

Modern Tendencies in the Development of the Energy Industry

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Abstract. The article deals with renewable energy sources covering a number of different types of primary energy (solar energy, wind energy, biomass, water flows, geothermal heat, waste), the largest development rates in the world are currently achieved by China, India and the USA

Key words: energy industry, green energy, electricity, hydropower, wind, biomass, solar energy

Introduction

September 2015, the UN member states identified 17 priority political goals, including the fight against poverty, the protection of the planet, ensuring prosperity and sustainability development[1], According to the UN definition, the development work of the current generation should not conflict with the interests of future generations.

Each of these goals includes a number of indicators and is set to be achieved in 15 years, ie by 2030. Good luck to achieve stable The efforts of countries, the private sector, civil society and the population in need of developed work must be organized in a united and balanced manner.

One of the adopted goals is Goal 7, which is directly related to energy, “ Cheap, reliable, sustainable and modern for all energy supply ”. But almost all other purposes either or with a 7th goal achievement level directly related or is associated with multiple lab aspects. Here : eradicating poverty and hunger (1 and 2 goals), health and abundance (goal 3), clean water and sanitation (goal 6), decent work and economic growth (goal 8), industrialization, innova ts yalar, infrastructure (Target 9), sustainable cities and settlements (Target 11), responsible yacht consumption and production (Goal 12), the conservation of marine and terrestrial ecosystems (Goals 14 and 15) and, of course, the fight against climate change (Goal 13).

Material and Methods

The article uses elements of analysis, analysis and synthesis of expert opinions, aspects of the comparative approach.

Results

According to Shun According to the International Energy Ethics Agency, energy ethics as the engine of the global economy is at the center of the agenda and is set for sustainable development until 2030.

At the same time, “ A cheap value e, reliable, sustainable and modern for all The huge potential of renewable energy sources must be taken into account in energy supply. Interest in renewable energy sources is growing in the world. They are not only of environmental and energy importance, but also of global geopolitical importance. world e nerg contributes greatly to the ethical balance [2].

The unique practicality and features of renewable energy sources are their infinite resources is constantly replenished and significantly humanity 's expected needs will exceed i. In addition, Renewable energy sources in the heat balance of the earth almost do not pollute the environment. Renewable energy sources across countries and regions, as opposed to oil, gas, coal, and uranium evenly distributed. Therefore, their development can be considered as a factor of energy and geopolitical security. Even developed countries have these goals reduction of greenhouse gas emissions, active promotion of the use of renewable energy sources, energy through subsidies and legislation it is required to ensure the priority of required regulatory documents.

However, renewable energy sources include several types. A basic types of energy (solar, wind, biomass, water currents, geothermal heat, waste energy), the highest indicators solar energy and wind energy are currently being developed in the world according to the level of development. It should be noted that As

can be seen from the description, Because the exact performance of “ renewable ” sources cannot be considered stable by nature they are unstable and moved at a certain interval.

But use e ng backup power supplies at high load levels or energy storage complexes are required. However, traditional forms of energy have begun to be replaced by new renewable energy in a number of countries in the near future, however, conventional sources still play an important role in the global energy balance, making energy sustainable. participates in ensuring the development.

Renewable energy sources reserves and energy resources. There is a naturally filled ib First of all, the earth's surface is a dream come true formed by solar radiation ts iyasi. This is, in fact, solar energy and its derivatives - wind, biomass, water flow energy, as well as the Earth's geothermal heat from the inside and energy from various wastes.

In addition to reducing prices the share of renewable energy sources (excluding hydropower) in global electricity generation fast in recent years to go back : 2003 - 2%, 2012 - 5.2%, 2015 - 7.3%, 2020 - 11.2%.

to renewable energy in the coming years reported the possibility. The Paris Agreement was an important stimulus for the development of renewable energy sources. Its ultimate goal is to raise the temperature to 2°C and prevent greenhouse gas emissions by the end of the 21st century. In this regard The proposed radical changes in the structure of world energy include : gradual abandonment of coal, gas and carbon-free sources (RES, HES, AES). From 2050, the widespread use of non- carbon sources may begin. In this case, renewable energy sources have a special role to play can be separated. In Europe by 2030 Renewable energy sources are expected to be the main source of energy [3].

