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The Use of Alternative Energy Sources in Construction

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Abstract:

This article discusses the use of alternative energy sources in small business. Using the construction of a cafeteria as an example, the study shows solutions not only to the issues of the building itself, but also to the region’s problems, as well as analyzes the possibilities of the optimal use of natural energy in order to reduce costs in the process of exploitation.

Keywords - energy, renewable energy sources, small business.

I. INTRODUCTION

There are numerous support programs for small and medium businesses in Kazakhstan. The development of small business is mainly associated with the development of trade, services and tourism. The abundance of potential tourist areas in the country makes it possible to safely build resorts, restaurants, chalets, using natural sources as a basis. The introduction of renewable energy sources (RES) in construction in this area will have a positive impact on the ecology of the regions, and on the prices of the goods and services offered.

II. MATERIALS AND METHODS

We considered the construction of a cafeteria as an example for the use of renewable energy sources. The construction site is on the Mangyshlak Peninsula, famous for pilgrimages and the warm Caspian Sea. In summer, the coast of the Caspian Sea, namely, the beaches of Aktau, are filled with guests from neighboring cities, who came to visit their relatives, for a vacation, or for business, but the water temperature on the coast of Aktau rises to comfortable for swimming only in mid-July. In the Kendirli Bay, which is 210 km from Aktau, the water is warm 4-5 months a year. Given this, in 2014 the President set a goal: to turn the Kendirli resort area (Fig. 1) into a republican, and then international, recreation area.

Fig. 1. Kendirli resort area

Kendirli is a resort in the shallow bay of the Caspian Sea, located 210 km from Aktau and 70 km south of Zhanaozen.

Despite the climatic and natural amenities, tourism in this area is poorly developed, and there are significant problems in the infrastructure of the resort. In the Mangystau region, water supply is a big problem, which, far from the city, in the Kendirli resort area, is particularly acute. Only one road leads to Kendirli from Zhanaozen. The road condition is deplorable, which is why it takes about 4 hours to get to Kendirli from Zhanaozen. The resort is supplied with drinking water by the water supply system of the USSR times, which now works at the breaking point. The distance from the nearest town and the road condition are the reasons why in the resort area food and services are overpriced in general. In order to somehow promote recreation in Kendirli, the oil industry workers and their families are given special discounts.

In summer, the average monthly air temperature in Kendirli is +27.5ºC to +30ºC, sometimes reaching +45ºC. The average water temperature from May to October is +24ºC to +26ºC. In winter, the temperature in this area is -5ºC to +5ºC. It can take 1.5-2 hours to get from the nearest airport of Aktau to any capital of Europe [5].

The reason for selecting the project location is that the coast of the Caspian Sea is an open space where one can make the maximum use of alternative energy sources, thereby making it possible to solve the problems of energy and water supply. The climate in this area is sharply continental, arid, with very hot summers. The number of sunny days usually reaches 320 days a year, characterized by the presence of a very strong wind.

The climate is very convenient for using the sun and wind as energy sources in the power supply system.

The object of the study is a cafeteria with 230 seats, having a shop and a pastry shop, in the Kendirli recreation area.

The projected construction site of a cafeteria is right on the coast, where there are no buildings. The soil is sandy; the surface of the earth has no vegetation.

To self-supply the building with water, energy and heat resources, the elements of alternative energy sources were used: photovoltaic panels, providing energy for outdoor lighting, wind-rotor Bolotov turbines, providing electricity for internal lighting of the building and part of household appliances, solar thermal collectors, providing hot water, solar-wind water desalinators, intended for solving the biggest problem of the region – lack of drinking water, ground heat exchangers, improving air exchange, and absorption refrigerators.

Lanterns with photovoltaic panels are used for outdoor lighting. Solar photovoltaic panels (solar batteries) are designed to convert solar energy into electrical energy and are used to create solar or mixed energy systems.

The principle of operation of solar batteries is the direct conversion of sunlight into electric current. This generates a constant current. Energy can be used directly by different DC loads, stored in batteries for later use or for covering the peak load, and be converted to the 220V alternating current in order to power different AC loads [6].

