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ANALYSIS OF TECHNOLOGIES FOR OBTAINING ALTERNATIVE ENERGY SOURCES AND COMPARISON OF THE MAIN CHARACTERISTICS OF THE EFFICIENCY OF PHOTOVOLTAIC CONVERTERS

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ABSTRACT
The article provides a comparative analysis of technologies for obtaining alternative energy sources and compares the main characteristics of the efficiency of photovoltaic converters. In order to study the parameters of photoelectric converters, the materials used in their manufacture are considered, and their current-voltage characteristics are compared. The operating temperature range, generated current and overall dimensions of photoelectric converters are also analyzed.

Keywords: alternative energy sources, photovoltaic converters, solar panels.

Recently, thin-film photoelectric converters - technologies of amorphous silicon, CdS/CdTe, CuInSe - have been increasingly used. The last of the listed ("CIS-technology") provides the maximum efficiency of photoelectric converters known at present - about 16% [1].
The current-voltage characteristics of all the types of photoelectric converters considered above are fundamentally the same, since they are determined by the physics of the photoelectric effect and practically do not depend on the technology [2].
A typical current-voltage characteristic of photovoltaic converters at an ambient temperature of 25^0C is shown in fig. 1.2. Some normalized current values are plotted along the y-axis, their specific values depend on the area of photoelectric converters and the light flux density. On fig. 1.2, we can note the "reference" values of the generated voltage and current, which we later also use when evaluating solar panels, since the form of dependence for solar panels, of course, is preserved:
U_{xx} - idle voltage;
U_{max} - voltage corresponding to the maximum generated power;
U_{work} - recommended operating voltage;
I_{max} - current corresponding to the maximum generated power;
$I_{s.c.}$- short circuit current.

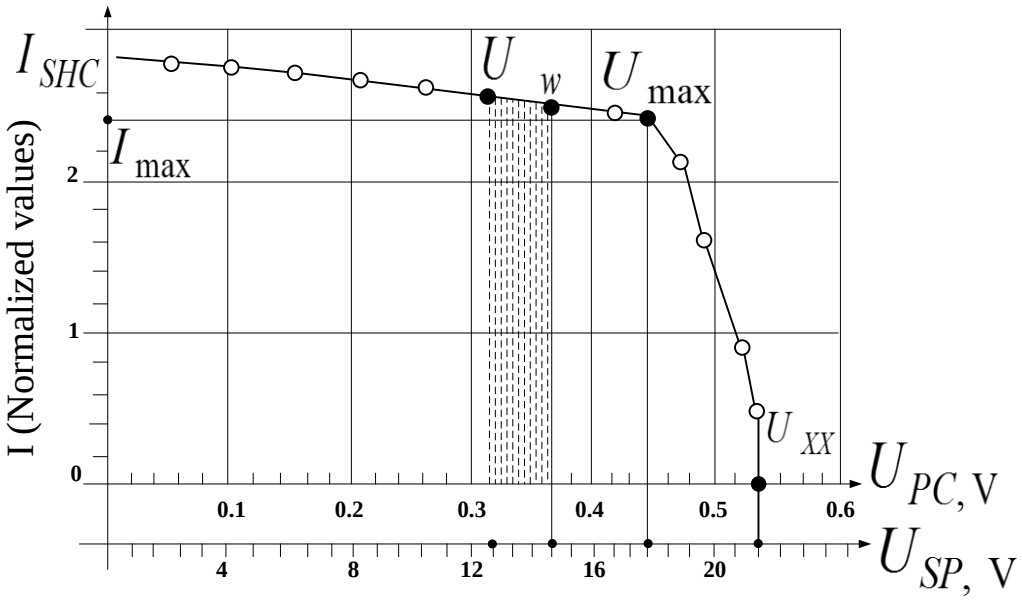

Fig. 1. Reference values of generated voltage and current

In table. 1.1 and 1.2 show the parameters of photoelectric converters manufactured by CJSC Telecom-STV.