Is struggling to become dependent on energy imports or reduce greenhouse gas emissions The goal is to prioritize the development of renewable energy sources in countries with active participation. In 2017, this indicator is based on wind, solar and biofuels in the European Union Electricity generation is 2 1 % of all electricity generated by coal, the amount of electricity is from 20.5 %, as well as obtained when using natural gas Increased from 19 % and 1 1 % from hydropower. In the European Union The UK and Germany have contributed and continue to contribute to the growth of the share of renewable energy in the energy balance. Together, they have accounted for more than half of the renewable energy growth in the EU over the past three years.

Spain has also paid close attention to the development of renewable energy sources. According to him, the share of renewable energy by 2030, according to the Energy and Climate Change Plan submitted to the European Commission in early 2020. Should reach 74%. That's all solar and wind power grow to 97 GWh, and Spain's installed power systems account for about 60% of the power[5].

As a model for developed and developing small countries can be shown. There, “ green ” energy is 98% of the country ’s electricity (56% - hydropower, 33% - wind, Provides 6% biomass and 3% solar) [6].

In 2018, the capacity of all solar and wind power plants in the world exceeded 1,000 GW [7]. It took the global green energy producers almost 40 years to achieve this. 1000 GWt or 1 tr l n. Vt almost equal to the entire energy-producing infrastructure of the United States. According to our research, 2 trillion.W will be enough for 5 years to launch renewable energy, and it will cost investors twice as much.

At the same time, the capacity of renewable energy sources in the world, installed at the beginning of 20 20 years of hydropower, reached 2351 GW and Compared to 2019, it increased by 7.9%. Renewable energy capacity is now about one-third of the total energy [8]. Half of the renewable energy capacity of hydropower is about 1,200 GWh. Installed _ wind power is 56 0 GW and solar power is 480 GW. At the same time, the development of solar and wind energy is the fastest growing sector, due to large investments is being done by many lip countries.

“Green” energy ethics China is a leading country investing in development. In the period from 2016 to 2020, the country will have 34 0 billion. investments in excess of e vro focused on wind and solar energy development. China is a world leader in the production and development of solar thermal energy.

World 's second largest investor in renewable energy. That is about 35 billion annually. e vro will be encouraged to develop “environmentally friendly ” energy projects. U.S. global is a leader in biofuel production. 3rd place 12 m l rd. The euro costs Japan with investments. 4th place is occupied by India, where the amount of investment 9 to 11 billion kWh per year in alternative energy generation. oscillates in the range of e vro. In 5th place is Germany in terms of investment in renewable energy with an annual rate

of 8.9 billion euros. As a result of active development of renewable energy sources and resources the cost of electricity generated is steadily declining.

By mid-2018, renewable electricity is equal to the price of traditional sources without subsidies. According to the results of 2019, there was a decrease in the cost of pure energy for all types on a global scale and the process of decreasing this value continue [10].

In recent years, entrilan solar energy by 26%, biofuels - by 14%, solar and wind energy - by 13%, hydropower - by 12% became cheaper. Electricity prices from geothermal sources fell by 1%.

Today is already solar and coastal dai wind energy any type of fossil The fuel capacity is relatively cheap. For example, in India, due to the development of solar energy, Chile, Mexico, Peru, Saudi Arabia and UAE electricity tariffs reduced to \$ 0.03 per kWh. 2020 April record year b, planned tenders for the construction of solar power plants to bring the cost of solar electricity to the lowest value n i 1.35 ts ent per kW / h Held in Abu Dhabi. At the same time, in September 2020, electricity will be generated at QES 1.1 ts ent projects for a new record kW / h on cost reduction Signed in Portugal.