For our project, photovoltaic panels of the model KZ PV 230 M60 can be used (Fig. 2, Table 1), produced at the domestic plant Astana Solar [2].

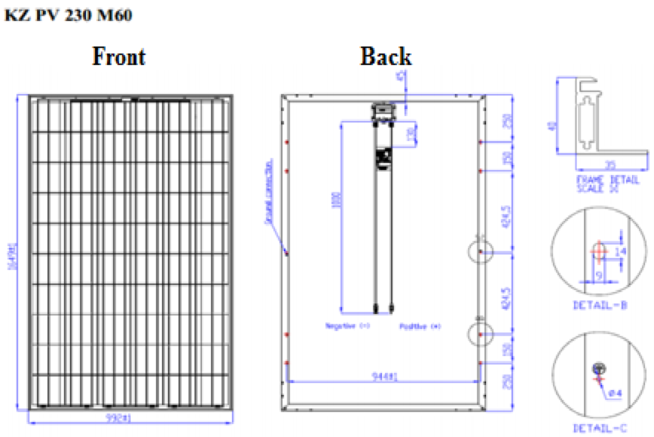


Fig. 2. Photovoltaic panel

Table 1. The characteristics of photovoltaic panel

Nominal voltage	24 V
Nominal current	A 7,5
Installed power	220-225-230-235-240 W
Cell type	Polycrystalline 6’’ (156x156 mm)
Module configuration	6 columns x 10 cells
Dimensions	1,649x992x40 mm
Weight	19,5 kg

We use 2 photovoltaic modules from which lamps and outdoor lighting projectors will receive energy.

III. RESULTS AND DISCUSSION

The energy source for indoor lighting and electrical appliances will be 2 wind-rotor Bolotov turbines (WRBT) (Fig. 3) with a capacity of 10 kW each, located on the sides of the building [3].

Fig. 3. Wind-rotor Bolotov turbine

The WRBT condensing unit is a hybrid complex for the transformation of renewable energy sources (wind, sun), safe for the environment, which is a block-modular system of terrestrial distribution consisting of:

• wind-rotor turbine VRTB4M2 (counterrotation);

• balancing photovoltaic device BUSB;

• single (unified) support for placement of VRTB and BUSB on the ground;

• battery pack;

• WRBT inverter-charging system;

• monitoring systems for WRBT operating parameters.

Features:

• reliability;

• high safety (no open moving parts);

• environmental friendliness (no generation of low-frequency oscillations);

• temperature and wind resistance;

• increased resource;

• minimum operating costs (does not require staff on duty, maintenance – once per year).

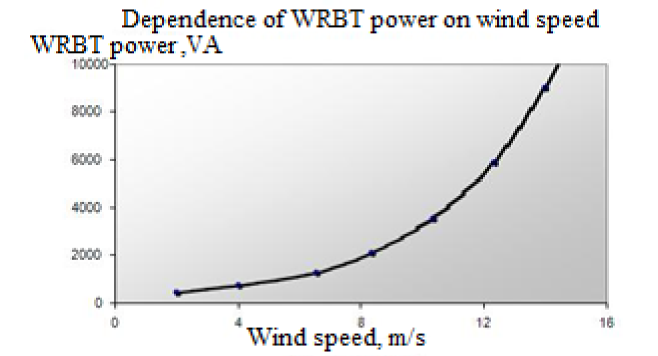
The specifications are given below and systemized in Table 2 and Table 3.

Table 2. The characteristics of turbine

Turbine performance properties	
Nominal wind speed	12,3 m/s
Starting speed	2 m/s
Shutdown speed	No
Turbine physical parameters	
Dimensions	
Swept area (4 modules)	16 sq. m
Module weight	750 kg
Temperature range	(-40)÷(+40)°C

Turbine noise level	
At a wind speed of 8	<35dBA m/s at a distance of 3 m
WRBT generator	
Type	3-phase on permanent magnets
Nominal voltage	420V AC
Nominal current	25 A
Nominal speed	125 rpm
Max speed	250 rpm
Temperature range	(-40)÷(+40)°C

