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Research of solar battery use and utilization problem

The studies presented in this article relate to the energy industry and the protection of the natural environment.

Effective use for energy potential can serve as the basis for further economic development of the country, which will directly affect the welfare of citizens, which is the socio-political stability of the key to its independence, can really contribute to Ukraine's integration into the European and world community, serve to protect its national interests. That is, energy security is one of the most important components of the national security of the state.

The territory of Ukraine for a year gets a significant amount of solar energy, which exceeds the current level of its consumption by more than five hundred times. In order to satisfy the energy needs of Ukrainians, it is enough to use only 0.5% of solar energy reaching the surface of Ukraine.

One of the main advantages of using solar energy is reliability, ecological cleanliness and the possibility of long-term operation, easy installation and disassembly, safety (automatic protection against short circuits, overheating, overloads of devices, discharging of batteries), resistance to the effects of natural factors.

Solar panels do not contain moving parts, therefore, they practically do not wear out and rarely fail.

It is confirmed by long-standing practice of use of service life without deterioration of operational characteristics - 25 years or more.

The operation of solar cells does not depend on the technical problems of power suppliers.

Solar batteries do not need fuel, which makes it possible not to depend on either the prices for it or the transportation problems.

The quietness of solar panels distinguishes them from wind systems.

The energy generated by solar panels is actually free (one "but" - all this is only after the initial capital has been invested in the solar system and it has paid off).

Today in the world, in particular in Ukraine, there was a significant danger of pollution of the lithosphere, the atmosphere and the hydrosphere by household and industrial waste. In the case of studies related to the study of the problem of domestic pollution, much attention is being paid to sources of danger of industrial origin. At the same time, the role of the negative influence of waste from the production and utilization of solar cells on the ecological state of Ukraine in the formation of the level of environmental hazard is not sufficiently studied.

To date, the media have a lot of information about the usefulness and economic feasibility of using solar cells, and there is hardly any information regarding their disposal after the service life. The urgency of this work is conditioned by the need to study the influence of waste from production and utilization of solar cells on the

ecological state of Ukraine. The problems of the further development of solar energy include the need to improve existing technology and technologies, to develop new materials and to reduce the negative impact of solar cell waste disposal.

By source, the category of electronic waste (e-waste) includes used solar modules.

In 2015, the world's annual volume of electronic waste amounted to 43.8 million tons. Taking into account expert assessments during 2017-2018, this figure has increased to almost **50 million tons**. Photoelectric panels represent just a few percent of the world's electronic waste. Solar energy is a very young industry and it has not yet managed to contaminate the surface, but this industry is rapidly developing. During 2017, around 110 GW of solar power stations were commissioned in the world. The global installed capacity is rapidly increasing, so in 17 years the problem of utilization of solar panels can be extremely acute.

The prices of solar power plants are decreasing, in this connection, the cost of dismantling objects can have an increasing impact on the economy of projects, simply because their share in life cycle costs will increase. And from this point of view, a very effective approach to solar panels is important.

In 2016, the joint work of IRENA (International Agency for Renewable Energy) and IEA (International Energy Agency) "End-of-Life Management: Solar Photovoltaic Panels" was published, detailing technologies and strategies for utilizing photovoltaic modules. The report is very voluminous and can be considered as a guide to today's topic.

The report predicts that by 2030 in the world 1.7-8 million tons of photovoltaic waste will be formed depending on different scenarios (regular loss - use of modules during 30 years of service life, early loss - the early termination of the service year for various reasons, for example, replacement of obsolete equipment to a more modern one). The total amount of "solar garbage" corresponds to 5-19% of the annual amount of electronic waste. For 30 years, the amount of spent solar panels will increase - up to 60-80 million tons.

In 2008, the site "Energy Efficiency and Renewable Energy Management" (EERE) in the section "Importance of Solar Energy" included the following: "Small electrical substations have a small environmental impact, as well as solar panels. Surprisingly, but so easily making the right person electric energy, solar panels do not pollute the environment, do not produce emissions and waste that are risky for fauna and flora. IRENA believes that the annual amount of waste solar panels in 2050 (5 million tons) will correspond to approximately 10% of all electronic waste generated on land in 2014. That is, the projected amount of "solar waste" is significant, but it will still account for only a small percentage of all e-waste.

This production of energy does not require either liquid or gaseous fuels, it does not need to be transported or burned .

PV-Cycle is a pan-European system that offers solar energy management services. PV-Cycle Company serves 91 receptacles for spent solar panels in Germany. One of the founders of PVCycle Company said that the installation of solar modules and the reception of waste panels are carried out by the same companies. But, with regard to large-scale equipment, even the PV-Cycle company has no conditions for its processing.

These solar power plants that need to be disposed of are in compliance with the "Directive on Waste Electrical and Electronic Equipment".

The Resource Conservation and Recovery Act is one of the key laws for disposing of panels in the United States. It is the legal basis for the management of hazardous and safe waste. In the United States, a national program for the voluntary recycling of panels was launched, which was supported by the Association of Solar Energy (SEIA) and was aimed at making recycling more accessible to the consumer.

Waste Management and Public Cleansing Act is one of the documents on spent solar panels in Japan. A roadmap for promoting the scheme for collection, recycling and proper management of renewable energy equipment with expired service life was developed in 2015. Japan's Photovoltaic Energy Association (JPEA) in 2017 published an article on the proper handling of solar modules after the expiration of their service, but the document is of a purely advisory nature.

