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Internet Portal for Evaluation of Solar and Wind Energy Resources

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Abstract- This scientific paper presents the results of using the software called "Internet Portal for Renewable Energy" developed at the State Energy Institute of Turkmenistan for a quick and accurate assessment of solar and wind energy resources in Turkmenistan. Studies have shown that the use of a software product allows you to quickly determine the resources of solar and wind energy in a given coordinate, which in turn affects the efficiency of the construction of the station.

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I. INTRODUCTION

Nowadays it is carried out combined works in order to increase the capacity of power energy industry, to strengthen its infrastructure and to modernize the all components of system in accordance with program of developing the power energy sector in our country [1].

Works are being done in order to accelerate the development of economic sectors and to simplify the services supplied to population with the help of digital technologies. With the purpose of improving the digital service system, some next tasks are being planned to be done in the economic sectors.

- To offer innovative equipment, technologies, leading methods and practices to the production in the science system;
- Remote collection of information about usage of energy sources in the power energy sector, creation of centralized report center for complete and mutual exchange of information across the country and to continue the improvisation of digital database. By wide implementation of digital technologies, it will have an opportunity to analyze the losses in the sector. Moreover, in order to strengthen the observation of usage of power energy, it is planned to place the energy saver and remote controlled lighting columns.

In connection with it, it is approved "The Program of President of Turkmenistan on socio-economic development of the state for 2022-2028" by the Decree No. 179 which is passed on July 8, 2022 by the President of Turkmenistan. In the respective article of

Program: with the purpose of "providing ecological advancement and developing «green economy»":

- To conserve the nature and biological diversity of our country;
- To establish the use of energy saving materials and technologies, producing and consuming the renewable energy sources;
- To reduce the material wastes that pollute the environment;
- To construct the solar and wind energy stations [2].

To put leading technologies of science into production and to benefit from them actively and effective solution of the technical problems arising in connection with establishment of waste-free production will be guarantee for regular operation of the system. In this case, it is vital task to solve the issues arising in connection with creating the internet portal which is digital system of evaluation of renewable solar and wind energy sources.

II. METHOD OF SCIENTIFIC-RESEARCH

It is considered suitable to use several type of renewable energy sources simultaneously that is to say to use combined technologies in order to supply the consumers with power energy [4]. Reliable and effective operation of combined solar and wind energy installments depends on several factors. So it includes geographical location of installation place of combined technologies, annual values of solar radiation rate that hits the surface inclined to suitable angle according to the horizontal surface of solar installations, suitable inclination angle for respective place of solar energy installations, outside air temperature, speed and duration of wind flow, wind directions and repetition, average values of annual specific capacity of wind.

On the basis of these notes, it is considered as significant issue to determine annual power energy productivity of photoelectric solar and wind energy installations, to specify its location which is planned to construct, as well as to study the impact of weather conditions to the energy parameters of station. Because annual productivity of photoelectric solar and wind stations depends on the technical-economic indicators of project. And this arises the importance of designing the digital system of working out the solar and wind energy cadaster on regions in where the project is planned to be implemented.

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Scientific-research works are done on benefiting from technologies which are directed to solve arose issues related with this field [5]. Nevertheless, when the solar and wind energy cadaster is worked out on respective regions, it isn't taken into account the analysis and comparison of information in the satellite database.