However, it should be noted that in this case it is possible to see the obvious signs of d e mping. In our opinion q The long- term decline in the price of renewable energy facilities and sources will increase the attractiveness and allow the introduction of energy sources in this area in more areas due to lower prices.

China is the world 's largest producer of renewable energy and India is leading. However, in China By the end of 2019 q The capacity of power plants based on renewable energy sources has reached 750 GW. Wind power plants in terms of installed power - 193 GWt, solar power plants - 186 GW and hydropower - 354 GW.

In India Q The capacity of renewable energy sources will increase to 175 GWh by 2022, including 100 GWh of solar energy and 60 GWh at the expense of wind farms [13].

The total capacity of renewable energy sources, including hydropower, is 225 GWh. It should be noted that for comparison, this figure is equal to the total capacity of all power plants in Russia. By 2030, India plans to increase the total capacity of renewable energy sources to 500 GW. Growth and development are mainly driven by solar energy and to a lesser extent, wind energy plays a major role, and hydropower sources play an important role in this process will not play. If India is able to implement such large - scale plans, it will most likely become the second largest green energy policy in the world after China.

At the end of the decade In solar energy ethics, capacities are set higher than capacities based on primary energy sources. These are the conclusions Bloomberg in the NEF report and in the United Nations Environment Program (UNEP) cited in [14].

end of 2009 the total capacity of solar power plants If it was 25 GW, in the last 10 years in the world About 6 40 GW of photovoltaic power plants were built.

Over the past decade, a total of \$ 1.3 trillion has been invested in the development of solar energy ethics, which is almost half of the investment in the development of renewable energy sources.

However, the cost of solar technology 2009-20 for 21 years by 81% from \$ 304 to \$ 57 per MWh reduced strain was achieved. China is a leader among investors in the production and development of renewable energy sources. invest to expand the line. The next places are occupied by the United States 3 60 mlr d dollar and Japan 20 0 billion. attracted more than \$ 1 billion in investment. In the European region, financing the construction of solar power plants is estimated at 700 billion euros. dollars. Germany and the United Kingdom E is the leader in Europe in terms of total volume are investors. In this case, Germany 1 80 billion. dollars and the UK 12 0 billion. dollars in investment in this area. According to HIS Markit, 123 GWh of solar energy will be commissioned in 2019. In 2018-2021, the construction of panels of solar power plants with a capacity of 460 GW in the world will be completed.

The average annual growth rate of solar energy capacity i At 25%, the installed capacity of solar energy ethics could reach 1,000 GWh by the end of 2022. By the middle of the 21st century, solar energy could become the world 's main source of electricity. About this “Autovoltaic Europe technology and innovation platform ” [16] and the United Nations 24 climate negotiations [17].

Solar power plants for about 30 years and roof panels can occupy about 70 % of the energy ethics market.

Despite the fact that different solar energy is converted into other types of useful energy The most advanced and effective of the available methods was the process of photoelectric transformation ts iya. In

this case, the production of solar panels prices fall and the efficiency of the efficiency ratio is transformed. Q also at solar power plants thermodynamic cycle m exists. In this case, the concentration of solar radiation to heat the heat carrier and so on thermal energy processing usually at these capacities, the conversion to electric energy, such as, can also be used in the process of direct heating.

In recent years, many projects are being implemented around the world to build and operate solar power plants.

In 2018, it was commissioned in southern India the largest solar power plant in the world Pavagadasolarpark has a capacity of 2 GW. Built-in power divided into eight sections, each of which is divided into 250 MW. The volume of attracted investments 2.5 billion estimated at \$ [18]. In terms of capacity, this QES has a installed capacity of two bar more than the “KurnoolUltraMegaSolarPark”, which was launched in India a year ago.

NoorAbuDhabi, one of the largest solar power plants in 2019 With a capacity of 1.18 GW, 3.2 million panels are located in one area and consist of a single system [19]. SES “Emirate Water and Electrification” The project also includes a project of a new solar power plant with a capacity of 2 GW.

