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Analysis of usage of the renewable energy in Kyrgyzstan

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Abstract. The paper describes the analyses results of the possibility of using renewable energy in Kyrgyzstan. The research methodology development based on complex analysis of using kinds of renewable energy sources by conducted a preliminary survey of residences and semi-structured interviews with representatives from the local village administration. There has been analysed the potential energy of the solar, wind, river, biogas and geothermal sources. Generally, the geothermal sources are mainly concentrated in Issyk-kul region. The perspectives of their usage for energy supply is low due to poor-quality of heat resources. The available geothermal sources are used for medical purpose. Study outcomes provide information of using renewable energy sources for rational management of natural resources. Using renewable energy for Kyrgyzstan should be taken into account as a solution of population's socio-economic problems in the decentralized region.

Keywords: solar energy, wind energy, biomass, hydropower, geothermal sources.

1. Introduction

For mankind the creation of favorable condition in his life is one of the important tasks. Increase in level and quality of the life requires improving energy efficiency in houses and social buildings such as schools, kindergartens and hospitals. Nowadays in Kyrgyzstan the import of fuel energy resources is about 59% of coal and 98% of gas, extracted traditional sources of our country do not cover the demand [12]. The volume of fuel and energy resources grows with the increase in population. As the literature data show, today in Kyrgyzstan non –traditional renewable energy sources are used less than 1% of the potential use [1, 13]. Implementation and development of renewable energy sources will allow in significant mere reduce the volume of fossil fuel and material resources; also improve the ecological state of the environment. The reason of importance in developing renewable energy sources comes out of the problems of global warming and reduction of CO₂ emissions [20]. The solar, wind and biomass energies, hydropower can provide with energy the remote areas of rural population, and also can reduce dependence on fuel resources and makes possible to create an additional opportunities in the development of infrastructure and agro-industrial sector. Rational use of energy resources should be conditioned not only with the introduction of renewable energy sources, but also by their effective use.

The aim of this research is to study the use of renewable energy sources, assessment of their possibilities and perspectives in Kyrgyzstan. The given tasks include the analysis of solar and wind energy, biogas, hydropower and geothermal sources to determine the economic feasibility of their use.



2. Materials and methods

The given methodology is structured in the following basic sequential steps: (i) select the literature of relevant sources for studying this subject and conducting analysis; (ii) compile a set of questions as required surveys and select groups of respondents and their analyses; (iii) develop recommendations on using renewable energy sources in rural areas. There was conducted individual survey of residents in rural areas for questioning. Respondents were identified by random sampling.

3. Results

Results of this analysis are given below:

Solar energy. The territory of Kyrgyzstan is represented by a mountainous relief about 94% and stretched in the direction of geographical latitude. The country altitude varies from 800 to more than 4000 meters above the sea level. Therefore, the solar radiation intensity as a whole varies insignificantly, and the difference in altitude of individual regions locations cause unequal impacts on heat from the sun. The solar radiation intensity is determined by climatic conditions, geographical location of the terrain, slopes exposure, also the time of a year and the day [1, 3, 4]. Direct solar radiation prevails in the highland region during the year. Fig. 1 shows monthly averages of solar radiation during the year in a high-altitude region. Increase in the solar radiation takes place in warm period from April to August and it increases again from October. Total solar radiation of the investigated region is 843.243 kW/m^2 . The maximum value of solar radiation reaches 1084 Watt/m^2 .

