

The cogeneration PV plants



The project received approval from the Solar Impulse Foundation, Switzerland as one of the top 1,000 environmental solutions.

Solar Energy Market

World market were in operation solar plants:

2017 г. – 98,5 GW

2018 г. – 102,4 GW

2019 г. – 125 GW – average forecast of the international association SolarPower Europe, including:

- China – 35 GW,
- USA – 12 GW,
- Europe – 16 GW.

Russia market were in operation solar plants:

2017 г. – 90 MW

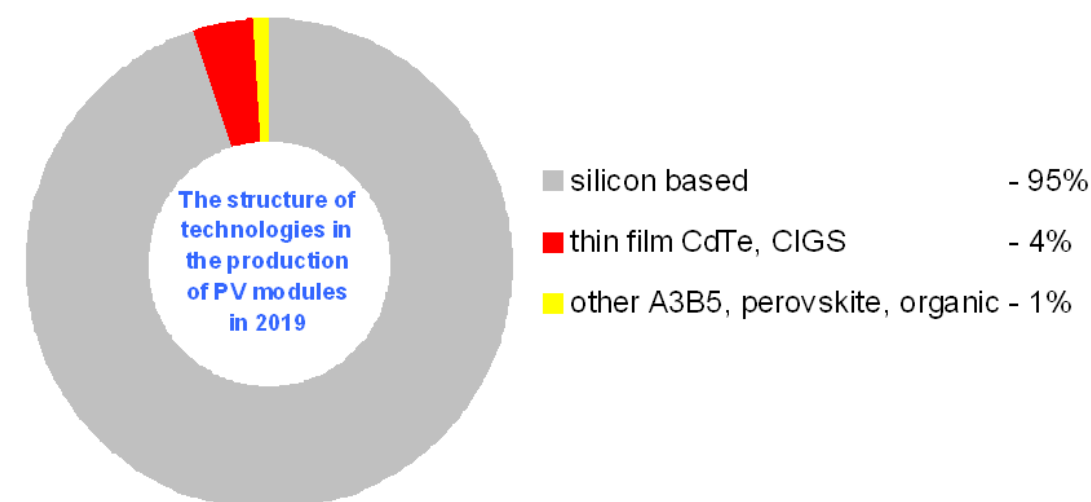
2018 г. – 300 MW

2019 г. – 420 MW (forecast for November 2019)