In order not to lose the lead in the field of solar energy, China has a new capacity of 3450 MW announced the construction of a solar power plant, in which a total of more than 40 Chinese companies participated. Gonghe is the largest solar power plant in the world It occupies an area of 298 km². The solar park structure includes a large Longyangxia power station. It consists of 4 million panels with a total capacity of 850 MW.

Spain is a leader in the construction and investment of HESs in Europe, led by Endosa and Iberbola. For example, the project of renewable energy stations A large production complex with a capacity of 1,725 MW is being built in the eastern province of Teruel, Spain, which is the largest solar power plant in Europe in terms of capacity of 1,585 MW [21].

At the same time, photovoltaic solar power plants are being built in some countries, but the share of solar energy in the structure of power plants operating in the mining industry will be less. In 2018, i kkit solar thermal power plant was launched in China: in terms of capacity in Delingha 50 MW and in Dunhuang Was equal to 100 MW. Stations collect and store heat equipped with system i. The thermal energy stored in the absence of solar radiation helped to generate electricity, ensuring the stable operation of the station. China plans to build a total of 20 solar power plants in the region. They are the main regional energy can be manifested as infrastructure si.

The largest solar power plant in the tower The type was launched in 2018 by the Spanish company Sener in the Moroccan desert. The Moroccan “NoorOuarzazate III” solar power plant has a capacity of 150 MW and an energy storage capacity of 7.5 hours. It has accumulated over time thermal energy allows you to meet energy needs for up to 5 hours a day during the most commonly used hours. Formerly a thermodynamic solar power plant in the form of a tower The capacity is 110 MW per cycle, and the capacity is the energy in the e rigan salt containers built for storage and power generation only in Nevada, USA. Morocco was enough had set great goals for itself. According to him, in 2020, 42% of electricity generated in the country Renewable energy sources have to be accounted for [22].

Traditional solar power plants focus on e nergy If it started 20 years ago, in our opinion, probably floating attitudes towards solar power plants could be formed on a large scale over the next 20 years [23]. On floating platforms By adjusting the solar panels, the growth of algae can be prevented from increasing during evaporation in hot climates.

Also, floating sun the battery is cheaper than onshore solar power plants, the main reason being the cost of land. Floating Another advantage of solar power plants is that the system does not need to be planned and installed on land plots. Typically, solar panels are inclined are placed on a floating platform and they are attached to the bottom of the designated area.

Most systems transmit electricity through floating inverters, but some small inverters may also be installed on land. But the main disadvantage is the use of waterproof electrical equipment is a need. Floating solar power plants do not need to be located on the seas or oceans. Research conducted by the World Bank shows that _ If 1% of the area of artificial reservoirs is used, floating solar power plants will be able to deliver global capacity up to 4 00 GWh.

S floating solar power stations in a number of states Japan is one of the first has focused on the active development of these technologies. The first floating solar power plant project was implemented in 2013 at the Okega Reservoir, which was designed to collect rainwater. In this case, the capacity of more than 45 00 solar modules installed directly on the water surface was 1.2 MW. To date, a total of 50 floating solar power plant projects have been completed and commissioned in Japan. Their total capacity is more than 65 MW. There are a number of similar projects in Europe, the largest of which is the Queen Elizabeth II floating solar power plant in the UK. its capacity is 6.43 MW. It is the largest in Europe with a capacity of 48 MW floating photovoltaic station n i It is planned to be built by the Dutch company Groenleven. Similar projects It has also been performed in Asia, South and North America. Ciel & Terre of France patented and developed this unique technology. Since 2013, the company has implemented Out of dozens of projects, the total capacity in the world reaches 100 MW.