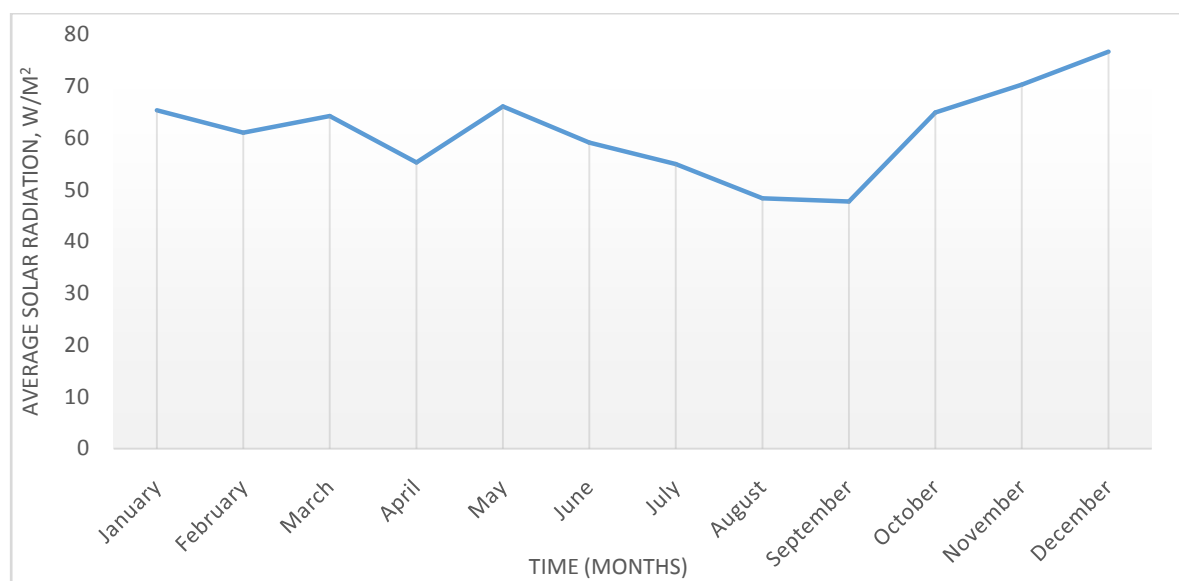


Figure 1. Average monthly solar radiation

Wind power. We analyzed the average monthly wind speed from 2016 to 2017 in the study area. In this period, the maximum speed reaches 13 m/s and the average annual wind speed shows 4,632 m/s. As the analysis shows (Figure 2), wind currents in the foothill zones have small energy potential.