Therefore, it is required to use database of NASA, to make an analysis and to develop an opportunity of digital system in order to calculate total solar radiation and average speeds of wind on regions of our country. So it has to be provided the sequence of various sources of wide information for working out the solar and wind energy cadaster on regions. The regular and accurate operation of technical means is important when the various information sources are used. It is described with arising of some unintentional technical errors which are not taken into account. As a result, it brings about inaccurate measures of calculation which is made in the frame of project, extension of project period and wrong options of components of energy installations. And this directly produces an effect to the values of technical-economic indicators of project. Accordingly, it is the major task to solve the vital issues on precise designing of solar and wind cadaster on regions, giving accurate values to the technical characteristics of energy installations under the renewable energy sources and determining the reliable operation capability of installations. For effective solution of priority tasks, the major goal of research work is to provide the digital system, which includes fast and reliable system on evaluation of solar and wind energy sources. In the research work, it is being analyzed the calculations and applied usage opportunities of web portal with name "Internet portal of renewable energy sources" on doing project works in the scientific-production center "Renewable energy sources" of State energy institute of Turkmenistan. To develop the renewable energy of state is the major way of providing stable development in the economic sectors of Turkmenistan, to diversify the fuel-energy means and providing long-term, stable development of energy sector. In order to provide the remote regions from the central energy supply system with affordable and clean energy, to better the wellbeing of population and to develop the industry, and also to meet the purposes of Paris convention on stable development and Climate change, it is adopted "National strategy on developing the renewable energy until 2030 in Turkmenistan" by the decree of President of Turkmenistan. In the program of national strategy, it is set tasks such as "Learning and preparing offers about places and fields which have opportunities to install industrial solar and wind energy stations", "Creating general database on determining the potential of solar and wind energy sources" and "Creating the internet portal of renewable energy sources" [3]. With the decree of Arkadag Serdar, it is

planned "To prepare offers for designing and putting into production the ecologically clean advanced technologies which are directed to use solar, wind and hydrogen energies for 2022-2028" according to the "Program of President of Turkmenistan on socio-economic development of state for 2022-2028" which is directed to develop the economic capacity of our state and to better the living conditions of our people [2].

By considering the importance of arisen issue, general database of digital system is created on evaluation of solar and wind energy sources. In the database of center, it is worked out improved methods to determine the installation place of photoelectric solar and wind energy stations on regions of our country, to increase reliability of system by using digital system on evaluation of solar and wind energy resources in the region. On the basis of active usage of worked out general database center, it is evaluated the potential of solar and wind energy sources, is determined the parameters and operation capacity of photoelectric wind and solar energy stations as well as it is evaluated the solar and wind energy capabilities by digital system in any regions of our country in the considering point of project. Solutions on conducted analysis are taken in short time with high accuracy and it is determined an economic effectiveness of solar and wind energy resources. As a consequence of correct option and combined usage of components of energy installations under the renewable energy sources, it is the main factor for accepting positive solutions on regular supply of consumers with clean power energy even in the unsettled weather conditions according to the seasons during the year. And also it completely includes the opportunities of transferring the calculations into the "pdf", "doc", "xls" files and printing.

Internet portal which is produced in the scientific-production center consists of following sections: home page, about center, projects and cooperation; programs; and contact. On the home page of internet portal, it is placed vast information about the potential of renewable energy sources in our country. In the section of "About center", it contains information about achieved outcomes, achievements and research works being carried out in the scientific-production center of "Renewable energy sources" that works in the State energy institute of Turkmenistan. In the section of "Projects and cooperation", it is given analysis to the works and projects which are done on renewable energy sources of our country and also to the works according to the programs of international cooperation.

Section of programs involves several subsections. These are: digital system of designing the photoelectric solar station; digital system of evaluating the solar energy; digital system of designing the wind energy station; digital system of working out wind energy cadaster; database.

In the section of “Digital system of designing photoelectric solar station”, it is available to determine the monthly and annual inclination angles of solar panels according to the horizontal surface and daily, monthly and annual power energy production capacity of selected solar panel at those angles on selected region and also it gives an opportunity to compare the productivity graphics of solar radiations and solar panels. It is also being determined the productivity of solar panel under the any inclination angle according to the horizontal surface in the selected region.

In the section of “Digital system of evaluating the solar energy”, when you click any point on the map of our country, software application automatically shows the respective point’s northern latitude, eastern longitude, monthly solar radiation rate that hits the 1m^2 horizontal surface on that latitude, monthly and annual suitable inclination angle according to the horizontal surface of solar installations and rate of solar beam that hits to 1m^2 surface in case of inclination of solar installations to those angles. In the section of “Digital system of designing the wind power station”, it is available to carry out the project works related with designing the wind power stations in easy and reliable method and to determine the wind energy resources in the region. This subdivision also contains some sections such as: calculation, regions, speed at heights and wind direction.

