

УДК 620-97

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SOLAR PANEL RECYCLING

Every year, science strives forward, bringing with more and more new technologies. But no one takes into account that behind the beneficial use of natural resources and obtaining fast energy there is a huge environmental problem - unrecyclable garbage that harms not only us and our health, but, according to scientists, it will be inherited by the future generations' as well. Lithium-ion batteries, accumulators, solar panels, uranium waste, etc. are already among such non-recyclable waste.

Today I want consider how to recycle solar panels, as they are widely used and have a maximum shelf life of 3-5 years. They are used everywhere – these are calculators, mini-chargers, and large panels at solar and wind stations. With the prices of solar power plant components constantly decreasing, cost of dismantling facilities can have an increasing impact on the economics of projects, simply because their share in life cycle costs will increase. Therefore, an efficient approach to the disposal of solar panels is also important from this point of view.¹ Used solar panels are classified by regulators as e-waste.

Annual global volume of e-waste in 2015 is 43.8 million metric tons, according to scientific reports. IRENA (International Renewable Energy Agency) and IEA (International Energy Agency) jointly published “End-of-Life Management: Solar Photovoltaic Panels” in 2016, which details technologies and strategies for recycling photovoltaic modules. The paper shows that in 2030, 1.7-8 million tons of photovoltaic waste will be generated. This amount of "solar trash" corresponds to 3-16% of today's annual e-waste. By 2050, the volume of solar panels that have served their time will grow to 80 million tons. Volume forecast is significant, but it represents only a small percentage of all e-waste.

Manufacturers offer recycling services for their solar modules and create specialized recycling facilities. Principle of "extended producer responsibility" (extended-producer-responsibility) is in effect, which includes the stage of handling the product at the end of its service life. First Solar company has established a program to collect and recycle CdTe solar modules (2005). Solar modules are made up of glass, aluminum, copper, and semiconductor materials that are recycled. Solid silicon panels are composed of 76% glass, 10% polymer materials, 8% aluminum, 5% silicon semiconductors, 1% copper, less than 0.1% silver, and other metals including tin and lead. In thin-film modules, the share of glass is 89% (CIGS) and 97% (CdTe).

The standard includes specific requirements for waste treatment, according to which the content of hazardous substances in the fractions of glass produced after processing should not exceed the following values: cadmium, selenium: 1 mg/kg (dry matter, silicon modules); lead: 100 mg/kg (dry matter). For costs to be negative, the value of the extracted materials and freed land must exceed the cost of decommissioning. The complete dismantling of a photovoltaic solar power plant is a simple operation, since there are no permanent structures with foundations, and a large amount of steel, copper and aluminum is used; the value of the materials outweighs the costs, making recycling preferable to landfill. The technology allows for the reuse of 90% of semiconductor materials and glass. It is possible to separate "rough" and fine processing (high-value recycling), which implies the extraction of most of the chemical elements of the photovoltaic panel. Rough processing does not ensure the recovery of environmentally hazardous (Pb, Cd, Se) and valuable (Ag, In, Te, Si) materials. Thin processing consists of three main stages: 1) pre-treatment, including removal of the metal frame and junction box, 2) delamination and removal of the laminating film, 3) extraction of glass and metals. This technology reduces electricity consumption by a third and greenhouse gas emissions by 1.2 tons.

In Ukraine, as of the end of 2020, there are no PEM recycling facilities, as well as special requirements for their disposal. However, the general requirements are specified in the national standards DSTU 8328: 2015 and DSTU 8635: 2016. Since there are few decommissioned solar modules, they are recycled by electronic or glass waste recycling companies. During recycling, the main components of the module (copper, aluminum, glass) are isolated, solar cells and plastic components of the modules are incinerated and sent to landfills for electronic equipment, which is not environmentally friendly. Therefore, the issue of FEM processing in Ukraine remains open.