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Investigation of Wind Energy Distribution in Height in Latvia

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Abstract

In the National Development Plan of Latvia for the time 2014 – 2020 a significant role is assigned to the renewable energy, whose share in the total energy production should be 40 %. This will facilitate the efficient use of wind energy. The paper is devoted to the investigation into the wind energy potential based on long-term observations of the wind speed and energy density fluctuations at heights from 10 to 160 m in the Latvian territory and on the coast of Baltic Sea.

The wind speed and wind direction values were measured and the statistical database has been accumulated during long-term observations in 2004 – 2013 using a LOGGER 9200 Symphonie measuring systems mounted on 60 m masts – one on the western coast and the second on the north-east of Latvia. From June 2011 to May 2012, these measurements were complemented with the data for the heights from 40 to 160 m obtained by means of a ZephIR lidar located on the western coast of Latvia and with the metrological data provided by "Latvian Environment, Geology and Meteorology Centre" for the same period. The results are presented in the form of tables, bar charts and graphs. The graphs of seasonal fluctuations in the wind speed have been obtained for the heights up to 160 m by measurements over the period of 2007 – 2013. The histograms are composed for the relative frequency of repetition of the wind speed. The wind speed distribution on heights up to 200 m are analysed and the coefficients of approximating functions for two areas with different terrain types are calculated. Extrapolation results of the distribution curves of wind velocity and density mean values on heights up to 200 m are presented. The results of the research on the wind speed distribution up to 200 m are promising for evaluation of the wind energy potential in Latvia and should help in assessment of prospective sites for construction of WPPs.

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1. Methodology of Research on the Wind Speed Distribution in Height

Systematic long-term measurements of wind speeds in Latvia taking into account the wind speed distribution at several heights have been carried out since 2007 at two sites on the north-west coast of the Baltic Sea in the Ventspils region (sites 1 and 3 in Fig. 1) and on the north of the country in the Ainaži region (site 2), 35 km from the sea shore [1]. Sites 1, 2, 3 where the meteorological equipment is located are shown on the map of Fig. 1 by blue stars. By pink circles on the map the locations of State MetStations are marked which keep long-term observations of the wind speed.



Fig.1. Map of Latvia with location of the wind speed measurement sites 1, 2 and 3 (blue stars) and State MetStations (pink circles)

The previous investigations pursued with the aim to estimate the wind energy potential (using the relevant database made up by the "Latvian Environment, Geology and Meteorology Centre" relate to the measurement height of 10 *m* above sea level. However, taking into account the Latvian topography with large territories covered by massive forests, for commercial purposes only the energy supplied by winds at heights 30 – 40 *m* can be used.

So far, in Latvia no systematic long-term measurements with gathering the relevant information have been carried out on the wind speeds at these heights and above.

At the same time, the results of long-term measurements of the wind speed that are stored in the database of MetStations provide valuable information based on which, with appropriate calibration of extrapolation coefficients, the annual average wind speed at a height up to 150 *m* could be calculated. This would allow a precise enough estimation of the potential of wind energy resource in a particular territory.

The measurements of wind speed at sites 1 and 2 were carried out using certified sensors of wind speed and sensors indicating the direction of air stream. Several levels of the measuring sensors are arranged on metallic masts with heights of 53 and 60 *m* above the ground [2].

For storing information from the sensors at all height levels, an NRG LOGGER Symphonie 9200 measuring complex was used. The measuring complex has an independent energy supply from batteries and it stores the average wind speed values for every 10 *min* intervals from nine sensors on its flash memory card.

Wind data retrieving and filtering from both the sites was done using an NRG Symphonie Data Retriever. Further data analysis was done using Microsoft Excel with additional scripts, WRPLOT View – Lakes Environmental Software and Natural Power software. The installation of the 60 *m* high mast with the Symphonie measuring complex is shown in Fig. 2.

At site 3, for measuring the wind speed the optical remote sensing complex ZephIR is used, which can measure the wind speed and direction at a distance. The complex ZephIR shown in Fig. 3 is installed on

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