In the calculation section, it is being defined the hourly, daily and monthly power energy productivity of wind power stations and is being drawn comparison graphics of power energy productivity on selected region. In this section, it is also being given analysis to the power energy productivity of wind power stations during the years for selected region which exists in the database. In the section of “Regions”, it is evaluated the wind energy resources of regions inserted to the database and suitable locations are made analysis for installing the wind power stations and the most suitable locations are chosen. In the section of “Speeds at heights”, it is assessed that there are various indicators of wind speeds at various heights. In this section, wind speeds are determined at various heights (between 10 meters and 100 meters) on regions inserted into the database. In the section of “Wind direction”, wind directions, one of the main indicators of wind cadaster, are taken into account and wind directions on regions inserted into the database are determined.

In the subdivision of “Digital system of designing the wind energy cadaster”, it is provided high accuracy of result by improving the digital system on calculation of wind energy cadaster. This subdivision includes units that contain vast information about an annual average wind speed, annual and daily change of wind, repetition of wind speed, repetition of wind directions, maximum wind speed, specific capacity and specific energy of wind, wind energy resources of wind

which give an opportunity to conduct respective calculations.

In the section of “An average wind speed”, it is determined the monthly and annual average wind speeds at various heights and is drawn comparison graphics on selected region. Multiyear average wind speeds characterize its condition in a long time. In this period, it is clarified that wind rate changes in wide ranges and is taken into account the daily changing time during the year. In the designing of wind energy cadaster, such changes are described as annual and daily changes of wind.

In the section of “Daily change of wind”, it is given analysis of daily change of wind speed at selected height on respective date in the region. Repetition of wind speed is considered as one of the main cadaster characteristics that needs to be approached with responsibility. It shows the blown time of winds with same speed in the observed period. It is identified the wind energy potential with the help of this characteristic and is determined the effectiveness of wind energy usage. It is still complex issue on determining the repetition rate of wind speeds. As a result, in the section of “Repetition of wind speed”, it is identified the repetition of wind speeds at any heights in the selected region.

One of the other main indicators of wind energy cadaster is a repetition of wind directions. The repetition of wind directions shows the blowing directions in the time intervals. In the section of “Repetition of wind directions”, it is also determined the blowing percentage of wind direction from each side in the selected region. Information about maximum speeds of wind is the main component of wind energy cadaster. It is vital to earn rigidity of special parts and components (tower, blades, adjustment structure of wind wheel according to the wind and others) of wind energy installation. Inaccurate record of given information about maximum wind speeds causes incorrect selection of construction of wind energy installation. This causes structural damage of construction in regions with a strong wind because of putting into operation of constructions with lack rigidity. In the section of “Maximum wind speed” of digital system, maximum wind speeds are determined at various heights on regions of our country. Annual average specific energy of wind (wind energy blows from 1m^2 cross section) depends on repetition of wind speeds. In the respective subdivisions of “Specific capacity and specific energy of wind” section, it is defined monthly, annual average specific capacity and specific energy of wind at various heights on selected region and their comparison graphic is drawn.

Continual placement of innovative technologies into production gives great opportunities for consuming the wind energy installations widely. In the subdivision of “General potential of wind resource” of section “Wind energy resources of region”, it is determined the

monthly and annual general potential of wind resource at various heights on selected region and its graphics are drawn. In the subdivision of "Technical potential of wind resource" of this section, it is considered to determine the monthly and annual technical potential of wind resources at various heights on selected region and the opportunity of drawing its graphics according to the taken values.

In the internet portal of renewable energy sources, it is available to insert information and to do various operations on it by user who has right to "Administrator". Database section consists of several subdivisions and contains information about solar beam rate in respective regions of our country and also information about technical indicators of photoelectric solar panels, accumulator batteries, controllers, inverters in the project of photoelectric solar station and technical indicators of wind power stations, annual and hourly average wind speeds in various regions and wide information about blowing directions.

