INNOVATIVE MECHANICAL ENGINEERING **ISSN 2812-9229 (Online)**
University of Niš, Faculty of Mechanical Engineering
VOL. 2, NO 2, 2023, PP. 39 - 44

POSSIBILITIES OF RENEWABLE ENERGY USAGE IN BELGOROD REGION OF RUSSIA

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Abstract *Climate change as a global problem is becoming more and more pronounced. As a result, most countries around the world are facing serious energy shortages, and forecasts indicate that such a situation will not change in the future. High consumption and population growth in the world will force most countries to face the problem of critical reduction of stocks of domestic fossil energy sources. The current energy dependence of most countries on oil and its derivatives requires significant economic expenditures will have negative effects on national economies, as well as on the international energy supply. Fossil fuel supplies are rapidly depleting, and within a foreseeable future, most countries will be forced to significantly increase the usage of renewable energy sources to meet their energy needs. Aim of this paper is to present the commonly used solar energy systems in terms of potential and possibilities, especially in southeast eastern Russia. Special attention will be given to solar concentrators, which use has reached the highest level from the technical-technological aspect. Most important economic indicators in terms of investment and exploitation profitability will be presented.*

Key words: *Renewable energy potentials, Exploitation, Technological point, Indicators, Investment*

1. INTRODUCTION

The concept of renewable energy is relatively new and denotes all those forms of energy which cannot be exhausted by the process of their use [1, 2]. The intention of this paper is to briefly present the most commonly used energy sources as well as the potential for their use and application in Belgorod region of Russia. Focus will be given to solar energy and biogas. Possibilities of use as well relative profitability depends on both geographical and meteorological circumstances as well as from the relief and the local biosphere.

All renewable energy sources listed here are characterized by a high degree of initial investment but also a low price in operational use [3]. Their common feature is that they pollute the environment less or not at all, which makes their environmental impact negligible or beneficial, especially compared to some conventional technologies of electricity generation, such as thermal power plants [3, 4].

[*]**Received: December 15, 2023 / Accepted December 22, 2023.**
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Renewable energy sources, with application of relatively cheap equipment, are usually available to both households and small businesses. Therefore, the basic goal of the paper is to introduce the potential of renewable sources energy in the city of Belgorod in Russia to all interested and supply practical advice on when and how to apply these resources in the surrounding areas.

2. SOLAR ENERGY IN RUSSIA

The rise in energy prices in Russia is forcing interest in cheap energy sources. Solar energy is the most readily available. The energy of solar radiation falling on the Earth 10,000 times exceeds the amount of energy generated by mankind.

Problems arise in the technology of energy collection and in connection with the uneven supply of energy to solar plants. Therefore, solar collectors and solar panels are used either in conjunction with energy storage or as a means of additional feeding for the main power plant.

Fig. 1 *Solar energy input in Russia*

2.1 Solar energy potential estimation

Solar radiation intensity can be classified in various ways. Areas of maximum solar radiation intensity are those with more than 5 kWh solar energy per square meter per day. Such regions can be found along the southern border of Russia from Baikal to Vladivostok, in the Yakutsk region, in the south of the Republic of Tyva and the Republic of Buryatia, oddly enough, beyond the Arctic Circle in the eastern part of Severnaya Zemlya, as it is shown on Fig. 1.

Solar energy supply from 4 to 4.5 kWh per sq. meter per day. Krasnodar Territory, North Caucasus, Rostov Region, southern part of the Volga region, southern regions of Novosibirsk and Irkutsk regions, Buryatia, Tyva, Khakassia, Primorsky and Khabarovsk Territories, Amur Region, Sakhalin Island, vast territories from Krasnoyarsk Territory to Magadan, Severnaya Zemlya, north-east of the Yamalo-Nenets Autonomous area.

From 2.5 to 3 kWh per sq. meter per day. Along the western arc - Nizhny Novgorod, Moscow, St. Petersburg, Salekhard, the eastern part of Chukotka and Kamchatka.

From 3 to 4 kWh per sq. meter per day - the rest of the country, Fig. 1.

The energy flux is most intense in May, June and July. During this period, in central Russia, 1 sq. meter of surface accounts for 5 kWh per day. The lowest intensity is in December - January, when 1 sq. meter of surface accounts for 0.7 kWh per day

Solar energy converted into electricity with the help of PV modules covers only about 1% of electricity consumption in the world. Solar energy is mainly used to generate heat (in a very small percentage), where it is very cost effective and relatively popular in households for water heating. In the Belgorod region, use of solar energy for obtaining electricity and the use of photovoltaic modules is symbolic, although the conditions are favorable. The number of sunny days Belgorod is 2340h annually. That is higher value than in most European countries, but generally unused. More intensive use of solar energy will depend on the development and implementation of a national renewable energy sources program.

Analyzing the usage of solar energy in Europe, this area of Russia gives opportunity for more intensive use of the Sun energy. The horizontal surface A in Belgorod annually receives on average about 1500 kWh/m^2 of solar energy, on average:

$$E= 1500 \text{ kWh} / (m^2 \cdot yr) = 4.3 \text{ kWh}/(m^2 \cdot day) \quad (1)$$

This means that, after passing through the atmosphere, on the soil of Belgorod (154km^2) arrives in total:

$$E^* = E \cdot A = 2.31 \cdot 10^{11} \text{ kWh/year.} \quad (2)$$

2.2 Solar panels project in the Belgorod region

Solar panels have been installed in the Jakovljev district, Belgorod region, Fig.2.