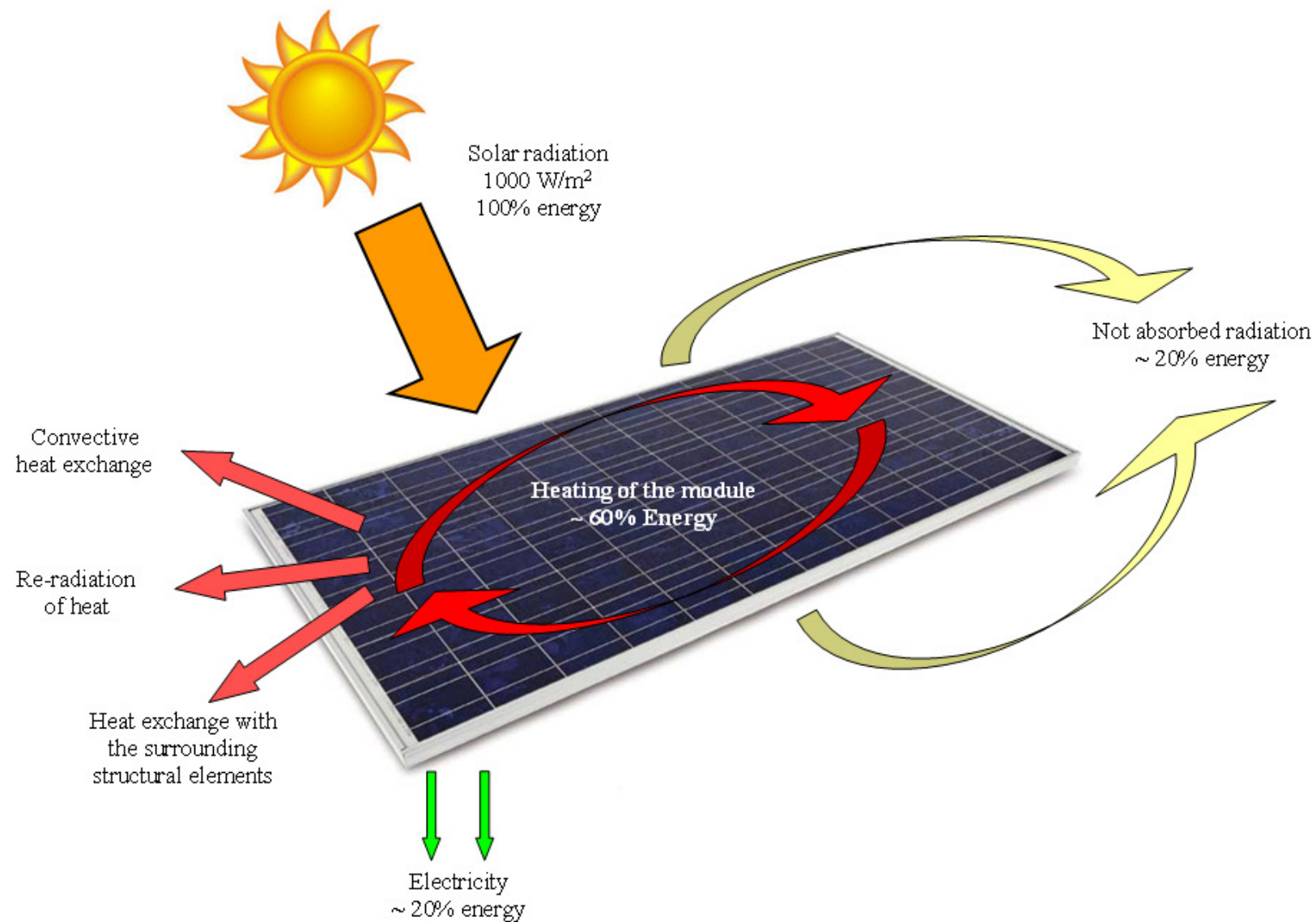
The total market capacity by 2023 is estimated at 2500 MW, including:

- grid power plants – 2000 MW;
- households, standalone objects – 500 MW.