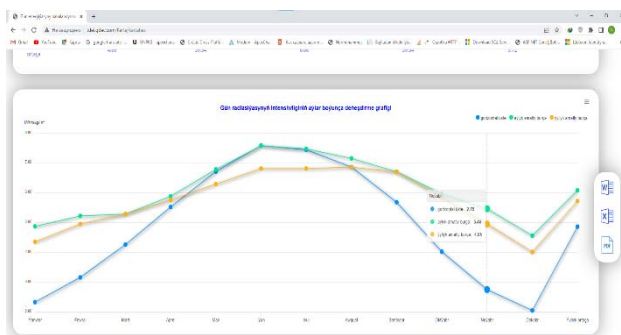
It has an opportunity to insert various information about solar beam rate of new regions and wind characteristics, to change technical indicators of components of photoelectric solar and wind power stations and to make corrections to existing information and to delete information from database.

III. RESULTS AND DISCUSSION

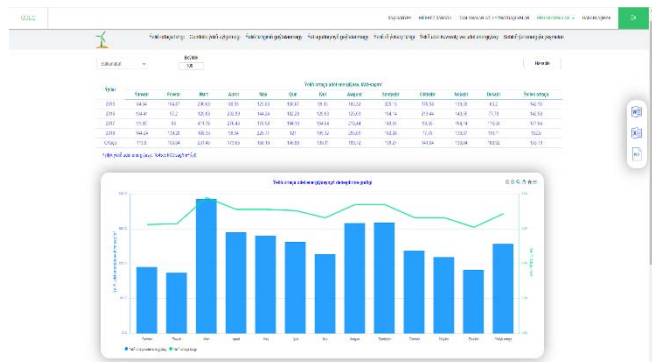
As a consequence of consuming digital system, it is determined the values of solar beam rate that hits the 1 m² horizontal surface as solar installations are

installed by directing to south – 1778,15 kWt-hour/m², monthly inclination values to β angle according to the horizontal surface of solar installations, values of solar beam rates that reach to 1m² surface of solar installations inclined to monthly suitable angles – 2218,63 kWt-hour/m², values of solar beam rates that reach to 1m² surface of solar installations inclined to annual suitable angles – 2087,55kWt-hour/m², (1st a picture) on Bukri village of our country, also it is defined annual total values of wind energy sources, blowing directions and an average values of annual specific capacity of wind at various heights – 1845,5 kWt-hour/(m²-annually) (1st b picture).

As a consequence of consuming the designed digital system, it is determined the values of solar beam rate that hits the 1 m² horizontal surface as solar installations are installed by directing to south – 1778.15 kWt-hour/m², monthly inclination values to β angle according to the horizontal surface of solar installations, values of solar beam rates that reach to 1m² surface of solar installations inclined to monthly suitable angles – 2218,63 kWt-hour/m², values of solar beam rates that reach to 1m² surface of solar installations inclined to annual suitable angles – 2087,55kWt-hour/m², (1st a picture) on Bükri village of our country, also annual cumulative values of wind energy sources, wind directions and average values of annual wind power and wind energy at different altitudes were determined for the city of Balkanabatcity – 1845,5 kWt-hour/m², (1st b picture).



a)



b)

1st Picture. Internet Portal for Evaluation of Solar and Wind Energy Sources on Regions

In the scientific work, calculations of solar power stations with various capacity are made especially for power supply of populated remote areas on the basis of information gathered in the base of internet portal. In order to construct wind energy installations, suitable locations for installing wind columns are determined with the help of digital system on regions of our country and now it is established the evaluation of wind energy resources on respective latitudes in scientific basis. Digital system portal which is used to evaluate the solar

and wind resources of our state is designed and Certificate with №290 is issued by state agency on Intellectual ownership of Ministry of Finance and Economy of Turkmenistan and is officially registered [6].

IV. CONCLUSIONS

1. Internet portal is designed in order to assess the solar and wind energy resources of Turkmenistan and general database center is created on

determination of solar and wind resources' potential of our state.

2. According to the technical task for constructing various capacity solar power stations in order to supply the populated remote areas with power energy, it is carried out the project of various capacity solar power stations.
3. Certificate with №290 is issued to the designed web portal by state agency on Intellectual ownership of Ministry of Finance and Economy of Turkmenistan and it is officially registered.
4. It is specified that received information can be used to determine the construction sites of solar and wind energy installations in the region.
5. Suitable places of installing wind columns in order to construct wind energy installations are determined with the help of digital system.

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