Solar cells use solar energy to generate electric energy. The solar battery consists of photocells connected in series and in parallel. The principle of operation of photocells, as constituents of a solar battery, is based on the photovoltaic effect.

Fig. 2 *Solar field in Belgorod region, Jakovljev district, 2010*

In 2010, AltEnergo implemented a project to install 1320 modules of two types of photoelectric converters, (polycrystalline and amorphous) with an active surface area of 1046 m^2.

Polycrystalline solar cells consist of a semiconductor silicone applied to the plate. When sunlight it falls to its surface, electrons move, a constant electric current is created, which is then converted to alternating current.

In amorphous solar cells, the semiconductors in vacuum are divided into tiny particles, and the light effect becomes most intense, so that amorphous sources have a high productivity and can work in bad weather and low light.

Technical and economic indicators:

Nominal maximum power - 100 kW

Polycrystalline - 46 kW, power of one module - 213 W, area of module 170 m^2

Amorphous - 54 kW, power of one module - 50 W, area of 876 m^2.

The nominal maximum power of the solar power plant is 100 kW. Experts have chosen two types of batteries: domestic polycrystalline, with capacity of 46 kW (Ryazan Institute) and Hungarian amorphous, with capacity of 54 kW. In an area of 3.5 hectares, 1320 modules with an active area of 1000 m^2 were installed. Converters are positioned near the batteries. They convert direct into alternating current and supply to the network.

The amount of energy produced in this solar collector can provide electricity for a hundred apartments. The amount of electricity production directly depends on the weather, season and time of day. Amorphous solar cells are more efficient than polycrystalline ones for low solar fluxes because they absorb more efficiently the indirect radiation in cloudy weather and in winter, while polycrystalline solar cells are more effective in summer.

3. BIOGAS IN THE BELGOROD REGION OF RUSSIA

The Belgorod Institute for Alternative Energy is studying experiences in the application of these technologies and gives recommendations on the expediency of their replication, both in the region and beyond.

Many working groups in the Institute (including experts AltEnergo and visiting scientists from leading universities in the region) study the methods for improving the functioning of "AltEnergo" facilities - solar collectors, wind generators, biogas stations "Luchki". (5)

The main goal of the project is to improve the safety of the atmosphere and land by processing livestock and poultry manure. The Belgorod region has very developed agricultural sector. The most promising method is for processing waste materials in biogas stations, Fig. 3.

Resource potentials in the region allows the operation of biogas plants with total capacity of over 200 MW.

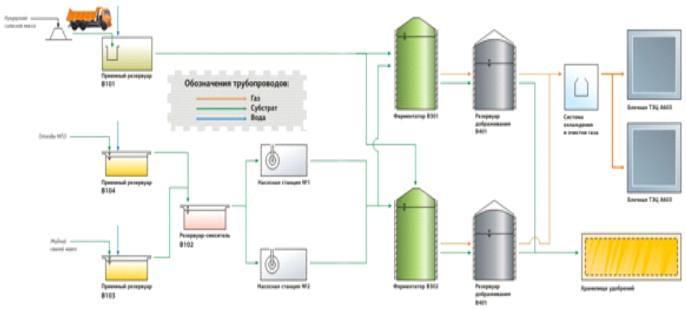

Fig. 3 *Biogas installation*

Construction of biogas plant by OOO AltEnergo started in October 2010 in the village of Luchki, district Prokhorov. In March 2012, the factory started the production cycle. Production in the projected capacity of 2.4 MWh was reached in July 2012.

Produced fertilizer and other organic raw materials are the base for the independence of production and supply for the infrastructure zones and production areas for fodder and poultry farms of the Belgorod region. Energy, heat, fuel, producing their own high-quality fertilizers, including organo-bacterial, which contribute to the production of high yields and improve land productivity.

The problem of reducing greenhouse gas emissions, as general practice, is solved by bioenergy plants in environmentally closed gas (biogas) conversion cycle. The process of processing organic waste into biogas helps in preventing the release of methane into the atmosphere - a source of unpleasant odors. Methane is known to have up to 40 times higher affinity for the formation of greenhouse effect than carbon dioxide and resides in the atmosphere for about 12 years. Recycled waste can be used as an environmentally friendly fertilizer, which would reduce the use of chemical substances, which would mean reducing the negative impact on groundwater too.

Biogas plant "Luchki" in figures for the year:

Installed power 2.4 MW,

Electricity production is 19.6 million KWh,

Thermal energy generation 21.2 KWh,

Production of organic biofertilizers 66.800 m^3,

Processing of 73.4 thousand tons of raw materials, (including 31 thousand tons of pig waste and 14.6 thousand tons of waste in meat processing).

There are no analogues in Russia in the production of electricity and heat from biogas-based plants on such scale.

4. CONCLUSION

Techniques and technologies, as well as equipment for use of renewable energy sources are rapidly evolving. Energy production from conventional sources is getting more and more expensive, which makes it attractive to invest in the field of free energy sources exploitation. Of high importance is the rise in awareness of the dangers of environmental pollution as well as everyday more pronounced effect of global warming. As a result of these pressures, many developed countries have introduced different models to subsidy the use of renewable energy sources, from tax cuts to procurement of equipment, to the mandatory purchase of electricity produced in households or micro power plants.

For this reason, this paper is dedicated to renewable sources energy used in Belgorod region of Russia. Special attention is paid to examples of the applications in both small and medium-sized households and companies. In this way, through individual examples, the wider use of renewable energy sources in Russia is encouraged and helps the local economic development.

Acknowledgement: *This research was financially supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia (Contract No. 451-03-9/2021-14/200109).*

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