
# Methods of forming elementary concepts of renewable energy sources in physics on the basis of interdisciplinary connections

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ABSTRACT

The article describes the possibilities of using the principle of interdisciplinary connection in the formation of knowledge, skills and competencies in renewable energy sources in physics education. Also, the results of pedagogical experiments on the teaching of "Elementary concepts of solar photovoltaics" are presented and analyzed.

**Keywords:** Renewable energy sources, wind energy, geothermal energy, biogas, biomass, power plant, construction, education, interdisciplinary communication, solar panels.

It is well known that in recent years, the world has undergone a great deal of scientific and practical work, programs and projects on renewable energy sources and their efficient use. For example, modern designs of renewable energy sources such as solar power plants, wind power plants, biomass and biogas production - bioenergy, geothermal energy, mini hydro power plants are being developed and widely implemented. The main reason for this is the depletion of raw materials available on Earth, as well as the increase in human demand for energy [1-2]. Therefore, from now on, this topical issue, that is, the study of future energy problems and solutions, is being considered as an important and urgent issue before humanity. In the process of education, especially in the teaching of physics, there is a need to gradually introduce into the educational process fundamental and practical concepts of the physical processes of renewable energy sources as modern knowledge. In the formation of these types of energy sources in the process of physics education, it is useful to develop lesson technology maps based on some methodological guidelines, recommendations, new pedagogical and information technologies.

The article develops methodological proposals and recommendations on the possibility of using the integration of disciplines in the formation of knowledge, skills and competencies in renewable and renewable energy sources in physics education in higher education. In this regard, the article recommended some information on the formation of knowledge and skills about the types of renewable and renewable energy sources using the integration of physical-mathematical-chemical and environmental sciences (natural and exact sciences). Table 1 below lists topics related to renewable and

renewable energy sources, as well as opportunities to use the integration of natural and exact sciences.

**Table 1**

| № | Subject name | Physics | Mathematics | Chemistry | Ecology |
|---|---|---|---|---|---|
| **1.** | Physics of converting solar energy into electrical and thermal energy | Internal photoeffect law, theoretical and practical bases of conversion of light energy into electrical energy | Calculation of efficiency of solar cells, calculation of solar cell capacity and charge factor | Methods and techniques of chemical treatment of the surface layer of solar cells, the formation of hermetic layers in solar cells | Determination of dust levels in the surface area of solar cells, determination of environmental conditions for normal operation of solar cells |
| **2.** | Wind energy and wind generators | Theoretical bases of conversion of wind kinetic energy into electrical energy, wind generators | Formulas for calculating the efficiency of wind generators, determining their power and mathematical methods of calculating them | Chemical processing technology for wind generator parts, creation of durable nanofilms for wind turbines and generators | Determining the ecological environment for the installation of wind generators, determining the impact of wind energy devices on humans and animals |
| **3.** | Biogas energy and biomass | Modern designs of biogas plants, physical methods and techniques for determining gas pressure, volume and temperature | Formulas for calculating the efficiency of biogas production and use, mathematical methods and techniques for determining quantitative characteristics | Chemical reactions of biogas production from local fertilizers, plants and humus. The released methane and carbon dioxide remain quantitative. Chemical methods and techniques to accelerate the | Ecological conditions of biogas production. Principles of interaction of natural gas with ecosystems and laws of ecological balance |

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|---|---|---|---|---|---|
| | | | | process of decomposition (formation of natural gas) | |
| **4.** | Geothermal energy physics and technology | Physical bases of geothermal energy, thermocouples of thermoelectric power generation, temperature gradient | Геотермал энергия ҳосил бўлиш миқдорий характеристикаларини ҳисоблаб чиқариш математик усул ва методлари | Methods and techniques for determining the chemical state in water with high temperatures (above 40 0C). Chemical methods for determining the quality and quantitative characteristics of ionized salt solutions in hot water | Environmental conditions for the use of geothermal energy. Interaction of geothermal energy devices with ecosystems |

As can be seen from the table, the use of the integration of natural and exact sciences (physics-mathematics-chemistry and ecology) has great potential in the study of topics related to the types of renewable energy sources. In particular, in mastering the topic "Elementary concepts of solar photovoltaics", each science has its own methods and techniques of research, where the "object" is one. The role of the integration of the natural sciences in explaining the compatibility of theory and practice in the production and use of solar energy is also invaluable [3-4].

There is a student elective subject "Heliotechnics and renewable energy sources" for students of physics in higher education institutions, and the possibility of using the integration of the above disciplines in the teaching of this subject has been applied in pedagogical experiments. The pedagogical experiment was carried out as follows:

1. Technological map of the lesson on "Elementary concepts of solar photovoltaics" in the working program of the student competition "Heliotechnics and renewable energy sources" was developed.

2. Demonstration animated presentations on "Elementary concepts of solar photovoltaics" were created and used effectively in the classroom.

3. An 8 W solar operating photovoltaic device was used.

4. The integration of natural and exact sciences was effectively used in the full coverage of the topic "Elementary concepts of solar photovoltaics":

a) Physics: the physical and technological bases of the conversion of light optical radiation into electrical energy are described in detail;

b) Mathematics: Mathematical operations were performed using the formula for calculating the efficiency of solar cells. Optimal values of efficiency were determined (based on issues).

c) Chemistry: chemical methods of chemical treatment of solar cells, the formation of reliefs in the surface area are explained. Information was also provided on the chemical methods and techniques of forming hermetic layers in solar cells.

c) Ecology: The impact of environmental cleanliness levels, dust, wind and various other natural phenomena on the optimal operation of solar panels has been described on the basis of environmental concepts.

5. The methods of "Debate" and "Question-Answer" were used in teaching the topic "Elementary concepts of solar photovoltaics."

6. On the basis of the technological map developed for the topic, test questions on the topic were distributed at the consolidation stage of the lesson, on the basis of which the knowledge, skills and abilities of students in the lesson were determined and evaluated on a rating system.

In general, experiments have shown that the effective use of the principle of interdisciplinary connection in the teaching of physics, while increasing the quality and effectiveness of the course, also serves to enrich it with new knowledge. In particular, with the formation of sufficient knowledge and understanding of an event or process, it is possible to fully understand and comprehend their content, to have a relatively clear and comprehensive in-depth knowledge and skills.

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