

# The Use Of Solar Energy In Heating Systems

Buzrukov Zakiryo Sattikhodjaevich<sup>1</sup>, Kahorov Abdumanon<sup>2</sup>

<sup>1</sup>Prof. Namangan Engineering Construction Institute, The Republic of Uzbekistan, Tel. +998972521962, e-mail.:[zbuzrukov@mail.ru](mailto:zbuzrukov@mail.ru).

<sup>2</sup>Teacher of Namangan Engineering Construction Institute

DOI: 10.47750/pnr.2022.13.S08.129

## Abstract

**Annotation.** Theoretical material on the use of solar energy as one of the types of non-traditional energy sources is considered. The issue of the use of solar collectors has been comprehensively investigated, their main types are presented. The technical requirements for their work are listed, without which it is impossible or irrational to operate these systems. In the calculation part, the goal is to study the theoretical possibility of using solar collectors for heating hot water in the engineering systems of a residential building in Uzbekistan to assess the rationality of installing such a system. Based on the results of the calculation, a conclusion was made about the possibility of real use of the system in this territory, and proposals for the further development of this area were presented.

**Keywords:** solar energy, alternative energy sources, renewable energy, solar collectors.

**Introduction.** The sun is a pure and inexhaustible source of energy. Heat, light and other types of radiation emanate from it, which contain enormous reserves of energy and are responsible for almost all natural processes on our planet. But only recently, man has learned to use this energy for his own purposes - for heating water and heating rooms, as well as for cooling (thanks to the technology of cold absorption).

Modern solar-powered heating and hot water systems are economical, comfortable and environmentally friendly solutions. The biggest benefit of using solar systems is the significant cost savings. In addition, it is complete independence from heating networks, electricity networks, as well as heat tariffs, inflation and instability in the business, since no fuel is required.

It should also be noted that the cost of such an installation exceeds the cost of a traditional heating and hot water supply system, but the economic advantages of the system are obvious, and with a constant increase in the cost of energy carriers, they are noticeable from the first day of operation.

Solar energy is generated by the sun: it is heat, radiation and natural cycles (wind, water flow and plant growth, driven by the energy of the sun). The total flux of energy radiated by the Sun is  $3.9 \times 10^{26}$  J/s. Solar radiation is the electromagnetic energy emitted by the sun. Solar energy reaching the Earth's surface is dissipated in various ways (Figure 1). Solar energy is clean, easy to use, cheap, constantly plentiful, has no negative impact on the environment, and can be used as a decentralized source of energy.

The main advantages of using solar energy:

- the prospect of using free thermal energy of the sun;
- noiseless operation of power plants and installations operating on solar batteries;
- absence of gas emissions, and as a result, protection of the environment;

Various technologies for using solar energy have been developed. From small power supplies for individual home systems to large-scale systems concentrating solar energy. What these solar systems have in common is that they allow us to diversify energy sources, improve efficiency and ultimately meet our energy needs in an environmentally friendly and sustainable way. Depending on the way it is used, solar energy falls into one of two categories: active or passive. In systems for converting active solar energy, a solar collector is used (Figure 2).