Technologies in the production of PV modules in 2019



The power balance in the crystalline solar module



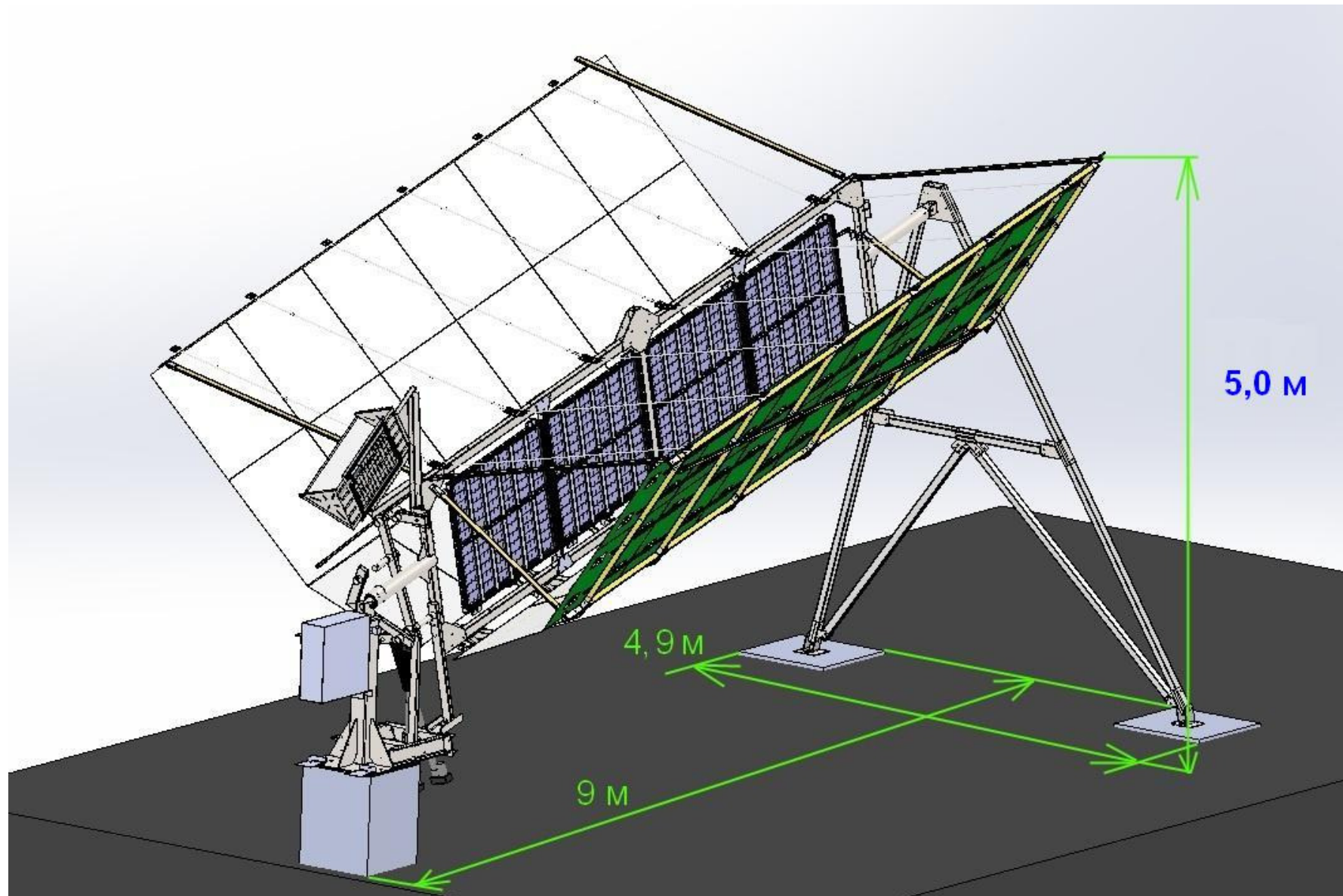
Utilization of heat generated by the PV module, can significantly improve the economic performance of the energy generated by the PV module, and best meet the market needs of individual households and other autonomous objects.

Comparative efficiency of use of the solar cells in the plants

Plant type	SEU2/5TDK, Russia	Plant of Cogenra Solar (SunPower), USA	Plant of Airlight Energy & IBM CSC, USA
PV cell type	Bifacial on crystalline silicon	Crystalline silicon	On A_3B_5 elements
PV cell size, mm x mm	52 x 156	52 x 156	10 x 10
Efficiency of the PV cell on total specific peak (electrical and thermal) power, %	70	57	80
The sun tracking system type	In polar coordinates. The increase in power due to tracking by 28%.	By one axis. The increase in power due to tracking by 20%.	By two axis. The increase in power due to tracking by 32%.

Efficiency of the PV cell in terms of total peak power of **70%** achieved in the SEU2/5TDK, is the highest in the world for a silicon solar cell. The PV cell in terms of the standard size of 156 x 156 mm in the plant produces about 14 W of electrical and 36 W of thermal power - only **50 W** from one PV cell.

Solar cogeneration plant SEU2/5TDK



The plant is set at an angle of 15° to the horizon.

