Combined solar collectors

B I Kazandzhan
National Research University "MPEI"Moscow, Russia
Moscow, 111250, Krasnokazarmennaya 14
Email: alten-1@rambler.ru

Abstract. The report considers the possibility of organizing in the MEI the production of combined solar collectors, which have become widespread in foreign countries recent years. In Russia, such collectors are not produce despite the presence in many parts of the country of favorable conditions for their use. The report presents the proposed design of combined solar collectors for production and shows the practical possibility of their manufacture and use in Russia. Application of combined solar collectors: roofs of residential and public buildings to provide them with electricity and heat. In a combined solar collector photovoltaic panel and a heat collector are located in one housing, function together, produce more energy and take up less space than if they work separately. The free area on the roof of the house in this case is doubles in comparison with separately installed photovoltaic panels and thermal solar collectors, which creates conditions for placing additional capacity on the same area and reduces the cost of installation work.

Introduction
The report considers the possibility of organizing in the MEI the production of combined solar collectors, which have become widespread in foreign countries in recent years. To solve this problem, MPEI has the necessary production and personnel capabilities. The pilot plant at MPEI is equipped with modern appliances and a design and engineering base. In Russia, such collectors are not produce despite the presence in many parts of the country of favorable conditions for their use. The report presents the proposed design of combined solar collectors for production and shows the practical possibility of their manufacture and use in Russia. Application of combined solar collectors: roofs of residential and public buildings to provide them with electricity and heat. Advantages of using combined solar collectors.

In a combined solar collector, a photovoltaic generator and a heat collector put in one housing function together, producing more energy and taking up less space than if they operate separately. The free area on the roof of the house doubled in comparison with separately installed photovoltaic panels and thermal solar collectors. It creates conditions for placing additional capacity on the same area and reduces the cost of installation work.

Combined solar collectors in the modern world
By the end of 2018, more than $10^6 \text{m}^2$ of combined solar collectors were installed in 25 countries. In 2019, the total number of installed combined collectors was 1166888 m², including 484587 m² in France, 28814 m² in South Korea, 133942 m² in China, 112326 m² in Germany, and 12902 m² in Spain. [1]
The physical basis of combined solar collectors operation.

The nominal passport value of the characteristics of photovoltaic modules is determined in special laboratories under standard conditions corresponding to the illumination of 1000 W/m² at a temperature of 25°C [4]. Electricity generation by solar cells when heated at 1°C above the nominal temperature falls by about 0.5%. The surface temperature of photovoltaic panels, depending on the time and place of operation, is approximately 50°C-75°C. Solar cell power generation at these temperatures is dropped by up to 25%.

The main idea of a combined collector.
Cooling a photovoltaic panel with a liquid or air heat carrier results in two useful products - additional electricity and heat removed from the photovoltaic cells with a significant gain in the total useful energy. In addition to a direct gain in energy, combining a thermal solar collector and a photovoltaic panel in one housing leads to significant savings in the space where the combined collector is located. In the report two variants of combined collectors are proposed, the production of which can be mastering in the MEI.

Figure 4 shows a combined solar collector with liquid cooling [6]. The Design of the combined collector is adapted to the real conditions of Russia, the possibility of purchasing and manufacturing the necessary accessories.

![Figure 4. Combined solar collector with liquid cooling.](image)

1 absorber, 2 multi-layer structure including a photovoltaic panel, 3 heat transfer tubes, 4 prefabricated pipes, 5 side profiles, 6 thermal insulation, 7 back wall

When developing a combined collector with liquid cooling, special attention was payed to the simplicity and availability of manufacturing components included in the design. II-shaped profiles forming the side walls of the structure and the absorber can be manufacture by extrusion at profile companies available in Russia (for example, the industrial complex "Agrisovgaz", the company "Furnitu"), photovoltaic panels available on the Russian market (Hevel Group of companies, solar systems LLC, and others).

![Figure 5. Model of the absorber to figure 4.](image)

Through the collecting pipes 4, the cooling liquid enters the system of tubes 3 through which heat is withdrawn from the back side of the absorber 1 and through it from the photovoltaic panel. Another option for implementing a combined solar collector is the cooling of the photovoltaic panel with air, and as a result appeared additional electricity and warm air (patent no. 2388974, 28.05.2009, author Kazandzhan B. I.) [7]
Figure 6. Air combined solar collector

1-photovoltaic module, 2-absorber with turbulizing ribs, 3-input air channel, 4-output air channel, 5-glass, 6-back wall, 7- П-shaped profiles with holes for air passage, 8- П-shaped profiles forming the side wall of the air channel, 9-thermal insulation (for example, polyurethane foam reinforced with foil).

The input 3 and output 4 channels for air are formed by П-shaped profiles 7 with holes for supplying air blowing the photoelectric module 1 and the absorber 2. Cold air enters through the inlet air channel 3, washes the photovoltaic panel 1 (the purchased product), located on the absorber. In the version in Figure 6, the absorber is offered in the form of a flat metal plate on the back wall of which elements can be located that turbulize the air flow. Such an absorber can be manufacture by extrusion at Russian enterprises (for example, the industrial complex "AGRISGAZ", the company "Furnitu"). The photocells 1 installed in the absorber 2, and cools them, and with elevated temperature enters the air outlet channel 4.

Conclusion

The purpose of this report is:
1. To initiate in Russia the development of the technology and fabrication of the combined solar collectors.
2. To show that in many regions of Russia, climatic conditions meet all the necessary requirements for the use of combined solar collectors.
3. Show that in Russia there is an opportunity to purchase all the necessary component parts for the production of combined solar collectors.
4. To show that MPEI can organize production of combined solar collectors with its own brand

References

[1] https://www.iea-shc.org/Data/Sites/1/publications/Solar-Heat-Worldwide-2020.pdf
[2] https://www.solarthermalworld.org/news/put-and-seasonal-storage-innovative-technologies-spain
[3] https://www.solarthermalworld.org/news/israeli-firm-offers-large-variety-pvt-systems
[4] NATIONAL STANDARD OF THE RUSSIAN FEDERATION GROUND-BASED PHOTOVOLTAIC MODULES MADE OF CRYSTALLINE SILICON Test method, Crystalline silicon terrestrial photovoltaic modules. Test methods Industrial standards and requirements (https://www.solarhome.ru/basics/solar/pv/ptc_conditions.htm#lwptoc1
[5] https://www.solarenergy.ch/fileadmin/user_upload/spf/publ/PVT_WrapUp_Final_EN.pdf
[6] Solar collector patent no. 2485417, 12.03.2012 author Kazandzan B. I
[7] Multifunctional solar collector patent no. 2388974, 28.05.2009, author Kazandzan B. I