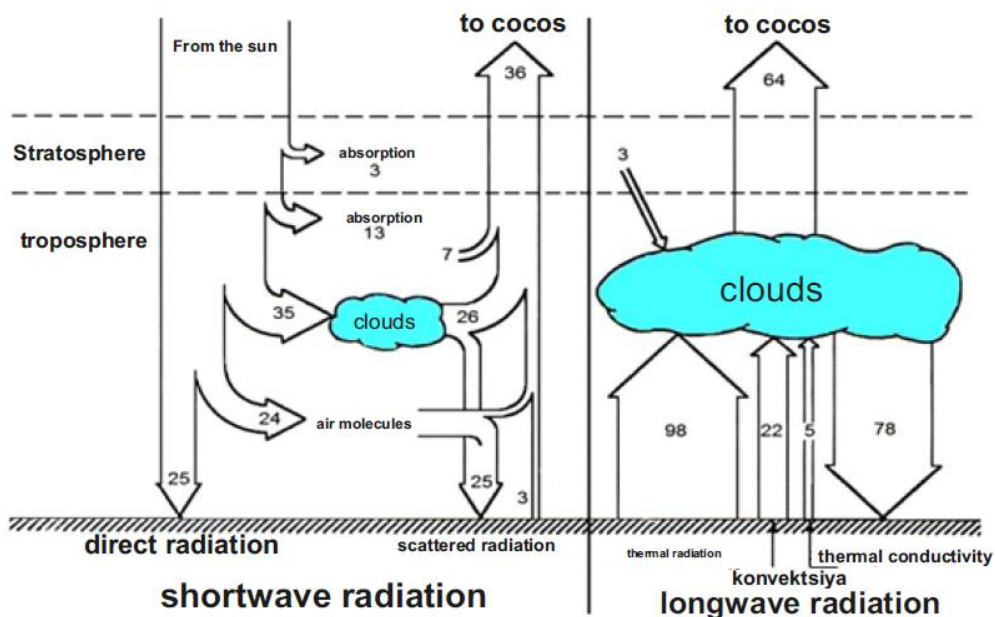


Fig. 1. Thermal balance of the "Earth-atmosphere-space" system.

In turn, active solar energy is divided into two categories: thermal and photovoltaic solar energy.

Thermal solar energy is used in heating systems such as water and air heating, food cooking and drying, distillation and steam generation.

Technologies using thermal solar energy are used to create:

- complete autonomy in work and independence from external energy sources;
- the possibility of own production of solar panels and collectors from improvised means and their use as the main or additional source of energy supply;
- long service life of solar installations, which is more than 30 years;
- the absence of constant voltage drops, from which the sensitive electronics of the equipment may suffer;
- less technological and labor-intensive installation process compared to some traditional methods of energy supply;
- there is no need to constantly supply external fuel, and the self-service mode of operation of solar installations will allow you to forget about their existence altogether;
- high quality and reliability in the operation of solar panels will enable the consumer to use environmentally friendly and free electricity for many years.



Fig. 2. Vacuum solar collector (solar collector)

Technologies that use thermal solar energy are used in the creation of solar water heaters, concentrators, cookers and desalination plants. Photovoltaic solar energy is used to generate electricity, using silicon cells to convert solar energy into electrical energy that can be used directly or stored in a battery system.

**Discussion.** The principle of operation of solar cells of most common types is based on the photovoltaic effect. The essence of this effect is the

appearance of a potential difference (or voltage) between two layers of a semiconductor material when light falls on this two-layer material.

Solar modules (Figure 3) are typically made from silicon that has been treated in such a way that when light strikes it, free electrons appear in it, creating an electric current. Currently, it is practically the only material used for

mass production of solar cells. In addition to it, gallium arsenide (GaAs) is used to produce high-efficiency solar cells. The efficiency of such elements reaches 25–28% with concentrated solar radiation. Special types of photocells used in spacecraft have an efficiency of more than 30%.

The term passive solar energy is used when the architectural design, natural materials or absorbent structures of the building itself are used as an energy saving system. The building itself serves as a solar collector and solar energy storage, which allows the designer to reduce the need for solutions for the supply of external energy: lighting, heating and cooling, water supply.



**Fig. 3. General view of solar photovoltaic panels**

The task of passive solar design is to create such architectural and building systems that capture solar heat, direct it deep into the room, accumulate and release it at the right time, significantly reducing heating costs. There are various methods of passive use of solar energy for heating buildings. The most common of them can be considered the device of light transparent thermal insulation and built-in or attached greenhouses and winter gardens. The combined use of several systems is effective. There are 8 principles of solar design of such buildings:

Principle 1. The house is placed so that the wall and roof are oriented to the south with a deviation of no more than 10–20°. Take into account the features of the landscape: trees, buildings, features of the terrain that can protect the house from harsh weather or wind in winter or shelter it from too bright sun in summer.

Principle 2. When developing a design, the annual cycle is taken into account. Before construction, you need to visit the site of the future house several times during the year, study the position of the sun, the direction and strength of the winds.

Principle 3. Use reliable heat and waterproofing. The entrance is equipped according to the principle of a vestibule with two doors.