In 2018, in cooperation with the Chinese state -owned enterprise CECEP Ciel & Terre has for the first time launched a floating solar power plant with a capacity of 70 MW. This has been done in the Anhui region before this region was one of the leaders in coal mining in China. The facility covers an area of 140 hectares. Monocrystalline solar modules It is mounted on special floating devices manufactured by Ciel & Terre. This the facility is the largest float in the world by 2018 was a solar power plant, but in 2019 a new floating solar power plant with a capacity of 150 MW was launched in China.

Another project to unite China in 2020 aqua culture [25] and photovoltaic solar energy project will be implemented. Such business model - two bars obar income, one r for Chinese entrepreneurs A fish and electricity project has been developed from the region. Its size is large, many fish bite solar power stations in the pool, power more than 300 MW. Q uyosh The panels reduce surface evaporation of water, save water resources and create a more favorable fishing environment.

Samanggeum in South Korea will be the largest in the world Construction of a 2.1 GW floating solar power plant has begun at the dam.

This will require 30 km² of water. The Korean government emphasizes that this is a floating solar power plant and its capacity will be greater than all floating solar devices in the world. About \$ 4 billion has been allocated for the project. About \$ 1 billion is being invested and to start the power station about 5 million photo power modules are required. Construction the project began in the second half of 2020. According to him, it is necessary to assess the impact on the environment, including the process of obtaining appropriate licenses and permits. Construction of the station is expected in two stages. The commissioning of the first floating solar power plant with a capacity of 1, 2 GW is scheduled for the end of 2022, the second - It will take place in 2025. As a result, q is in the construction phase new 1.6 million by the government. It is planned to create new jobs.

In the 1970s, ways to place solar power stations outside Earth's orbit and transmit received electricity began to be discussed. However, despite active research in a number of countries, it is only close in a decade certain lines of technological progress began to appear. Chinese scientists are developing an orbital power plant that will convert solar energy directly into electricity in space and transmits it to the Earth via a laser [27].

Laser light-receiving experimental base has begun in Chongqing. The launch of the first experimental power plant in space is scheduled for next 2021 and 2025 planned for years. Loyiha ni The country is overseen by the Academy of Space Technology, which in early 2019 successfully landed the "Chane - 4" spacecraft on the moon and plans to launch its own space station by 2022. Expenditures on China's space program to reach \$ 8 billion in 2019 dollars. The U.S. has spent more to study osmosis. Roscosmos ' budget is about \$ 1.3 billion. was equal to \$. According to the data, this device is parallel to the ground and has a speed of 35 thousand km. should be placed in a distant geostationary orbit. Unlike solar panels on Earth, space station energy, weather, change of seasons or produces throughout the day regardless of the time of day and is about six times more efficient.

However, the electricity collected from the orbit the problem of how to deliver to the ground has not yet been resolved. Theoretically laser light or microwave light can rotate and transmit to the ground, but it is strong coming day and night it will be necessary to study how radiation affects the atmosphere and ecology.

Various proposals and solutions for the collection of solar energy and their wireless transmission, which have become of particular importance. 2008 space solar power plant identified as promising research

programs in the country. In 2020, three articles on wireless transmission of energy appeared. The Japanese in April Mitsubishi Heavy Industry has reported that it has successfully wirelessly transmitted 10 kW of power for a distance of about 500 m. In May 2020, the portal Spacenews reported that the U.S. had launched a spacecraft and launched an experimental laboratory into orbit. Its main function is to transmit energy from space to the earth through microwave light [28].

Special antenna module was included in the laboratory and tested as part of research programs. Research data and preparation launching the module into Earth orbit NRL side data started in 2010. But the results achieved and no clear indications have yet been made of the experiments.

In August 2020 By the portal i e mrod construction company in New Zealand energy was a fairly large distance that is, a few The first prototype system for wireless transmission in kilometers announced the completion. In 2020, the Russian concept, which has not yet been officially supported, emerged.

