law "On Energy Conservation and Energy Efficiency Improvement and on Amendments to Certain Legislative Acts of the Russian Federation" (Federal Law No. 261 of November 23, 2009) was adopted. After its introduction, the question arose about how exactly to reduce energy consumption in buildings.

The simplest solution to this problem is the usual energy savings. With respect to ventilation and air conditioning systems, energy saving can be achieved by reducing the operating time of ventilation units.

However, there may be a problem of air quality (and microclimate in general) in the premises, which must comply with standards and requirements.

Automation of ventilation systems can be a solution. In an automated system, using the program, it is possible to provide operating modes of the system for different times of day and time of year. For example, it makes no sense to supply office premises at night with the same volumes of air as during the day. Or you should not heat the supply air in hot summer, unlike in winter.

Despite the apparent simplicity and logic of this solution, it has some drawbacks. When the electric motor of the ventilation unit is switched off, the coolant consumption does not decrease, which leads to underutilization of the heat energy returned to the heat source.

For quite a long time, in some enterprises, in order to eliminate this precedent, devices have been used to automatically reduce the flow of coolant when the electric motor of the ventilation unit is stopped. An automatic valve with a motor drive is installed on the supply pipeline of the heating system of the heaters. A throttle device is installed parallel to the valve on the pipeline, through which the minimum flow rate of the coolant passes, eliminating the defrosting of the heaters. The automatic valve is powered through the free contact of the magnetic starter by means of an intermediate relay. The scheme works as follows. When the electric motor of the ventilation unit is stopped, the contact of the magnetic starter closes the power circuit of the intermediate relay coil, the contact of which closes the power circuit of the automatic valve motor. The engine is

switched off in the extreme position by the limit switch and operates until the automatic valve is completely closed. The pipeline of the heating system of the heaters turns out to be closed [1].

There are several other ways to reduce energy consumption in ventilation and air conditioning systems. One of them is recovery.

Air recovery is the process of returning part of the thermal energy due to the effect of heat exchange [2].

There are several types of recovery equipment. The most commonly used are the following:

- An organized system of channels with walls made of aluminum plates (Fig. 1). The efficiency of temperature transfer to the supply masses is ensured due to the thermal conductivity of aluminum. There is a special coating on its surface that optimizes performance characteristics.

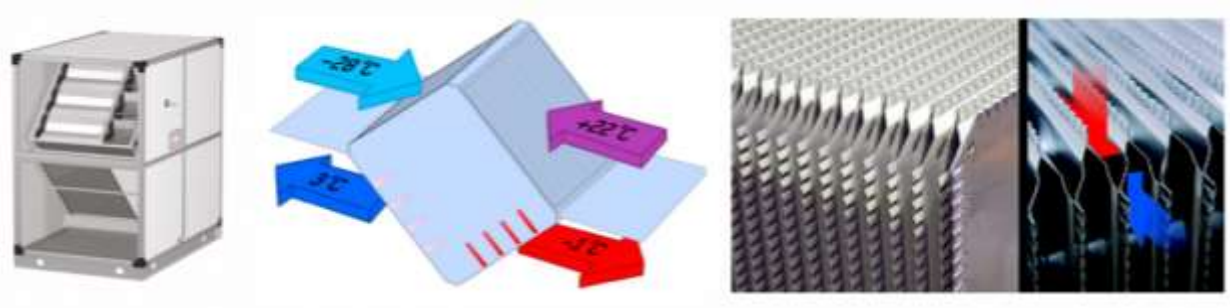

Figure 1. Appearance and principle of operation of the plate heat exchanger

- Systems, the main element of which is a rotor (Fig. 2) with adjustable speed [3].

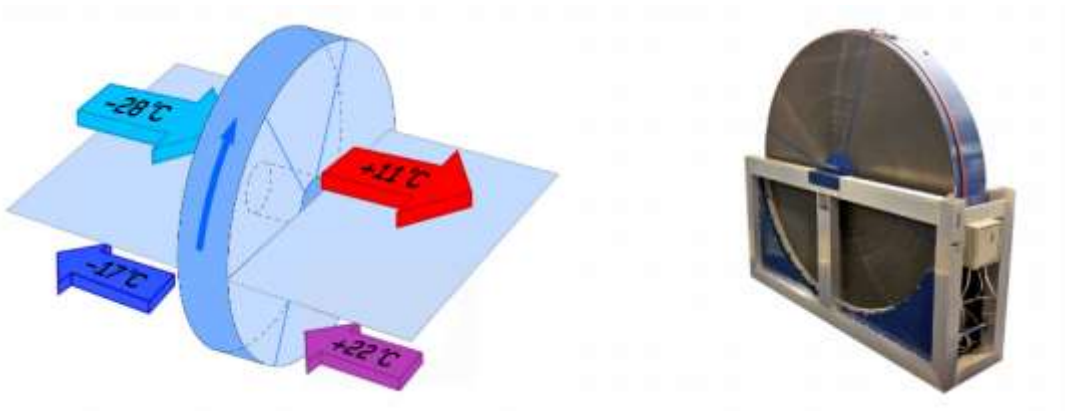

Figure 2. Appearance and operating principle of the rotary heat exchanger

- Systems with liquid (most often ethylene glycol-based) heat carriers located in exhaust and/or supply channels (Fig. 3).