Technical characteristics of SEU2/5TDK

Parameter		Value
Electrical peak power of the plant, not less than, W		2000*
Thermal peak power of the plant, not less than, W		5300
Total peak power of the plant, not less than, W		7300*
Maximum own energy consumption, no more, W		100
Output voltage DC, V		310±8
Number of bifacial PV modules in the plant, pcs.		4
Size of bifacial PV modules, mm		1200 x 1200 x 60
The temperature of the coolant at the outlet to the SEU heat exchanger is selected by the consumer from the range, °C		35 - 70
The maximum temperature of the cooling liquid from the consumer at the exchanger inlet, °C		55
Azimuth tilt angle (options), degrees		7, 15, 30
The maximum angle of tracking the sun from the vertical, not less, degrees		± 60
Ambient temperature range, °C		-40 ... +55
Maximum 3-second wind gust, not more, km/h		900
Weight of the plant without foundation supports, no more, kg		1500
Dimensions of placement at an inclination angle on an azimuth, degrees, L x W x H, m	7	8,0 x 4,9 x 4,0
	15	9,0 x 4,9 x 5,0
	30	11,0 x 4,9 x 6,4

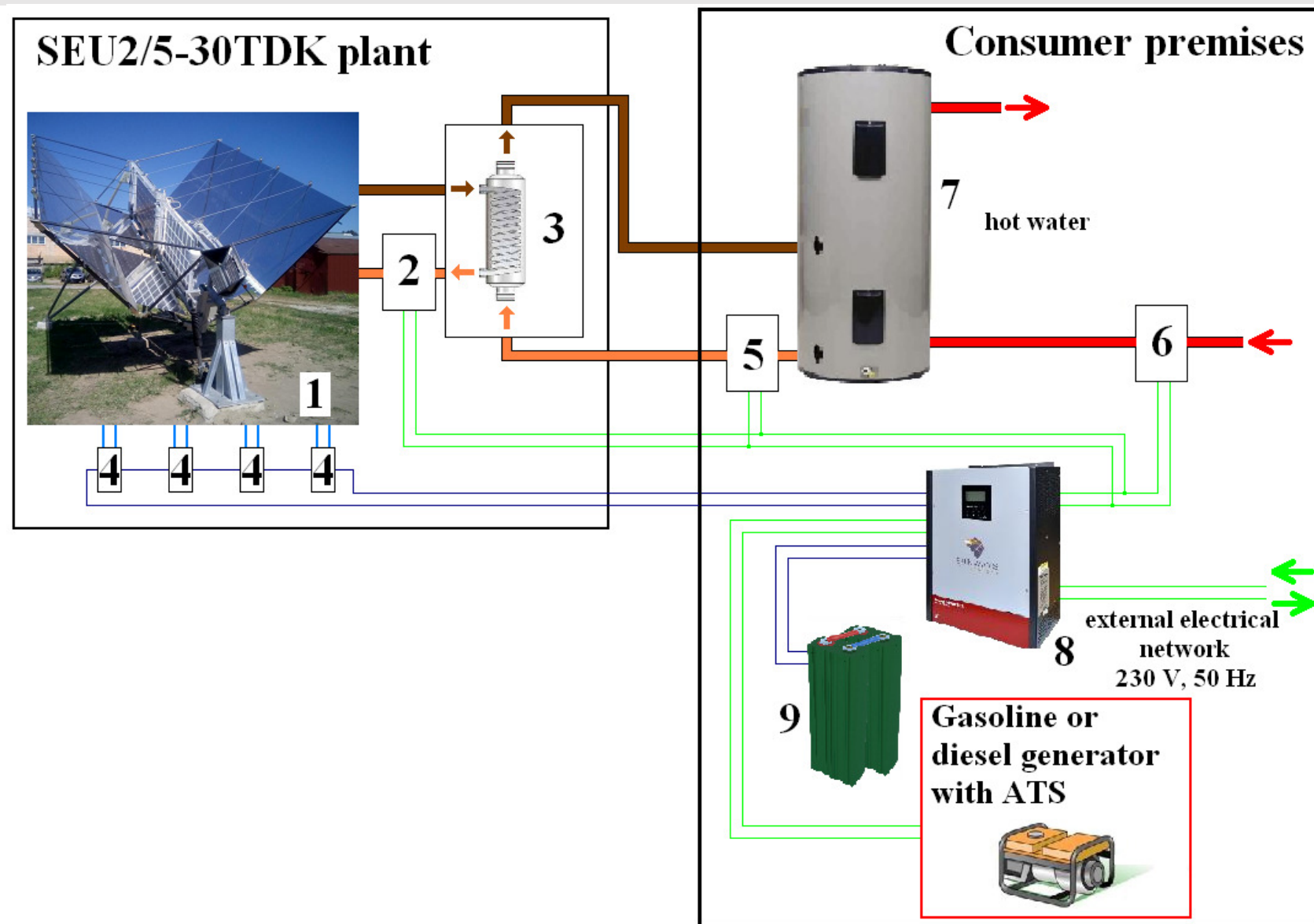
Data under the conditions:
insolation 1000 W/m²,
T=25 °C, AM=1.5

