Some Methods for Assessing Wind Energy Resources of the South of Kyrgyzstan

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Abstract: The article discusses the creation of geographic information systems (GIS), which allow you to quickly and in detail analyze various alternatives based on the available geographically-related information for assessing the consequences of plant design options in a given wind power industry with the goals of ensuring sustainable development of the region. This mainly relates to energy facilities and systems that use wind energy sources, with their high spatial and temporal irregularity and variability. In accordance with the tasks that determine the necessary design parameters, the requirements for the initial physical-geographical, climatic, metrological, wind energy resources and energy-ecological potential information necessary for creating a GIS database arise. Estimates of wind energy and its distribution over the territory is hampered by the limited amount of energy potential in time and space. With the help of GIS, energy, economic, environmental, social issues and climate change mitigation opportunities can be solved on the basis of wind power plants, and their resources, environmental benefits, goals and objectives on scientific and methodological foundations in the field of wind power for the implementation of state programs of Kyrgyzstan for energy supply in the region.

1 INTRODUCTION

The Kyrgyz Republic is one of the states with huge renewable energy potential. First of all, it is the energy of the sun and watercourses, wind energy and biogas. The calculations of experts show that potentially renewable energy sources in Kyrgyzstan can replace up to 50,7% of the need for fuel and energy resources consumed by the republic today [1].

Use of renewable energy sources to the republic is “dictated” by natural specificity. Almost 90% of the total area of the country is occupied by mountains. Most of the population (more than 60%) lives in rural areas in the foothills and mountains, where access to traditional fuels is difficult [2]. This makes it advantageous to use local autonomous renewable energy systems that do not require connection to existing electrical networks. The use of wind power plants for power supply of such consumers will be much cheaper. The lack of good roads in the mountains, their insufficient length and branching makes the delivery of traditional fuel and energy resources (coal, gas, fuels and lubricants, etc.) very expensive. For poor, low-powered and autonomous consumers, such expensive fuel will not be affordable. In this situation, renewable energy is the only available opportunity for villagers to solve energy problems.

2 METHODS FOR ASSESSING WIND ENERGY RESOURCES

The potential of wind energy in the regions of the Kyrgyz Republic is different and varies depending on the speed from 0,8 to 6 m/s [3]. Estimation of wind energy potential, based on generalized statistical data of weather stations and methods for calculating wind reserves based on known average annual wind speeds, made it possible to establish that the Republic wind potential is 49,2 105 ton of fuel. An analysis of the specific power of the wind flows in Kyrgyzstan shows that it varies within fairly large limits. According to annual data, it is 40-180 W/m^2, and monthly – 30-230 W/m^2, the average – 100 W/m^2. The average annual specific energy of the wind flow varies from 170 to 1300 kWh/m^2. Their mean monthly values, as a rule, do not exceed 50-60 kWh/m^2. Analysis of the data shows that for large-scale and medium-scale wind power, the dispersion of indicators makes it possible to use only 17-22% of the potential wind power resources to be economically justified. However, a comparison of the need for small objects in electrical energy with the data of the wind inventory shows that for this type of consumers the wind energy potential is sufficient and can be successfully used to cover their energy needs. According to estimates, out of 2 billion kWh per year of the gross potential of the energy of wind flow in Kyrgyzstan, no more than 140 million kWh are technically justified, no more than 4 million kWh can be considered economically viable for development. This is due to the specific conditions of the distribution of the wind rose in the highland regions. Analysis of the wind flow features showed that over 50% of all Kyrgyz winds fall on light winds and calm, 30-40% on light winds (2-5 m/s) and the rest on moderate and fresh winds (6-10 m/s).

From the meteorological data, the average wind speed in the foothill areas of the Osh region reaches up to 20 m/s, which indicates the possibility of large-scale use of wind power installations. According to regulatory data, if the wind speed is in the range of 4,5 to 20 m/s, then these figures are considered sufficient for the introduction of wind power plants in these areas.

In Table 1-6 shows the average monthly and annual wind speed, repeatability of wind directions (in %) per year, average monthly and annual wind speeds at different hours of the day, the number of days with strong wind (15 m/s), the probability of wind of different speeds in directions in %, wind speed for 2017 for the city of Osh. The most densely populated valleys with an average annual wind speed are summarized and given in Table. 7

Table 1: Average monthly and annual wind speed, m/s.

	I	II	III	IV	V	VI	Year
Osh	1,9	2,1	2,3	2,4	2,8	3	2,3
	VII	VIII	IX	X	XI	XII	
	2,5	2,4	2,4	2,4	2	1,8	

Table 2: Repeatability of wind directions (%) per year.

Direction	N	NE	E	SE
Osh	6	6	5	8
Direction	S	SW	W	NW
Osh	45	5	14	11

Table 3: Average monthly wind speed at various hours of the day, m/s.