Principle 4. Windows are used as solar collectors and cooling devices. Vertical, south-facing glazing is particularly effective in capturing solar heat in winter. Use curtains or blinds of insulating material to minimize nighttime heat loss during the winter and prevent excessive heat in spring, summer, and fall.

Principle 5. It must be taken into account that with excessive glazing, the house will overheat. Principle 6. It is necessary to correctly calculate the additional heating system.

Principle 7. Air exchange should take place through special openings in external walls with built-in fans in the kitchen and bathroom, and not through cracks in poorly insulated doors and windows.

Principle 8. Good organization of air flows in the building is the basis for the distribution of the received heat throughout the premises due to natural convection.

For the conditions of Uzbekistan in the forecast period (until 2020), the component of electricity production using solar energy will be practically not noticeable. The main areas of solar energy use will be solar water heaters and various solar installations to intensify the processes of drying and heating water in agricultural production. In addition, active and passive solar energy has all the prerequisites for use in the design of agro-towns and remote small objects in agriculture.

Using the energy of the sun, solar systems allow you to annually save traditional fuel:

up to 75% - for hot water supply (DHW) for year-round use; up to 95% - for hot water supply during seasonal use; up to 50% - for heating purposes; up to 80% - for the purpose of standby heating.

It should be taken into account that each system is individual, and the percentage of energy savings when using a solar system must be calculated.

Direct solar radiation - solar radiation arriving at the surface in the form of a beam of parallel rays emanating directly from the solar disk.

Scattered solar radiation is solar radiation that reaches the surface from the sky after scattering in the atmosphere.

Total solar radiation on a horizontal surface - solar radiation arriving on a horizontal surface in the form of direct and diffuse radiation.

Total solar radiation on vertical surfaces - solar radiation arriving on vertical surfaces in the form of direct, scattered and reflected radiation from a horizontal surface.

Solar heating systems (SST) are systems designed to convert solar energy into thermal energy for the purpose of its further use for the needs of hot water and heating systems.

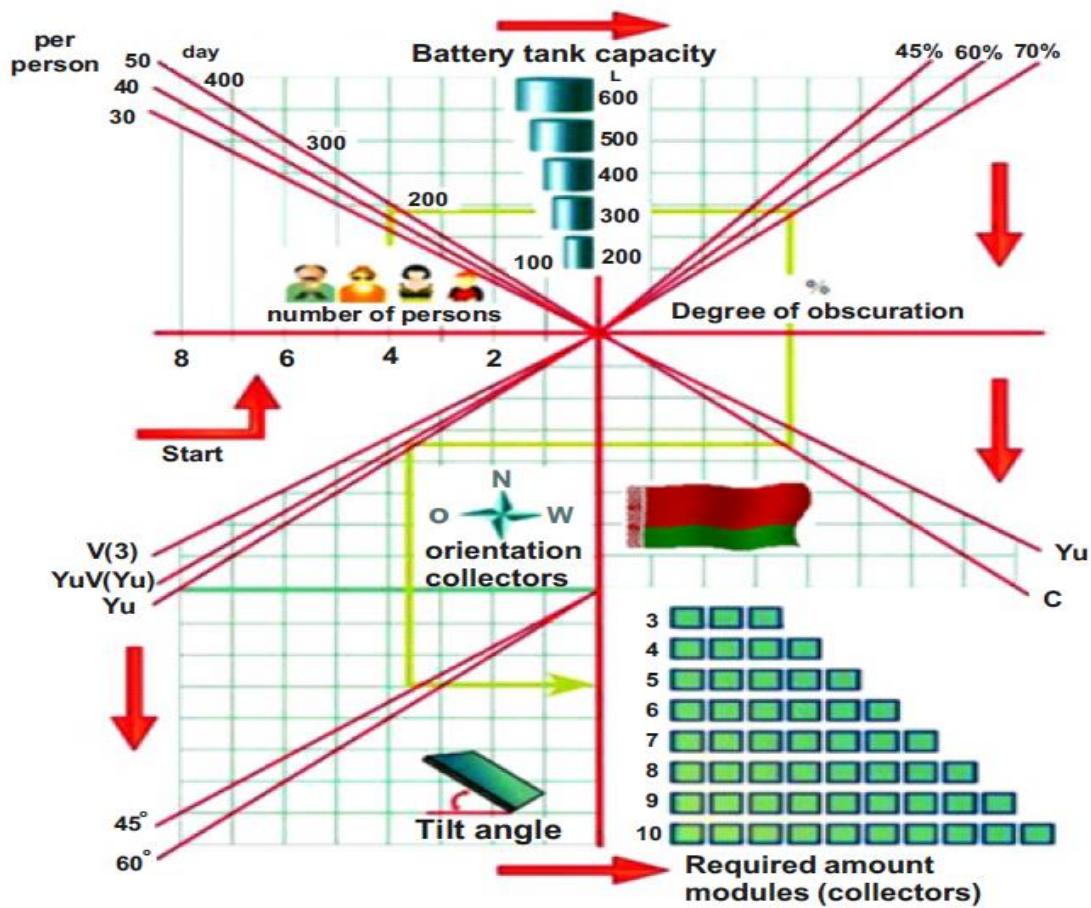
Solar collector (SC) is a device for absorbing solar radiation and converting it into thermal energy. It is an essential element of any solar system.