However, one of the countries that does not have special rules for the disposal of solar modules is China. But within the framework of the National Science and Technology Program during the last five years research and development in the field of "solar waste" management has been financed.

The Ministry of the Environment, Forests and Climate Change, in accordance with the Solid Waste Management Regulations of 2016 and the Rules of Hazardous and Other Waste, is taking care of the waste of photovoltaic power in India.

At the international level, the new leadership standard in the field of environmental sustainability for photovoltaic modules (NSF 457 - Sustainability Leadership of Photovoltaic Modules) includes criteria for managing these products at the end of their lifetime.

The power of solar power will increase steadily. According to scientists' forecasts, the power in the field of solar energy will be 4500 GW by 2050 (now this figure is 400 GW).

In the territory of the European Union, the disposal of photovoltaic modules is regulated by the Directive on waste electrical and electronic equipment.

Solar energy is completely safe for the environment and is a public and inexhaustible source of energy (taking into account the presence of toxic substances in photocells).

The risk to local flora, fauna and human health is to utilize large volumes of solar modules. The leakage of chemical reagents from utilized modules gives the possibility of contamination of local soil and surface water.

The purpose of the paper was to study the problems of waste production and disposal of solar panels.

From the source states that for the use of solar energy it is necessary to use large areas of land under the power plant (for example, for a CEC capacity of 1 GW it may be several tens of square kilometers). But this disadvantage is not so significant, for example, hydropower employs significantly larger areas of land.

On large CEC, photoelectric elements are installed at significant heights (1.7-2.6 m). It allows the use of these lands for agricultural purposes, for example, for grazing livestock. Such power plants do not work at night and do not work efficiently in the morning and evening dusk. At the same time, peak power consumption falls on the evening hours.

Due to weather changes, power plants suddenly and rapidly fluctuate. The use of efficient electric accumulators or the construction of hydroaccumulating stations, which also occupy a large area, is to overcome these shortcomings. The use of the concept of hydrogen energy can also be used for greater economic efficiency.

The solution of the problem of dependence of solar power power from time to time and weather conditions is the construction of solar balloon power stations. Another way to solve the problem is to build hybrid power plants, that is, in the afternoon electricity is produced by parabolic concentrators, and at night from natural gas.

Solar photovoltaics are expensive. With the development of new technologies, this flaw will be overcome. During 1990-2005, the price of photocells fell by an average of 4.3% annually.

Another shortcoming that will soon be solved is the inadequate efficiency of solar cells. The need for dust and other contamination of the surface of photovoltaic panels can also be considered a disadvantage, as their area can reach several square kilometers.

When heated photovoltaic cells significantly reduces their efficiency, so there may be a need to install a cooling system, usually water. It is also lowered after 30 years of exploitation, which is also a matter of concern.

Assuming that the resulting energy is environmentally friendly, the photocells themselves may contain toxic substances such as: cadmium, lead, arsenic, and gallium. The problem of utilization of modern photocells is a limited lifetime (35-55 years). Due to this, in recent years, the production of thin film photovoltaics, which contain about 1% silicon, began to be actively developed, making them cheaper in production, but have less efficiency.

One of the newest branches of industry in Ukraine, which is just gaining momentum, is the processing of photovoltaic modules. In this connection, the number of solar energy wastes will increase rapidly.

About 90% (the largest percentage of waste) is glass. Significantly smaller share is made of cables and semiconductors of precious metals that are wound on all sides with plastic .

The reserves of ore will decrease, which will entail the need to develop new depths for the extraction of rare metals.

Today, most parts of the solar module can be recycled. Such as: semiconductor materials or glass, as well as a significant amount of colored and ferrous metals.

Solar processing is a process for restoring and exploiting the materials from which they are made. During this process, it is possible to extract metals, which will then be included in the new products for the second time. The purpose of this process is to preserve raw materials.

The preservation of the environment for healthy human life is the processing of similar products.

A reactive method is proposed for the processing of solar modules. It is based on the different ability of cadmium, lead and their compounds to complex formation, the ratio of acids, alkalis and solubility.

Solar panels which have worked their term, it is necessary to shred and split different fractions first. After that, fractions containing lead and cadmium need to be dissolved in 60% of sulfuric acid.

Conclusion

The problem of solar cell production and disposal waste and its solutions are investigated. It is established that for today it is expedient for Ukraine to create specialized enterprises for the processing and utilization of solar cells.

It is established that about 70 percent of the components of the panels to be recycled are reused for re-use. In addition, the International Directives regulate compliance with the requirements of the content of hazardous elements in secondary raw materials (cadmium and selenium - not more than 1 mg per kilogram for silicon panels and not more than 10 mg - for non-silicon, lead - not more than 100 mg in dry matter).

Predictable assumptions about the development of the research object - the development of solar energy, the increase in the number of solar cells, in the absence of rational utilization - a sharp increase in pollution of the environment waste solar cells.

Studies show that the total final energy demand will grow at a moderate pace of around 1.3% per year, as opposed to today's trends, when aggregate demand is decreasing. The first consequence may be that the overall use of renewable energy sources will also grow at a slow pace, following the general demand.

Since Ukraine does not have a single system for receiving waste solar panels to the manufacturer, the development of the processing market is just beginning.

The results of this article can be used to assess the development of solar energy in Ukraine in terms of its impact on the environment. Also, research results can be used by environmental specialists in the field of environmental protection and specialists in the field of production and operation of solar cells (batteries).

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