		I	II	III	IV	V	VI
Osh	1	2,3	2,4	2,4	2,8	2,9	3,4
	7	2,2	2,4	2,3	2,4	2,8	2,9
	13	1,5	2	2,8	3	3,2	3
	19	1,7	1,4	1,5	1,5	2,3	2,7
		VII	VIII	IX	X	XI	XII
	1	3	3	2,8	2,9	2,2	2
	7	2,6	2,4	2,4	2,3	1,9	2
	13	3	3	3,1	2,9	2,1	1,7
	19	1,5	1	1,3	1,6	1,5	1,6

Table 4: The number of days with strong winds (15 m/s).

	I	II	III	IV	V	VI	Year
Osh	0,9	0,4	0,6	1,8	1,9	3,2	0,9
	VII	VIII	IX	X	XI	XII	
	1,4	0,2	0,1	0,2	0,2	0,4	

Table 5: The probability of wind of various speeds in the directions, %.

	Speed, m/s	N	NE	E	SE
Osh	0 – 1	3,2	2,8	3	3,4
	2 – 5	3,06	3,2	2,6	4,3
	6 – 9	0,07	0,2	0,2	0,14
	> 10	-	0,01	0,1	0,02
	Speed, m/s	S	SW	W	NW
	0 – 1	18,1	2,4	4,9	4,36
	2 – 5	25,6	2,5	6,9	6,6
	6 – 9	0,57	0,2	0,94	0,07
	> 10	0,05	0,07	0,15	0,01

On a large part of the flat and foothill zones, where the main low-power consumers are located, its energy potential is low. In zones where there are winds with high energy potential and wind speeds of 8-12 m/s, consumers are practically absent. Therefore, it seems promising to develop small wind energy (1-10 kW units) and, first of all, for the power supply of low-energy autonomous consumers located in decentralized foothill and remote mountainous areas.

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Table 6: Wind speed in Osh for 2017.

2017 year	Month					
	Jan.	Feb.	March	April	May	June
I decade	0,64	0,65	0,89	0,94	0,79	0,9
II decade	0,76	0,81	0,77	0,99	0,93	0,92
III decade	0,75	0,81	1,08	0,87	0,87	0,71
Month average	0,72	0,75	0,92	0,93	0,86	0,84
Month maximum	5,5	6,63	8,32	9,19	8,18	13,53
	July	Aug.	Septem.	Octob.	Novem.	Decem.
I decade	0,9	0,85	0,60	0,54	-	-
II decade	0,7	0,76	0,64	0,59	-	-
III decade		0,68	0,62	0,58	-	-
Month average	0,8	0,76	0,60	0,57	-	-
Month maxi-mum	6,94	8,42	6,10	7,0	-	-

Note: The wind speed is defined in m/s. The maximum wind speed is an instantaneous value (gust).

Table 7: Average annual wind speed.

№	Name of the observed areas	The number of days in a year a strong wind of 10-25, m/s	Average annual speed, m/s
1.	Sary - Tash	7	2,5
2.	Dzantyk	45	3,5
3.	Daroot - Korgon	14	2,6
4.	Kyzyl - Dzhar	9	2,4
5.	Gulcho	2	0,8
6.	Ozgon	5	1,6
7.	Osh field	10	2,3

All of the above factors indicate the urgent need to develop a wind energy inventory. To systematize the characteristics of the wind situation in a particular region for the purpose of its efficient energy use, as a rule, a wind energy cadastre is developed, which is a combination of upper-air and energy characteristics of the wind, allowing determining its energy value, as well as appropriate parameters and operating modes of wind energy installations. The main characteristics of the wind energy inventory are:

- Average annual wind speed, annual and daily wind speed;
- Speed repeatability, types and parameters of velocity distribution functions;
- Maximum wind speed;
- Distribution of wind periods and periods of energy lag by duration; - specific power and specific wind energy;
- Wind energy resources of the region.

The most convenient way to use the wind energy cadastre is the development of a geographic information system (GIS) “Wind Energy Cadastre of Kyrgyzstan”.

The final task of the developed GIS technology is the formation of a benevolent information environment for the user a visual map.

The data can be used by end users, whether it is an investor or a farmer, a person engaged in farming, animal husbandry, bee keeping. Why install wind turbines in a particular area, the area with what power type wind turbines, the interested person can find the answers through the global network.

If the GIS inventory is multi-component either includes the wind, the sun's biomass, the flow of the rivers, this makes it possible to estimate the energy potential as a whole, it also makes it possible to predict the climatic conditions, the weather, the yield, of a particular region or area.

3 CONCLUSION

As the studied experience shows, one of the obstacles in the practical use of renewable energy technologies is the low public awareness of the possibilities of these technologies and technical illiteracy in the installation and operation of equipment. Therefore, it is extremely important to conduct educational work among the population to disseminate information about these technologies.

Mapping of wind - energy resources would give a preliminary assessment of measures to reduce emissions in the energy sector from the use of wind turbines from one meter square.

GIS will allow assessing the competitiveness of the projects considered regarding quotas in the region and rank them according to the degree of attractiveness to investors.

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