Table 3. Other characteristics

Annual energy performance	
If 10÷40% per year wind speed – nominal	9980÷37450 kVA*h
	
Features	
- high safety (no vibrations, no open moving parts); - increased resource; - service life of 10+ years; - does not depend on wind direction; - work in turbulent conditions; - construction modularity; - possibility of embedding into the tower, no additional land uptake; - low operating costs; - synergistic effect in combination with solar panels.	
System output characteristics	
Voltage, frequency	220VAC, 50Hz, sine

For normal operation of the cafeteria, a large amount of drinking water is needed, which can be achieved with the help of a solar-wind desalinator. The device proposed by I.B. Biryulin, A.A. Vetrova and D.D. Vasilieva in the patent No. 2354895 of the Russian Federation [4] can be used as a solar-wind desalinator.

The device relates to heat engineering, in particular to devices for salt water desalination using solar and wind energy. The solar-wind desalinator, as shown in Fig. 4, contains a desalination tank, a transparent condenser installed above it with a branch pipe for the output of the steam-air mixture in the upper part with a wing mounted on it installed on the wind turbine shaft. A non-transparent condenser is installed above the transparent one, connected in the upper part with the circulation pipe, which ends with an annular distributor located in the tank. A conical tube is attached to the shaft below on the lower and upper crosspieces, which has a spiral triangular thread on the outer surface in the direction opposite to the rotation of the disk with which it is partially connected.

On the surface of the non-transparent condenser, cylindrical rings are fixed, which are hydraulically connected by tubes with a groove that is connected by a pipeline with a fresh water tank. In air humidifiers, water is sprayed simultaneously on two sides of a rotating disk, which contributes to its evaporation.

The proposed desalinator in the presence of wind will work at night with lower productivity. It is advisable to be used on the shores of salt lakes and seas for getting fresh water.

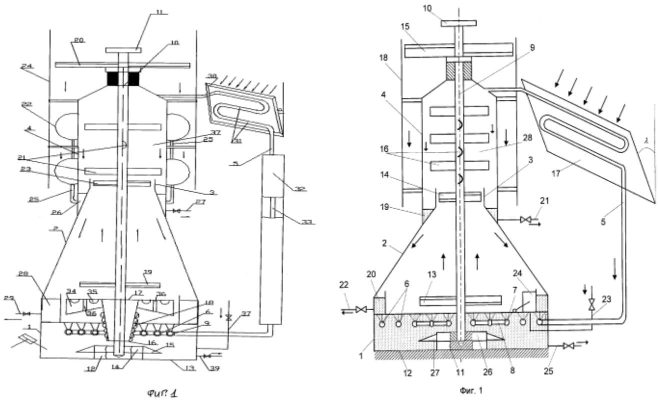


Fig. 4. Diagram of the solar-wind desalination system

A solar thermal collector is a device for collecting solar thermal energy (solar power generator), carried by visible light and near infrared radiation. Unlike solar batteries directly producing electricity, solar thermal collectors heat up the heat-transfer material (Fig. 5).

They are usually used for hot water supply and space heating. On average, up to 15-30% more energy per year can be obtained from a vacuum collector than from a flat collector, and this additive will be due to more efficient operation at low temperatures (that is, when it is necessary to maintain the heating system).

The advantages of solar thermal collectors will especially manifest themselves:

- at low outside temperatures;
- when water is heated to a high temperature;
- at low intensity of solar radiation;
- during diffusion radiation when the sun is covered with clouds.

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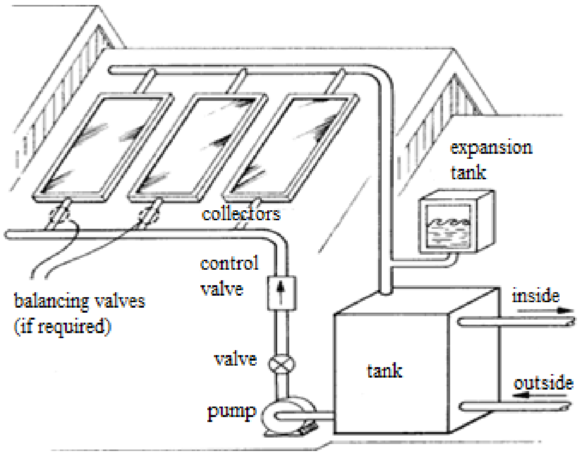