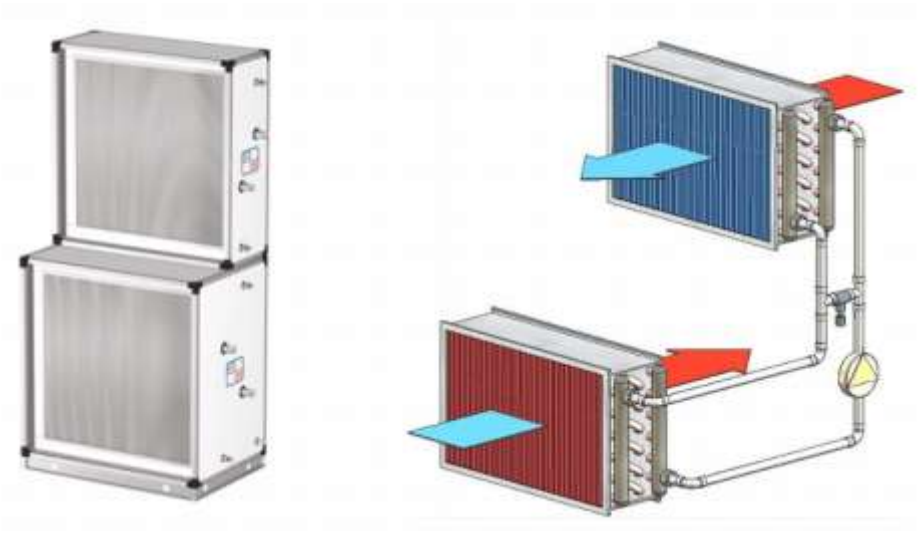

Figure 3. Appearance and principle of operation of a heat exchanger with a liquid coolant

- Heat pipes (Fig. 4) – transmission occurs when the aggregate state of the carrier changes [3].

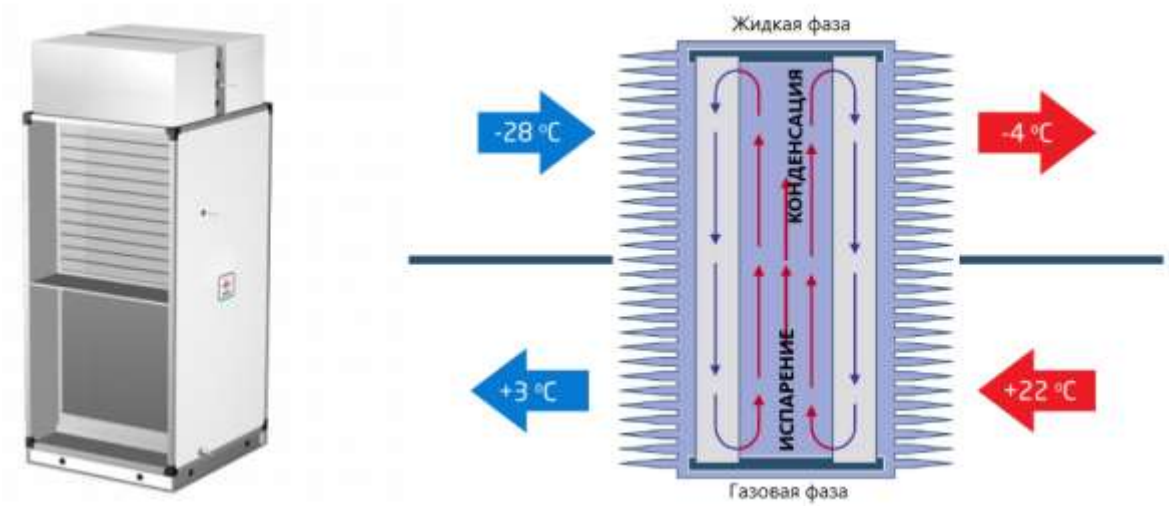


Figure 4. Appearance and principle of operation of the heat exchanger with heat pipes

In addition to the use of recuperators, in order to reduce the cost of heating the supply air, recirculation methods are used.

Air recirculation implies the reuse of indoor air with the addition of fresh air from the street and the supply of this mixture to the same or other premises.

Energy efficiency when using recirculation is achieved due to the fact that when mixing already heated (or cooled, depending on the time of year) air from the room with outdoor air, the temperature of the mixture is obtained closer to the required one and requires less temperature preparation.

However, it should be borne in mind that the ventilation system cleans the air masses from dust and dirt, but not from respiratory or industrial products, bacteria and microbes. This condition should be taken into account when choosing filters and systems.

There are a number of conditions that must be observed when using recycling:

- the mixture of the generated air must contain at least 10 % of the supply air of permissible purity;
- the newly entering air masses should contain no more than 30 % of the maximum permissible concentrations of harmful impurities.

In addition, there are requirements listed in [4] that do not allow the use of air recirculation.

To enhance the efficiency of energy saving using these methods, it may be useful:

- create vestibules, i.e. transition chambers on doors;
- improve the thermal insulation of premises;
- maintain tightness of ventilation ducts;
- perform timely cleaning/replacement of air filters in order to reduce hydraulic resistance.

These methods are the most typical for automated ventilation systems. However, there are common ways to reduce electricity consumption for any automation systems. These are, for example, the use of frequency converters, the use of new modern automation equipment (the efficiency of new equipment is higher), ensuring timely and high-quality maintenance of electrical equipment, etc.

Thus, with the correct calculations and combination of these methods, it is possible to achieve significant savings in electricity consumption and, as a result, money savings during the operation of ventilation systems.

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# ТЕОРИЯ И ПРАКТИКА СОВРЕМЕННОЙ НАУКИ: ВЗГЛЯД МОЛОДЕЖИ

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Часть I

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