A storage tank (BA) is a container designed for thermal energy diverted from the solar collector circuit. Connection station (SP) is a pumping and mixing group designed for hydraulic connection of the solar collector circuit and the storage tank heat supply system. The coefficient of replacement of the thermal load of the object by the solar system is the share of solar energy that can cover the thermal load of the object for some considered period of time, most often a season or a year. The useful heat output of the solar system is the amount of heat energy removed from the SST for the considered period of time (usually a season or a year), taking into account heat losses.

The specific heat output of the solar system is the useful performance of the SST, referred to one square meter of the area of the solar collector (collector field). Depending on the intended use and taking into account the choice of one or another technical solution, solar heating systems can be classified as follows:

- by purpose (hot water supply systems, heating systems and combined systems);
- according to the technical solution (year-round and seasonal systems); - by device (single-circuit, double-circuit and multi-circuit systems);
- by type (open (not glazed), flat and vacuum systems).

Design thermal calculation, the purpose of which is to determine the heat exchange surface area that ensures the transfer of a given amount of heat from one coolant to another. To identify the possibility of using existing devices for one purpose or another, a verification thermal calculation is performed, determining the final temperatures of the coolants  $t_g$  and  $t_h$  and the amount of heat transferred.

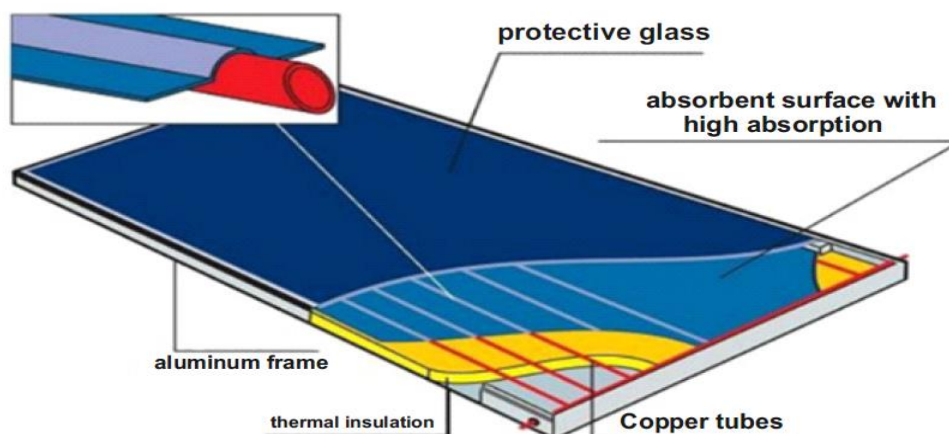


**Fig. 4. Nomogram for an approximate calculation of solar collectors for the hot water supply system of an individual house (up to 8 people)**

All design principles of solar collectors come down to ensuring the maximum absorption of solar energy and the maximum reduction of heat losses.

Open solar collectors are just one absorbing panel (no casing) that is usually made of UV-resistant plastic or rubber and fixed directly to the roof. The advantages of such systems: the highest possible efficiency of the system, simplicity, reliability, easy installation, low weight. The disadvantages of the systems include: a significant decrease in efficiency with an increase in temperature difference, a large dependence on weather factors (cloudiness, wind, etc.), limited use (used only for swimming pools), high sensitivity to sub-zero temperatures, short effective service life.

