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Innovative technological solutions for heat supply in recreational complexes of the Lviv Polytechnic educational institution

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Abstract: The world is increasingly paying attention to the use of so-called renewable energy sources – ground heat, wind energy, tides, biogas, solar radiation, and so on. Almost all of these energy sources are entirely due to direct influence from the Sun. Among these sources, one of the most promising is the direct conversion of solar radiation. The direct conversion of solar energy into heat or electricity is one of the main advantages of using solar energy as a future energy resource. The article presents the actual use of solar systems to provide hot water and electricity to educational and health establishments.

Keywords: renewable energy sources, energy-saving, solar energy, solar systems, heat pumps, solar power plant

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Introduction

The development of the world economy is inextricably connected with the growth of energy production. This is due to many factors:

- general increase in world production;
- development of transport and telecommunications;
- development of remote mineral deposits;
- waste disposal;

– growth of energy consumption in the home (heating, lighting, power supply of various appliances).

At present, the energy sector faces many problems, and the most important is the problem of its sources. Today, 6 billion people on Earth consume more than 12 billion kWh of energy per year at an average of 2 kWh per person. This energy is obtained mainly from organic fuels – coal, oil, gas. About 90% of the energy we receive is from non-renewable energy sources, so-called, because the rate of their accumulation is much lower than the rate of their consumption (by approximately 106 times).

Material and methods

As humanity requires more and more energy, which soon will be difficult or impossible to obtain from non-renewable sources, so the world is paying more attention to the use of so-called renewable energy sources – ground heat, wind, tides, biogas, solar radiation, etc (Voytyuk, 2010; Devyatkina, 2006). Almost all of these energy sources are entirely directly influenced by the Sun. Among these sources, one of the most promising is the direct conversion of solar radiation into heat and electricity (Zhelykh et al., 2015; Voznyak, 2010).

The sun is an almost inexhaustible source of energy, which is available to us in almost unlimited quantities, it is environmentally friendly and free energy (Shapovalov et al., 2014). The sun emits 960 billion kWh every day. This amount of energy can theoretically meet the world's energy needs for the next 180 years.

Solar energy, as an alternative energy source, can be delivered directly to the consumer, without transporting the energy over long distances.

Modern methods of obtaining electricity and heat from solar radiation:

- obtaining electricity;
- geothermal energy;
- thermal air power plants;
- solar balloon power plants.

Considerable attention to the use of non-traditional energy sources is also being paid at the National University "Lviv Polytechnic". In the educational and health complex "Polytechnic-3" (Fig. 1), which is located in the south of Ukraine – in the village of Kobleve in the Mykolaiv region. Solar energy is widely used for both water heating and electricity generation.

The health campus was founded in 1965. It is conveniently located at the beach (Fig. 2). The complex covers about 6 hectares. The sharp contrast between the mainland and the sea creates a special climate and range of flora. The complex hosts vacationers from June to October, with a total of 250 places.

In Polytechnic-3, there is a dining room with 250 seats overlooking the sea (Fig. 3). Given that the health campus was founded more than 50 years ago, most engineering systems use traditional energy sources.

Fig. 1. Residential building of the educational and health complex (*own photo*)

Fig. 2. Location on the beach (*own photo*)

Fig. 3. Dining room establishment (*own photo*)

In particular, hot water was provided through the use of two electric water boilers. The volume of each was 2000 liters, electric power 24 kW.

However, the use of these battery-type water heaters did not fully meet the complex's need for hot water. And the cost of electricity was quite significant.

The only solution to reduce energy consumption and provide the campus with a good and reliable hot water supply was the use of renewable sources, namely solar energy (March, 2007).

ATMOSFERA® vacuum solar collectors have been installed to produce hot water (Fig. 4). Vacuum solar collectors are ideal for year-round use. The main purpose is to heat hot water. These solar collectors are characterized by high performance in summer and winter. ATMOSFERA® solar systems provide from 30 to 90% of the hot water with a working lifespan of 25 years. There are 6 modules of 30 vacuum tubes with a capacitor diameter of 25 mm.

The air-to-water heat pumps are additionally installed to compensate loads on the solar system, as well as for uninterrupted hot water supply in cloudy weather (Fig. 5).

Fig. 4. Vacuum solar collectors for heating water on the roof of the educational and health complex (*own photo*)

Fig. 5. Air-to-water heat pumps (*own photo*)

An air-to-water heat pump is a type of heat pump that provides hot water using the heat of the environment. The air-to-water heat pump is used to supply hot water with maximum efficiency. Its main advantage is the economy. Air-to-water heat pumps produce up to 4.44 kW of heat for every 1.00 kilowatts of electricity consumed. Thus, the hot water supply system becomes much more efficient.

Solar panels are used to generate electricity. A solar battery is an electrical installation that generates direct current and consists of solar-oriented solar modules (Fig. 6).

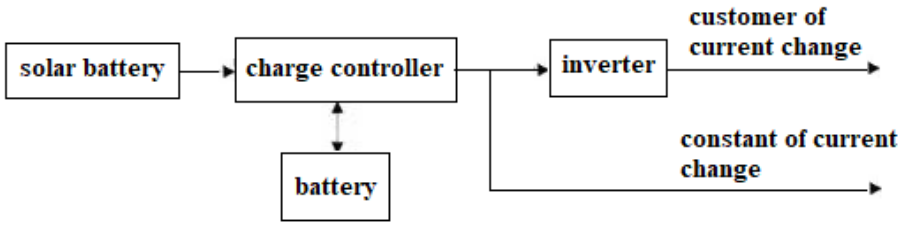

Fig. 6. Scheme of solar installation (*own study*)

The solar power supply system consists of the following elements (Fig. 7):

- solar panels (photovoltaic solar module);
- charge controller;
- battery;
- inverter.

a) b)

Fig. 7. Photoelectric system: a) solar photovoltaic module, b) mains inverter and charge controller (*own photo*)

A solar module is a set of interconnected solar cells and semiconductor devices that convert the sun's light energy into electricity. Modules are placed on the roofs of the dormitories of the campus. The total number of solar modules is 80 pcs.

Charge controller – a device designed to control the charging and discharging modes of batteries. The charge controller plays an important role in the operating system; regulates the battery charge (which increases the service life of the object).

An inverter is a device that converts direct current from solar modules into alternating current with a voltage of 220 or 380 V. It is the inverter that makes it possible to supply electricity to various types of electronic equipment, lighting devices, as well as the already mentioned hot water supply systems. The power of the photovoltaic system is 40 kW. The solar power plant provides a stable power supply, reduces electricity costs, and serves as an additional power source.

Conclusion

The use of solar energy is a popular and inexhaustible source. The use of various solar systems makes it possible to reduce the cost of hot water, save fossil fuels and reduce harmful emissions into the atmosphere.

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