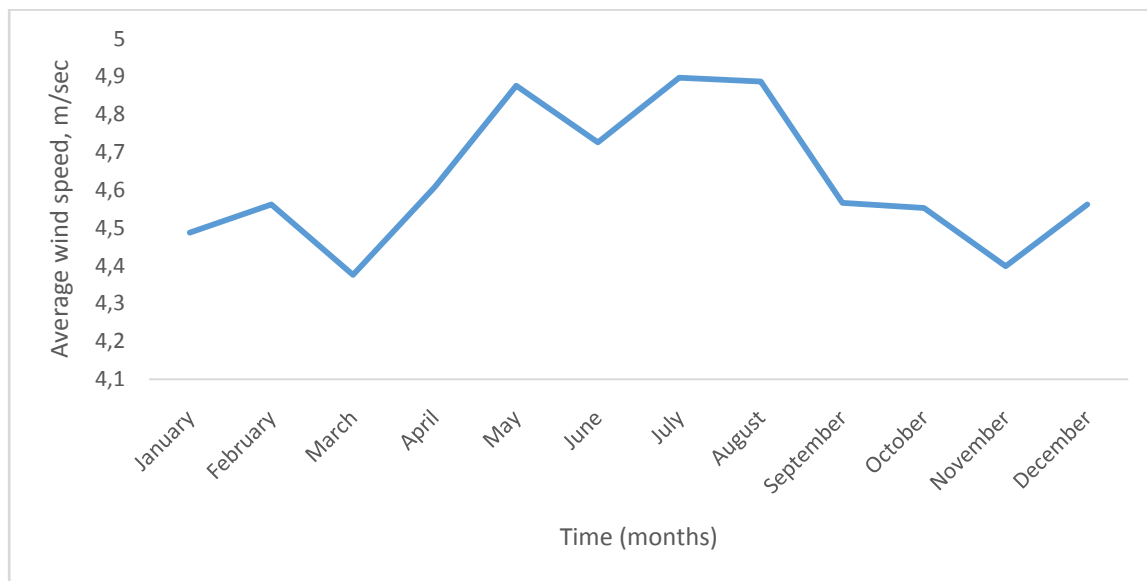


Figure 2. Average monthly wind speed

Energy of biomass. Currently in Kyrgyzstan, there are approximately 1.5 million heads of cattle and also the main source of biomass. In addition, there is biomass from the cultivation of agricultural plants. Potential of biomass energy use is estimated at 9.732 thousand TJ per year. Residents of rural areas use dung for heating their houses. Total forest area is 5.6% of the total country territory or about 1.2 million hectares [2, 15]. According to experts analyses, forest biomass is not suitable to use in energy purposes due to its seasonality, geographical dispersion and remoteness from populated areas [15].

Hydropower engineering. There are about 2,047 rivers streams in the territory of Kyrgyzstan and streams more than 10 km long [5]. Currently, the potential of Kyrgyzstan's small hydropower as total hydropower potential of 252 large and medium-sized rivers makes more than 80 billion kW·h per year [2]. Electricity consumers are dispersed in the upper and middle sections of small watercourses. The main large rivers in Kyrgyzstan are Naryn, Talas, Saryzhaz, Chatkal, Chu and Karadarya [2]. The existing hydroelectric stations are located on the Naryn River with a total capacity of 2,870 MW and with an average annual power generation of 12-15 billion kW·h. The hydropower potential of 267 large and medium-sized rivers makes 27,950,000 kW in power [5]. The potential of hydropower resources of small rivers and streams is about 5-8 billion kW·h per year, but only 3% is used.

Geothermal sources. In general Kyrgyzstan geothermal sources have a low-temperature character of thermal resources and the temperature does not exceed 55 ... 60 °C. The main geothermal sources are located in recreational areas of the Issyk-Kul region. In resort areas, the energy of these sources are used for heating and hot water supply. There are more than 100 hydro mineral deposits in Kyrgyzstan. Depending on the chemical composition water is divided into: salty and bitter-saline, carbon dioxide, siliceous thermal, radon, sulphide and iodine-bromine [11]. About 30 sources have carbon dioxide, as well as more than 50 places refer to warm and hot springs that are available in the form of rhodonic, sulphide and ferruginous in chemical composition. The presence of carbon dioxide deposits can be found in the territory of the Fergana Range, in the basins of rivers Jazy, Tar, Arpa, Kara-Kulzhy and in Ak-Say, Jumgal, Issyk-Kul valleys [18]. According to the chemical composition, these sources are of type of hydrocarbonate-calcium and hydrocarbonate-sodium with a mineralization of 1.8 to 40 g/l. They have strong therapeutic properties. These deposits have been

studied unevenly, many of them are known only for facts of existence, and some of them have detailed exploration work and, basically they are used as spa local hospitals.

Geothermal sources in Chui oblast are located in the central part of eponymous basin, Ak-Suu and Alamedin deposits are located in the middle and foothill part of the Kyrgyz ridge. The appearance of first source from boreholes with a depth of 1500-2000 meters is characterized by a chloride-sodium composition with mineralization of 6-18 g/l and spout temperature of 39 °C with operational reserves that make 466 m³/day. From the second source are produced nitrogen thermal mineral waters along the boreholes at depth of 600 m. The composition has chloride sodium-calcium type and sulphate-chloride sodium-calcium type with salinity of 0.3-2.2 g/l and spout temperature of 41-53 °C with a margin of about 345 m³/day. On the northern slope of the middle part of the Kyrgyz ridge there is Issyk-Ata field with mineralization of 0.2 g/l and spout temperature of up to 55 °C. The operational reserves of this source are 2203.2 m³/day [11, 18].