Flat solar collectors (Figure 5) have a design, the main element in which is an absorber that absorbs solar radiation. On top of the collector has a transparent coating (usually glass).



**Fig. 5. Schematic diagram of a collector with a special coating.**

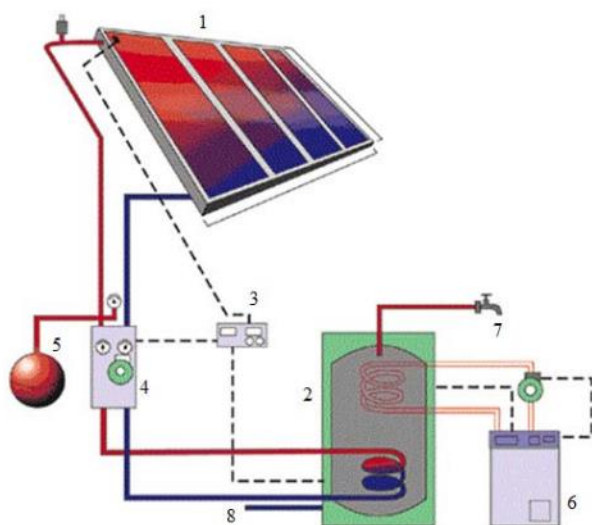
To increase the efficiency of the collector, a special optical coating of tempered glass with a reduced metal content is used, which has a transmittance of up to 95%. When heated, the coating radiates thermal energy, the main power of which is in the infrared range (this radiation spectrum is practically not transmitted by glass). Thus, the accumulation of solar energy inside the collector is achieved. The transfer of heat to the coolant is carried out with the help of structural elements made, as a rule, of aluminum or copper. Heat removal is carried out by a coolant - water or a solution of non-freezing liquid.

The advantages of such systems are the ability to clear snow and frost, high performance in summer, and the ability to install at any angle.

The disadvantages of the systems include high heat losses, low performance in the cold season, the complexity of installation associated with the need to deliver the assembled collector to the roof, high windage when installed on a stand. In addition, flat collector systems have the problem of bacterial and other microbial growth that does not exist in vacuum collector systems.

Calculations of the solar heating system are performed by specialized organizations, but as a first approximation, you can do them yourself using a nomogram (Figure 4). This is an approximate calculation.

Solar collectors should be oriented as far south as possible. However, without a significant drop in performance, it is possible to deviate from the south direction by 30°. For photovoltaic panels, it is possible to deviate up to 45° without significant deterioration. Exceeding these recommended figures will severely degrade the efficiency of the solar heating or power supply system.



**Fig.6. Scheme of solar water supply with forced circulation: 1-collector; 2-boiler; 3-control panel; 4-pump; 5-expansion tank; 6-source of additional heating; 7-hot water outlet; 8-cold water inlet.**

В случае применения замкнутой водонагревательной солнечной системы с незамерзающим теплоносителем, вода будет продолжать нагреваться и при отрицательных температурах, но из-за отношения площади коллектора к площади бака (рисунок 6), will provide fully, first of all, individual houses. With forced circulation and when the boiler water heating is switched on in case of insufficient water temperature in the tank, a more economical heating system for an individual house using solar energy

is possible. Thus, solar energy technologies are especially promising for single-family houses; in large cities with a

high building density, their installation and operation are difficult. With some modifications, these technologies can be applied at negative outdoor temperatures; the effect of their use will depend to a greater extent on the amount of solar radiation.

**Conclusions.** Modern solar collectors are able to heat water up to the boiling point even at negative ambient temperatures. The cost of a solar installation can be significantly reduced by combining the roof structure with a flat solar collector. At the same time, at the design stage, it is necessary to correctly choose the orientation of the roof, building structures, the location of the storage tank, and cleaning methods. The heat transfer resistance of the solar collector insulation in this case must be no less than that required for the roof, and the light-transmitting panel must reliably withstand the snow load. The thermal efficiency of the collector is increased by reducing optical and thermal losses when using several layers of glazing, selective coating, evacuating the space between the beam-absorbing surface and transparent insulation, and using solar concentrators with helio-tracking in the design [7].