Table 1 Pseudo-square photovoltaic converters

Dimensions, mm	85+1*85+1	103,5*103,5±0,5
Short circuit current, A	2,0…2,45	3,0…3,8
Thickness, mm	0,4±0,05	0,4±0,05
Open circuit voltage, V	0,57…0,61	0,57…0,61
Maximum power voltage, V	0,45…0,48	0,45…0,48
Maximum power current, A	1,92…2,38	2,96…3,6
Efficiency, %	13…16	13…16

Parameters measured under standard conditions 1000 W/m^2, 25^{0}C [3,4]. As an example of the layout of such photoelectric converters in Table. Table 3 shows the electrical parameters of the solar panel (called the FSM-65 photovoltaic solar module) manufactured by the same company and built on 85x85mm pseudosquare photovoltaic converters, the parameters of which are given in Table. 1 (column 1).

Table 2 Round photovoltaic converters

Diameter, mm	100±0,5
Short circuit current, A	2,3…2,8
Thickness, mm	0,4±0,05
Open circuit voltage, V	0,57…0,51
Maximum power voltage, V	0,45…0,48
Maximum power current, A	2,25…2,7
Efficiency, %	13…16

Table 3

Maximum power, W	65
Maximum power voltage, V	16,5
Maximum power current, A	3,9
Open circuit voltage, V	20,5
Short circuit current, A	4,3
Rated operating temperature of the element, ^{0}C	43
Voltage temperature coefficient, mV/^{0}C	-90

The overall dimensions of the FSM-65 panel are 1255x472x28mm, weight 7.4 kg, operating temperature range from 3^0 to $+75^0$C, the generated current is proportional to the solar flux density. The panel contains 70 photovoltaic cells laminated on tempered glass [5].

Telecom-STV CJSC produces about 30 solar panel models, which, to one degree or another, outperform solar panels produced by other Russian enterprises. These solar panels are at the level of the best foreign samples and, with equal characteristics, are cheaper by 20...30%. For comparison in table. 4 shows the parameters of PVM panels (photovoltaic modules) from Exide Electronics, USA.

In addition to the "single-layer" solar panels discussed above, a number of foreign and domestic companies produce:

- solar panels with double-sided sensitivity, which, with the same illumination of both sides of such panels, the maximum power generated by the "rear" side of the panel is from 60 to 67% of the power generated by the "front" side.

Table 4

Type	**Maksim. power**	**Voltage, V**			**Current at maximum power**	**Short circuit current, not less than**
		corresponding maximum power	**working**	**Open circuit**		**I_{sc},A**
	P_{max},W	**U_{max}**	**U_{oper}**	**U_{oc}**	**I_{max},A**	
1	**2**	**3**	**4**	**5**	**6**	**7**
PVM-10	10	17,0	12	21,0	0,61	0,82
PVM-25	25	17,0	12	21,0	1,6	2,00
PVM-30	30	17,0	12	21,0	1,8	2,00
PVM-33	33	17,0	12	21,0	1,95	2,10
PVM-35	35	17,0	12	21,0	2,10	2,30
PVM-40	40	17,0	12	21,0	2,5	2,70
PVM-45	45	17,0	12	21,0	2,8	3,10
PVM-50	50	16,5	12	20,4	3,1	3,72
PVM-55	60	16,5	12	20,4	3,68	4,02

- solar panels with increased power output, which in essence, in these panels, photovoltaic converters are located in two layers, and solar energy passing through the first layer acts on the second; efficiency such panels are 25...30% more powerful than "simple" solar panels of the same area, the specific cost per 1 W of generated power is 2.2...2.4 times higher [6,7].

In table. 5 shows the parameters of elements with double-sided sensitivity and in table. 6 - parameters of solar panels (photovoltaic solar module FSM 50/32), containing 36 such elements.

Table 5

Parameter Front	Parameter Front	Parameter Front
Maximum power, W	1,6	1,15
Maximum power voltage, V	0,5	0,5
Maximum power current, A	3,2	2,3
Open circuit voltage, V	0,605	0,605
Short circuit current, A	3,5	2,6

Table 6

Parameter Front	Parameter Front	Parameter Front
Maximum power, W	50	32
Maximum power voltage, V	17	17
Maximum power current, A	2,97	1,88
Open circuit voltage, V	21,7	21,6
Short circuit current, A	3,12	2,1

FSM 50/32 dimensions are 1020x470x35 mm, weight 7.0 kg, temperature range from -60^{0}C to +70^{0}C. The manufacturer of these photoelectric converters and solar panels (FSM 50/32) is CJSC Telecom-STV.

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