Fig. 5. Layout of solar thermal collectors

Table 4. Solar thermal collectors characteristics

Tubes	
Vacuum with a three-layer coating	
Number	15 pcs
Tank	
Double-layered, steel, top layer - painted steel	
Diameter	Outer - 460 mm
	Inner - 360 mm
Capacity	125 liters
Heater	Polyurethane 50 mm
Frame	
Steel with an electroplated coating 1.5 mm thick	
Volume	
Volume	0,63 м^3

On the attic floor, under a flat roof, we install tanks for collecting hot water, as well as pumps for distributing hot water throughout all structures of the hot water supply system.

Absorption household refrigerators are intended for short-term storage of perishable food products and for obtaining food ice (Fig. 6). The industry produces absorption refrigerators with a volume of 30–200 dm3 and a power consumption of 50 W to 200 W.

Fig. 6. Electrogas (absorption) auto-refrigerator

One of the features of absorption refrigerators is the noiseless operation, the absence of shut-off valves and moving parts. Absorption refrigerators have another significant advantage: they can operate using other heat sources apart from the electric current, such as heating with a kerosene burner or with a gas household network. In the latter case, the refrigerator consumes no more than 0.8-1.0 m3 of gas per day.

During operation, the absorption refrigerator consumes the thermal energy emitted by the electric heater. The principle of operation of the absorption refrigerator is based on the absorption of refrigerant vapors formed in the evaporator by a liquid absorber. The refrigerant is ammonia, and the absorber is ammonia water solution. In addition, hydrogen and sodium chromate are introduced into the refrigeration unit: hydrogen equalizes the pressure in the refrigeration system, and sodium chromate prevents the internal surfaces of the refrigeration tubes from corrosion.

Kendirli is a summer resort. The summer in the Mangystau region is very hot and dry, so it is very important to properly organize air exchange in the cafeteria. In order to maintain fresh and cool indoor air, it is proposed to use ground horizontal heat exchangers.

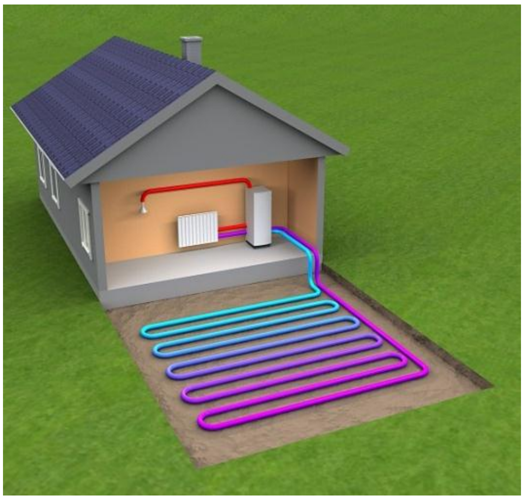

Fig. 7. Absorption refrigerators

Fig. 8. Absorption storage refrigerators

Underground, below the ground freezing point, the duct system is settled, which performs the function of a heat exchanger between the earth and the air passing through these ducts [1]. Since the ground temperature at a depth of 1-3 m in winter is +2 to +4°C and in summer is +8 to +10°C, the air that passes through the duct warms in winter or cools in summer by the soil duct wall.

IV. CONCLUSIONS

The use of ground heat exchangers makes it possible to cool the air, which reduces energy consumption costs.

In the warm season, the ground heat exchanger cools the input air. The outside air enters through the air intake device into the ground heat exchanger where it is cooled by the soil. Then the cooled air is supplied through the air ducts to the air handling unit and then to the cafe premises. Thanks to this solution, the temperature in the rooms is decreased, the microclimate in the building is improved, and the costs of electricity for air conditioning are reduced.

The use of renewable energy sources in the construction of the cafeteria allows the building to work properly, despite the distance from communications and common resort problems.

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