Hot water systems using solar energy still require a lot of improvements, especially for applications in Uzbekistan. Abroad, the use of renewable energy sources is receiving much more attention, while we still continue to use limited natural fuel resources. It is possible that the energy crisis predicted by many will push Russian scientists and engineers to actively develop the use of inexhaustible energy resources that are freely available throughout the planet. Increasing the efficiency of solar collectors can significantly reduce the area required for their installation. The use of solar energy in heating systems can be effective at least during the summer period, since solar radiation at this time is quite high.

At least for private houses, solar systems can be a more economical option, since the costs for such houses are not high and can easily be covered by solar energy.

Despite the sufficient scientific knowledge of the issue, the use of solar energy in the heat supply of hot water systems in individual housing construction has great prospects.

## REFERENCES:

1. Тараненко Д.В. — Опыт использования солнечной энергии для создания комфортной среды в зданиях // Архитектура и дизайн. – 2018. – № 3. – С. 20 - 29.
2. Соловьев А.К. Пассивные дома и энергетическая эффективность их отдельных элементов //Промышленное и гражданское строительство. 2016.№ 4. С. 46–53.
3. Ананьев А.И. Физико-технические основы создания энергоэкономичных кирпичных стен для жилых зданий / А.И. Ананьев // Универсальный справочник застройщика. Теплый дом. - М.: ИА NORMA, 2000. - С. 115-120.
4. Береговой А.М. Энергоэкономичные и энергоэффективные здания. [Текст]: 2-е изд./Береговой А.М. - М.: Изд. АСВ: ПГАСА, 1999. - 160 с.
5. Боронбаев Э.К. Графики оптимизации круглогодичных режимов тепло- обеспечения микроклимата в здании [Текст] / Э.К. Боронбаев // Изв. вузов. Строительство, 2004. - № 10. - С.81-86.
6. Роза А. Возобновляемые источники энергии. Физико-технические основы: учеб. пособие / пер. с англ. под ред. С.П. Малышенко, О.С. Попеля. – Долгопрудный: Интеллект; М.: Изд. дом МЭИ, 2010. – 704 с.
7. THE SRB SOLAR THERMAL PANEL C. Benvenuti – SRB Energy, c/o CERN – 1211 Genève 23, Switzerland – DOI: 10.1051/epn/2013301http://www.europhysicsnews. org or http://dx.doi.org/10.1051/epn/2013301.
8. Buzrukov, Zakiryo, Ikhom Yakubjanov, and Mukhtorzhon Umataliev. "Features of the joint work of structures and pile foundations on loess foundations." E3S Web of Conferences. Vol. 264. 2021.
9. Sattikhodzhaevich, Buzrukov Zakiryo. "WAYS TO SOLUTION THE UNLOADING OF THE TRANSPORT NETWORK IN MODERN CITIES." INTERNATIONAL JOURNAL OF RESEARCH IN COMMERCE, IT, ENGINEERING AND SOCIAL SCIENCES ISSN: 2349-7793 Impact Factor: 6.876 16.3 (2022): 14-19.
10. Alimov, Khorisboy, Zakiryo Buzrukov, and Mirzohid Turgunpulatov. "Dynamic characteristics of pilot boards of structures." E3S Web of Conferences. Vol. 264. EDP Sciences, 2021.
11. Buzrukov, Z., and A. Khamrakulov. "Joint work of a flat frame and pile foundations under dynamic impacts." Materials Science and Engineering Conference Series. Vol. 883. No. 1. 2020.
12. Buzrukov Z.S. Selection of the design scheme of the system "flat frame-grillage-pile group" under dynamic load. // UNIVERSIUM, Moscow. 2020. № 12(81), Chapter 1 .pp 86-92.
13. Buzrukov Z.S. Features design of foundations of high-rise buildings, taking into account soil conditions.// "Bulletin of Science and Education", Moscow. 2020. № 22 (100). Chapter 1.pp.79-86.
14. Award H. 1 Bligh Street. Architectus and Ingenhoven Architects. Sydney, NSW//Architecture Australia. - №12. - 2012. - P. 56 - 57.