# Data sources for RES evaluation

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**Abstract**

Usage of renewable energy sources (RES) – is a modern powerful trend in energy development. "Green energy" technologies (technologies of gathering energy from renewable sources) are actively developed and will allow in the future significantly to reduce use of non-renewable resources (oil, gas, coal, peat), reduce the ecological impact of energy plants, improve the ecology around populated areas, reduce the cost of obtaining energy in some cases, increase the autonomy of life support systems and energy security of the country Heterogeneous data are needed to evaluation renewable resources. Paper considers data sources that accessed for researchers. The Kazakhstani problems are briefly discussed.

*Keywords:* Renewable energy resources, data sources, information systems

## 1 Introduction

According the expert calculations the potential of the renewable energy sources in the Republic of Kazakhstan exceeds one trillion kWth yearly [1, 2], of which less than 0.1% are used (as mentioned below). The use of RES is associated with a certain complexity due to the dependence of the systems performance from random natural factors. Wind speed, solar radiation, hydropower resources can't be predicted exactly. Due to the depletion of the fossil fuel and ecological problems, the role of RES and of the more intellectual systems of energy distribution is going to increase. To solve the problem of RES evaluation we need collect several kind of data. Information system should collect weather, geographical and social data. After analysing gathered data the system can support decision making process.

## 2 Data sources

Energy resources monitoring tasks imply collecting data from different sources. Weather stations, autonomous sensors, remote sensing data, surface images from satellites, results of mathematical modelling can serve as the data sources for the parameters of the environment. Besides crowd source data-mining gradually becomes of more importance [3]. SETI@home, Galaxy Zoo, Citizen Weather Observer Program (CWOP) serve as the examples of such projects [4]. The latter is intended to collect meteorological data by the community of users, providing the data to the weather forecast services and to the security services, providing the feedback to the users in order to improve the quality of the collected data. The data received by the project is used in the universities, research centres, weather forecast services etc. The data collection in this systems is performed by the weather stations owned by the enthusiasts, by measuring the temperature of the mobile devices' batteries [5] etc. E.g. OpenWeatherMap [6] project uses the data from private weather stations in order to improve the accuracy of the weather forecasts as the number of measuring points is more important in predicting than the accuracy of the measurements.

For European researchers, several databases are available. For example, some databases present data for solar radiation of varying levels (global, continental). The Meteonorm [7] database is based on the 3D interpolation of solar radiation measured by meteorological stations. It includes data on global solar radiation, as well as direct and diffuse fractions.

The PVGIS database [8] includes month averaged values of solar radiation and ambient temperatures for Europe. It processes climatologically data that is available within the European Solar Radiation Atlas using interpolation methods and the r.sun model [9]. This model is implemented in GRASS GIS, an open source environment. Data is freely available at [10].

The HelioClim 2/3 databases contain long-term solar radiation data series for Europe and Africa. Satellite images of Meteosat are used to form global radiation maps on a horizontal surface [11]. The estimates are based on the Heliosat2 method [9, 12], whose software at the time of this writing was available at www.helioclim.net, but currently at [13].

Many researchers also use local data sources available in selected areas. For example, in [14] the local data sources of the county of Vermont, the state of Poltney, were used. This approach allows a more balanced assessment of resources, especially for mountainous and remote areas.

The problem of collecting data for the territory of the

Republic of Kazakhstan is quite actual as data itself is not sufficient for full-scale analysis. E.g. in order to assess the energy potential of wind and solar energy it is necessary to get the data about the weather conditions on the territory of the whole country with the best possible resolution in the first place. This data should also contain information about time. The force of wind, illumination and temperature affect the performance of energy plants of the given type directly. In order to assess the parameters the weather stations are placed on the territory of interest.

But according to the NASA Global Surface Summary of Day (GSOD) [15] data for the year 2015 the territories of the Republic of Kazakhstan covered by the World Meteorological Organization (WMO) are about 1 for 7590 km2. This cannot be compared with the coverage in Europe and USA and does not allow assessing the weather conditions accurately enough.

Despite the fact that the number of automatic weather stations is gradually increasing, but this number still is very small for such a large territory (Figure 1).

FIGURE 1 Automatic weather stations on Kazakhstan territory [23]

The presence of a large number of the weather stations should allow improving the weather forecasting models assessing the energy potential more precisely. Currently, these models are mostly based on the data of the remote sensing and interpolation taking into account this data. The errors of the given models are assessed in ref. [16].

E.g. it is about 10% to 30% for the solar energy in comparison with the data observed on the surface, significantly increasing during the winter. Thus, the basis of assessment of renewable energy potential in Kazakhstan should become remote sensing data and ground-based meteorological data.

The list of the main sources of the meteorological data consists of:

NASA SSE (Surface meteorology and Solar Energy) [17]

ECMWF (European Centre for Medium-Range Weather Forecasts) [18] archived sets of data

NASA GSOD (Global Surface Summary of Day) [19]

Some sets of publicly available data from NOAA (National Oceanic and Atmospheric Administration), NCEP (National Centers for Environmental Prediction)

Currently, the data provided by numerous subsidiaries of NASA and NOAA are of the highest interest. This data is mostly results of remote sensing of earth's surface. NCDC (National Climatic Data Center) [20] should be noted out of these organisations also as the data can be ordered in a certified printed form and the authenticity is guaranteed [21].

In addition to the text and numerical information, spatial data may be stored in the form of maps (layers of maps). There is a significant amount of map sources on different subjects. Lately, online map suppliers such as OpenStreetMap (OSM) [22], OpenWeatherMap (OWM) mentioned above, Google Maps etc. become popular. E.g. OWM provides the maps of cloud coverage, air pressure, temperature, precipitation all over the world. Typically, the map suppliers have a well-documented API (which often is free of charge) using which it is possible to create own web-GIS with maps consisting of different layers, available from the map suppliers. However, the most of the spatial information is stored in the form of the map's files and satellite images. The most popular formats of map storage are Shape, GeoJSON for vector information and TIFF, JPEG for raster maps.

## 3 Conclusion

For decisions on the use of various mechanisms of state regulation in the transition to renewable energy sources and the use of other useful resources a decision support system at national and regional levels is necessary.

One of the main problems that apply to the conditions of the Republic of Kazakhstan is the low quantity of the data sources, especially the local one. Nevertheless, it is possible to use the remote sensing and global meteorological data for initial assessment of the resources.

For the implementation of the system it is necessary to solve some important problems related to the detailed system architecture, services, data collection, integration and processing, functionality provided to users, aggregation of heterogeneous data and methods of their storing.

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