* With a solar cell
efficiency of 22.7%

All types of solar systems have a system for tracking the position of the sun in polar coordinates. This system increases the production of electrical and thermal energy by 28%, which is equivalent to an increase in the total peak power by this value.

The structure of the pilot autonomous hybrid photovoltaic-thermal station SETS2/5

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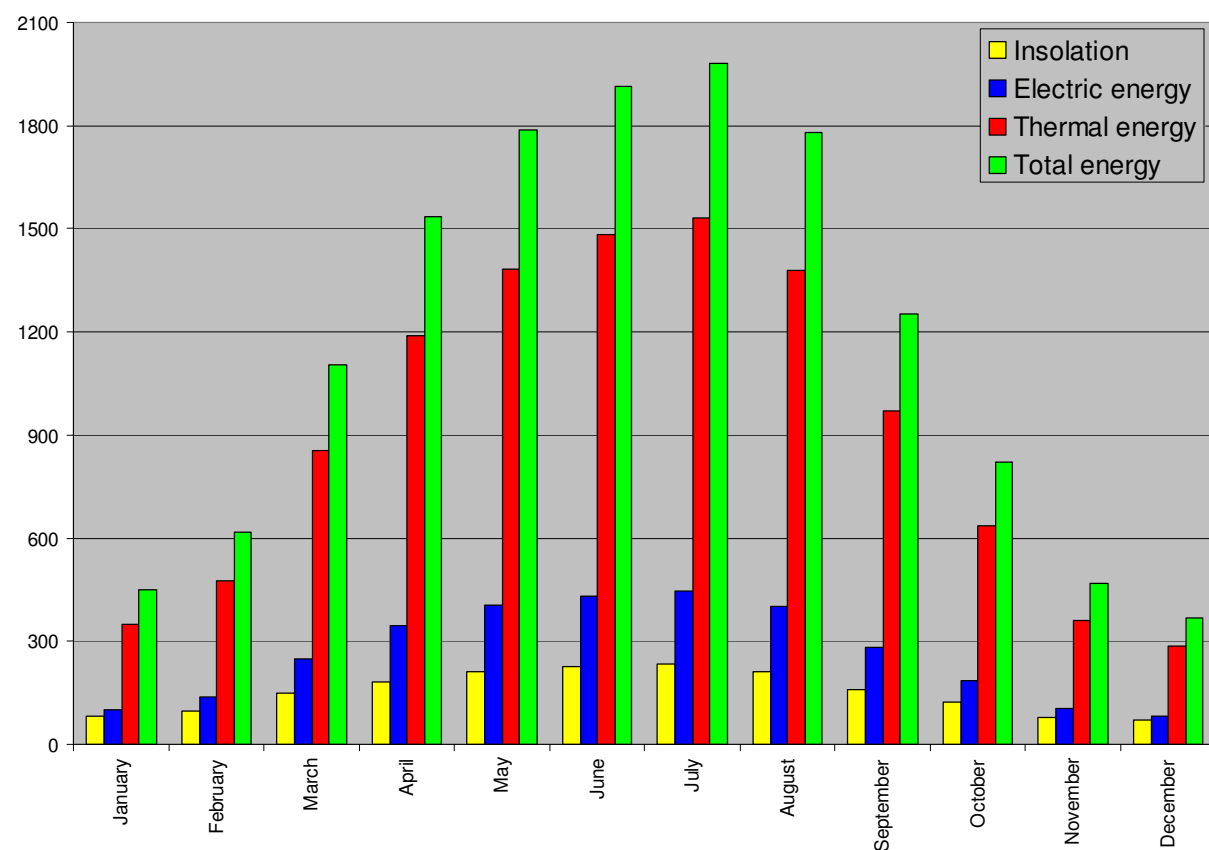


