Unconventional energy sources as a topic used in teaching mathematics, physics and technology at junior high-school (Polish "gimnazjum", children aged 13-16)

Leszek **Piekut**, **MA**; **Polvit,** lelek34@poczta.onet.pl
85 - 005 Bydgoszcz, Ul. Gdańska 27, Poland

Exploiting unconventional energy sources raises estimation and calculation issues related to: new technologies of generating and extracting energy, estimation of their profitability and productivity as well as problems for physicists and technicians. This creates a strong incentive to take up the topic in teaching mathematics, physics and technology already at the junior high-school level. Theoretical and practical issues related to unconventional energy sources may serve as an excellent basis for mathematical, physical and technical problem issues included in the junior high-school curriculum. The following topics may provide a good opportunity to formulate and solve mathematical problem issues (Jabłoński, Piekut, Kirkiłło-Stacewicz, 2004; Jabłoński, Pielich, Piekut, 2004): the significance of electrical energy, renewable and non-renewable sources of energy, energy from unconventional sources, wind power stations, hydro energy, solar energy, energy from biomass. Hereunder I enclose one example of problem, which may be used in mathematics teaching in secondary school, regarding the subject matter specified before. **Problem is in form** of a certain **text,** which contains diverse information, followed by **a list of example questions** and **an instruction to formulate other ones**, important from point of view of subject matter under consideration. A student solving that problem has to take into account **necessity to obtain** some **additional data**, as well as, if it becomes necessary, **additional information** in the scope of studied matter. A problem like this puts a student in the position of a researcher, who studies particular problem, **teaches how to read text with understanding**, and gives **an opportunity to acquire and select on one's own any information** needed in the scope of studied matter.

Example: Wind power stations. Atmosphere movement energy, that is wind energy, is a converted form of solar energy. Wind is generated by the difference in heating of land and seas, poles and equator, that is by the differential pressure between individual thermal zones, as well as by Coriolis force, generated by Earth rotary motion. It is estimated that only maximum 2% of solar energy reaching Earth is subject to conversion into wind kinetic energy, which is 2700 TW. Approximately 25% of that energy falls to a hundred-metre atmospheric air layer, which directly surrounds Earth surface. Winds blowing over land surface have energy potential reaching 40 TW power (provided that losses and possibilities to install wind power stations are taken into account). Only 10% of that value exceeds the whole potential of inland water energy, and is 20 times higher than current power rating of electric power stations installed all over the world. In case of winds blowing over an open sea, wherever sufficient depth allows to install wind power stations, their power rating is estimated for 20 TW. Basic terms specifying wind power engineering include: windmotor, wind turbine, wind power station and complex wind system. Wind sets operate at wind velocity ranging from 5 to 25 m/s. At velocity under 4 m/s obtained power output is too low, and at velocity exceeding 30 m/s, wind sets are being shut off due to possible mechanical damage. In many areas in Poland, useful winds at the velocity of 3 to 10 m/s blow for more than 300 days in a year. So-called "wind farms" are being built in order to increase obtained power output. "Wind farms" are generator sets occupying dense area of high local wind velocity. In order to avoid rotors disturbing each other air streams they use, they are usually installed at minimum distance of 10 m from one another. According to other estimates, it is unacceptable to locate wind systems of total rotor surface in excess of 1500 m^2 on the area of 1 km^2. It means that units with propeller span 60 m cannot be set closer to each other than approximately 2 km, due to noise and harmful vibrations.

Questions: Search out information on Earth rotary motion and Coriolis force. Assess solar energy reaching Earth. Compute wind kinetic energy that falls to a hundred-metre atmospheric air layer surrounding Earth and assess losses. Compute power rating of electric power stations currently installed all over the world. Assess possibilities to eliminate coal power plants in Poland, by replacing them with wind power stations. Which data you have to search out in order to solve this problem? Search out data on wind power in your area. Does it allow to install wind power stations or "wind farms"? Suggest locations for wind power stations in your area, estimate their number and power rating. How would their installation affect environmental protection? Compare positive and negative effects of this decision. Formulate other, reasonable and important questions - problems involved in the subject matter discussed in this text. Suggest an approach to solve them.

Bibliography

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