EVALUATION OF THE POSSIBILITY OF USING RENEWABLE ENERGY SOURCES TO IMPROVE AIR QUALITY STANDARDS

Aleksandra SZULC[1] and Barbara TOMASZEWSKA[1]

[1]*AGH University of Science and Technology, Faculty of Geology, Geophysics and Environmental Protection, Department of Fossil Fuels, al. Mickiewicza 30, 30-059 Krakow, Poland; aszulc@agh.edu.pl*

Introduction

Many towns around the world have been struggling with the problem of poor air quality standards. Air quality has become increasingly weaker which makes it necessary to take appropriate measures to protect human health and improve the quality of life. Poland is one of the European countries which recorded significant exceedances the limit values of particulate matter and benzo(a)pyrene in recent years. The main reasons of poor air quality in Poland are inefficient combustion of bad quality solid fuels for heating purposes and preparation hot water in local and individual boilers The high concentration of pollutants also occurs in the health resort areas, which constitute an important part of the health care system. In 2017, the measurement carried out by Chief Inspectorate for Environmental Protection shows that Rabka-Zdrój has a significant problem with exceeding the daily limit value of PM10 during the heating season. The same research shows that annual mean concentration of benzo(a)pyrene was 8 ng/m^3, at the 1 ng/m^3 limit value. Therefore, the main aim of this paper is to present the scheme of solutions based on renewable energy sources to improve the quality of the air on the health resort example.

Samples and methods

The potential estimation of renewable energy sources (RES) is determined by local conditions. Therefore it requires detailed reconnaissance studies. In order to assess the local potential of wind, solar and shallow geothermal energy, it is necessary to create a database of key indicators.

The first step in the analysis of solar and wind energy resources is to carry out the direct measurements of wind speed [m/s], wind direction [^{o}], solar irradiance [W/m^2]. The ground measurement station should record basic parameters for at least one year. The next step is collecting historical meteorological data from the nearest stations belong to national measurement networks.

For the assessment of availability shallow geothermal energy, detailed recognition of local geological structure to a depth of 100 m, should be defined. Furthermore, verification of hydrogeological conditions in the study area, it is also essential. In order to provide useful geological and hydrogeological information, data from the Central Geological Database (boreholes data, geological map, geological documentation) the Central Hydrogeological Data Banks (disposable and prospective groundwater resources, hydrogeological maps and objects, aquifers and intakes data) and State Groundwater Monitoring (results of physicochemical analyses groundwater samples) should be obtained.

The assessment of possibility for renewable energy sources will be conduct by using statistical and spatial analysis, completed through specialized software and tools dedicated to RES.

Results

The basic research problem is the need to identify the optimal ecological, technological and economic RES solutions to improve air quality in the area of a health resort.

According to the presented methodology in Rabka-Zdrój two ground measurement station were installed. The measurements of basic solar and wind parameters area presented as average, minimum, maximum values, recorded every 30 minutes. The required minimum measurement time period has not been achieved yet. However, based on already existing data it can be concluded that the health resort is characterised by favourable solar conditions. The local wind conditions depend on the topography of the region and are also subjected to relatively wide annual and daily fluctuations. Currently, in the research area occurs wind speeds ≤ 2 m/s with the predominance of western and south-western winds.

Geological and hydrogeological data provide basic information to assess the potential of shallow geothermal energy. The data obtained from 26 boreholes were used for the analysis. In the particular boreholes layers dominated by sandstones, shales, sandy gravels, and clays occurs. The detailed local lithology information allowed to assess the thermal conductivity coefficient for different localisation. In Rabka-Zdrój the value of weighted thermal conductivity coefficient is in the range of 1.59 - 3.4 [W/(m☐K)], while the unit heat output reaches a level between 38.0 and 54.0 [W/m]. The initial phase assesses the groundwaters as a lower heat source for heat pump systems is based on water samples taken from constantly used wells in Rabka-Zdrój area. A preliminary assessment of the chemical composition showed that the dominant type of water is HCO_3-Ca-Mg with electrolytic conductivity from 213 to 834 μS/cm, therefore with low mineral content. Moreover, water pH is in the range 6.1 – 7.9 and compliant the requirements laid down by heat pumps manufactures.

Conclusions

The proposed activities are directed to reducing the low-emission in a selected health resort area of the southern part of Poland. Due to the climate with confirmed therapeutic properties and a wide range of medical treatments the health resort became tourist and patient destinations. Implementation of RES solutions is to achieve the basic objectives of improving air quality in the spa treatment areas, making the local government and the local community aware of the importance of the problem, as well as to increase the environmental values of the health resort. In addition, assessment of renewable energy resources has demonstrated the potential which can be used in the area of research.

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