Key Specifications SETS2/5

Maximum electric power, kW		5,0
Peak electric power, 5 sec, kW		10,0
Estimated energy savings in the Ryazan region for the year, kWh	electric	1850,0
	thermal	6260,0
Output voltage, V		230± 10%
Frequency of output voltage, Hz		50± 1%
Waveform		pure sine
Accumulated energy of storage batteries, kWh		18,4
Battery voltage, V		48
Battery discharge depth not less than, %		80
The volume of the hot water storage tank, l		300
Type of tank heating, number of heat exchangers, pcs:		indirect heating 1
Tank material		heat insulated stainless steel
Daily tank energy losses, no more than kW		0,4
Range of working temperatures, °C	SEU2/5-30TDK	-40 ...+ 55
	other devices	0 ...+ 45
Service life, years		10

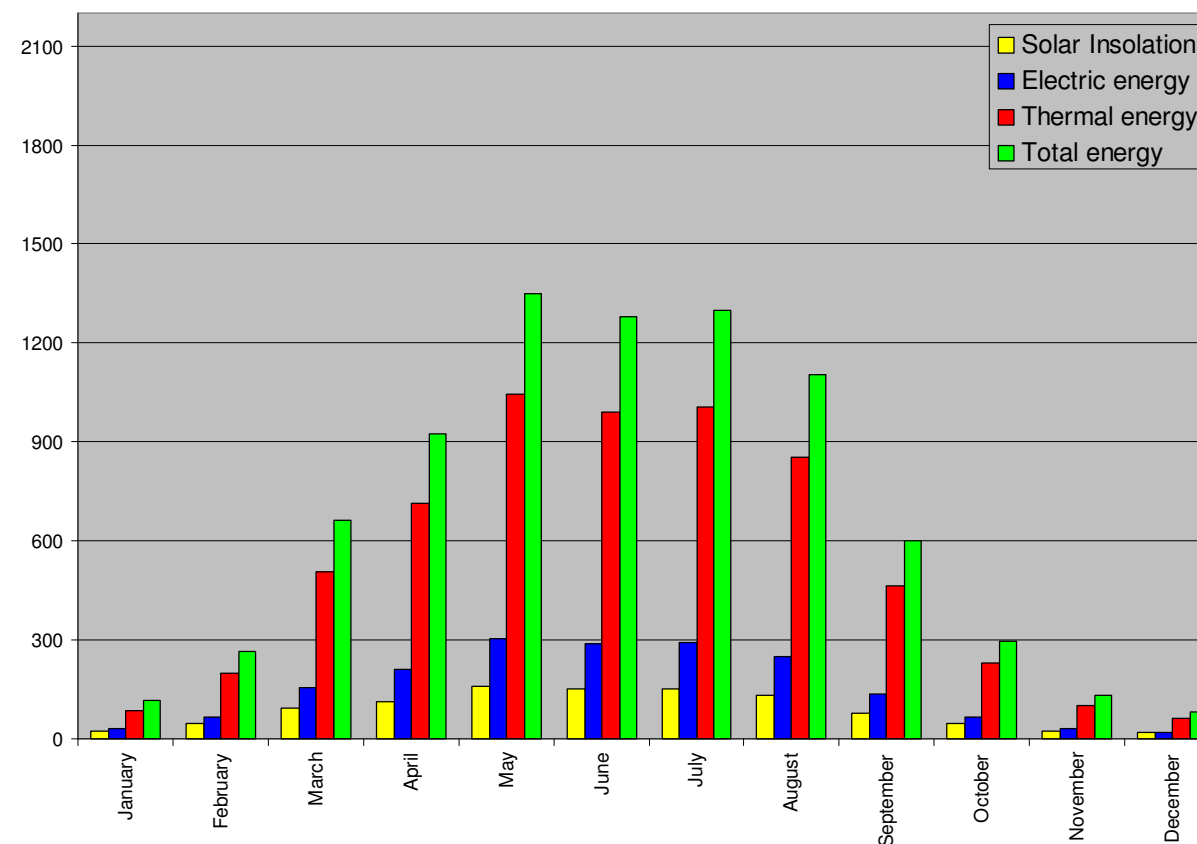
Calculated energy production by SEU2/5TDK