A large number of geothermal sources are located in Issyk-Kul region (Figure 3). In the coastal zone of Issyk-Kul Lake, geothermal deposits are used for medical purposes. Other sources, such as Juukuchak, Bozuchuk and Chon-Kyzyl-Suu, located on the northern slope of Terskey-Ala-Too are only slightly used by the local population, and most are almost not used. On the northern and southern coast of Issyk-Kul Lake, there are 24 wells with a depth of 800 to 1960 m, 21 of them are mineral waters with valuable balneological properties [18]. The temperature of these sources varies from 36 to 50 °C with a mineralization of 2.7-40 g/l and with wells productivity of 2.5-6 l/sec. The exploitation reserves of deposits on the southern slope of the Terskey Ala-Too mountain range - Arabel and on the northern slope - Ulahol and Turasu, are 62 thousand m³ per day [11].



Figure 3. Map of geothermal sources location in Issyk-Kul oblast

In Fig. 3. is shown the location of geothermal sources in the Issyk-Kul region. For example, well No. 6732 (1/75) was drilled in 1975 and has a depth of 1960 meters, with a water temperature of 40-42 °C. The chemical composition is characterized by slight mineralization of 0.3-0.4 mg/dm³, pH is 7.8. This source belongs to chloride-sulphate-hydrogen carbonate sodium composition [11].

The analysis of other country territories revealed that in Naryn region of the Kochkor and Jumgal basins in 1970, there were drilled 5 exploratory wells [11]. Potential reserves of these sources were calculated in the amount of 2.8 and 10.4 thousand m³/day, respectively. The operational reserves of the Jalal-Abad field are 1814 m³/day. The sources are characterized by nitrogenous thermal mineral waters with mineralization of 1.5 g/l. According to chemical type they belong to sulphate-chloride sodium-calcium water with a temperature on the spout of 30-50 °C. The sulphate-chloride sodium-magnesium waters with mineralization of 4.8 g/l and temperature of 45 °C also were found in the Tash-Kumyr fields at a flow rate of 5 l/sec. There are also sources of chloride-carbonate sodium-calcium type, sulphide in Maily-Say and chloride-sodium waters in the north-east of the town Kochkor Ata. The reserve of the last source is 338.4 m³/day and temperature reaches 85 °C at the mouth [18].

Low-resource sources are located in the Batken region on the Sarybel site with mineralization of 0.5 g/l, at flow rate of 432 m³/day and with temperature of up to 42 °C. The mineralization of the Archa-Bashi, Djilis and Gaumysh deposits is 0.5-0.9 g/l in spill over 42 °C and reserve of 850, 85 and 90 m³/day, respectively. In Osh region, there was drilled well No. 877 and the source is an analog of Jalal-Abad, which belongs to the composition of chloride-sulfate magnesium-calcium water with mineralization of 2.7 g/l. In the basin of the Iasi River there is a deposit of carbonic waters of Kara-Shoro. According to the chemical type, this is hydrocarbonate chloride and sodium chloride water with a salinity of 1.2-35 g/l and the operational reserves are 173 m³/day [11]. The technical potential of using Kyrgyzstan geothermal energy potential is about 170 GJ per year 27% of the reconnoitered sources [13]. According to experts' estimates, it is economically feasible for developing such sources reach 22 GJ per year.

4. Conclusions

The analysis shows that Kyrgyzstan has huge resources of renewable energy sources. Using the solar energy, hydropower and biomass is most appropriate in the territory of the country. Nowadays, using geothermal sources for energy purposes, namely, for heating and hot water supply is not extended. The temperature of the studied sources in average is 53 °C, it is also characterized by quite high mineralization and scaling and corrosion of materials. These parameters characterize the sources aggressiveness in respect to the metal and therefore their use is limited. As practice shows, using geothermal sources in the resort areas of Issyk-Kul oblast should provide the back-injection of waste water into the reservoir. Thus, the energy use from renewable energy sources occupies a small part of their total potential. The reason is the low solvency of the population for implementation and at the same time there are no incentive grants from the state.

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