Noted this is solar aerospace power stations (SASPS) laser and microwave lines can be cited as the most perfect and efficient option for generating and distributing energy will be

Discussion

In January 2019, the rating of the eleven largest solar module suppliers in 2018 by the consulting company PV InfoLink published [30]. The first place was taken by China's Jinko Solar company with its annual global sales volumes. Exceeded 11 GWh. In total, 11 companies have produced solar modules with a total capacity of 66 GW, accounting for about 70% of the global market. Mono - products account for 60 % of the total market, ie these modules monocrystalline silicon.

10 companies of 2019 Sold 80 GW solar modules. This accounts for 65.4% of the world market. Total trade volumes worldwide were 121.4 GWh.

134.8 GWh of solar panels were sold for 2020 and on production concentration - the share of the top ten exceeded 70 %. Manufacturer Jinko Solar will produce solar panels by the end of 2022 plans to increase capacity to 45 GW

Conclusion

As mentioned above, photo electric converter in solar energy modules monocrystalline used on the basis of silicon. A joint team of scientists in 2018 and a number of European engineering enterprises have announced that they are ready for industrial-scale production of solar silicon panels with a black silicon recovery coefficient of less than 1 % and an effective efficiency of a record 22 % [31].

Maximum module efficiency 22% and in the testing process there are unexpected advantages of fixed vertical technology, high stability compared to other solar panels and environmental pollution does not affect at all.

Traditionally, standard silicon efficiency of photo elements 29.1% should not exceed. By combining the three elements, the researchers can generate energy by sunlight in the blue-green part of the spectrum, which increases the bar by two bars. This theoretically allows to increase the maximum efficiency from 29.1 % to 35% [32].

In Berlin Scientists and experts from the Center for Energy Materials named after Gelmolts [33] and experts say that the method of attaching tetrasene to silicon can increase the efficiency of solar cells by up to 40 %.

2017 was a successful year for perovskite substances because of the inclusion of solar converters energy as their year-round the efficiency ratio increased to 22.7%. Experts are now at this material they plan to further improve the efficiency ratio. Theoretically, the efficiency of perovskite can be increased to 33% [34].

Solar panel been, which combines perovskite and silicon, had an efficiency rating of 25.2%, a record in this regard, according to the researchers' analysis. The maximum efficiency of these substances can be up to 30% [35].

A group of scientists from the University of Groningen (Netherlands) Unexpected The result was obtained, the result shows that perovskite changes in the chemical composition of the modules excess heat energy slows down. Theoretically this allows to increase the efficiency of the efficiency ratio to 66% [36].

The efficiency of organic photovoltaic panels is 15%, and this figure was recorded in 2018 by researchers from the University of Michigan (USA) [37].

One of the competitors may be this cadmium telluride. Researchers recently further improved thin film solar panels added cadmium telluride elements and the efficiency increased to 22%. For example, in November 2018 Researchers at the Fraunhofer Systems Solar Energy Institute study cadmium telluride Based on the development of new technology, the efficiency of photocells increased by 41.4 % [38].

Scientists from the National Renewable Laboratory in the United States in April 2020 found efficiency in converting solar energy More than 47% of the “ six -layered connected ” sun A photo element consisting of 140 layers announced that it was achieved through semiconductor materials [39].

By the International Organization for Renewable Energy (IRENA), a total of 2050 world 78 m l n. more than a ton of photo electricity wasted panels appear. This, in turn, has become a new environmental problem.

Technological processes Glass, plastic, silicon, silver at the Veolia plant and copper is processed and converted into granules to produce new solar panels. Typical photopanel are 65-75% glass, 10-15% aluminum, 10% plastic and only 3-5% - of silicon. Until 2030 Costs of renewable materials 450 m l n. and \$ 15 billion dollars by 2050.

Thus, we are now observing that it is time for the sustainable development of renewable energy in the world this is mainly due to solar and wind energy. We Consider the main development trends in the study of the source of electricity generation We have analyzed the development and installation of solar panels in the 21st century. The development of solar energy in China is taking place at a very high rate. The application of these approaches in our country can lead to effective results.

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