Algiers, 36° 46' N



The annual electricity energy output 230 V, 50 Hz – 3178 kW x h
The annual thermal energy output – 10897 kW x h
The total annual output of – 14075 kW x h
Plant is installed at an angle of 15°

Ryazan, 54° 37' N



The annual electricity energy output 230 V, 50 Hz – 1850 kW x h
The annual thermal energy output – 6260 kW x h
The total annual output of – 8110 kW x h
Plant is installed at an angle of 30°

Intellectual property

- Russian Federation patent № 2406043 dated March 12, 2009 «Solar power installation with the concentrator of solar energy from the flat reflecting wafers»
- Russian Federation patent № 2583317 dated January 29, 2015 «Combined concentrator PV plant»
- Russian Federation patent № 2426954 dated May 17, 2010 «The PV module with the system of flat mirror concentrators for controlling of PV stations position»
- USA patent 10,148,224 dated December 4, 2018 «COMBINED CONCENTRATOR PHOTOVOLTAIC INSTALLATION»
- The Republic of Korea patent 10-2026003 dated August 20, 2019 «조합형 집광기 광전지 설비»
- International application PCT/RU2016/000072 dated February 15, 2016 «COMBINED CONCENTRATOR PHOTOVOLTAIC INSTALLATION». The application transferred to the national phase in the countries of the European Patent Office



Application of the plant

Solar cogeneration power plants SEU2/5TDK simultaneously generate electrical and thermal energy. Energy generated can be used to provide hot water and electricity to:

- a standalone objects in areas with limited infrastructure;
- a greenhouses and enterprises for processing agricultural products;
- a enterprises for breeding valuable fish species;
- a desalination plants with mechanical vapor compression.

The plants can work in groups of two to four units.

Operating costs consist periodic cleaning of the solar modules and concentrator mirrors from dust and replacement of coolant (aqueous solution of propylene glycol) approx once in 4-5 years.

Unit cost of units (€/W) in terms of total peak power in mass production is significantly lower than conventional solar plants.

Comparative calculation of economic efficiency of hybrid photovoltaic-thermal stations

Type of the photovoltaic-thermal stations	SEU2/5TDK	Based on PV modules	Based on PV modules and solar collectors
The generated power of each PVTs, W: - 9360 total, including: - 2560 electric; - 6800 thermal.	SEU2/5TDK – 1 pcs / €8,000	PV modules 320 W – 37 pcs / €6,160	PV modules 320 W – 9 pcs / €1,500
			Solar Vacuum Collector, 20 tubes – 9 pcs / €9,200
	Hot water storage tank 500 l with heat exchanger – 1 pcs / €1,500	Hot water storage tank 500 l with Electric Heater 9kW – 1 pcs / €2,600	Hot water storage tank 500 l with heat exchanger – 1 pcs / €1,500
	Solar inverter 3 kW – 1 pcs / €500	Three phase solar inverter 12 kW – 1 pcs / €5,300	Solar inverter 3 kW – 1 pcs / €500
Estimated price, Euro	€10,000 / 100 %	€14,060 / 140 %	€12,700 / 127 %

1. Prices for the installation of SEU2/5TDK are taken when the production volume of the plants is more than 100 pcs. in year.
2. Prices for the remaining main components are taken from the Internet from the websites of sellers.
3. The cost of PV modules and solar collectors includes the costs of installation kits (frames, cables, etc.).
4. The calculation was carried out according to the peak capacities of the devices specified in the specifications, taking into account losses caused by the lack of tracking of the PV modules and solar collectors.

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