

# LEARNING ABOUT GREEN ENERGY IN THE ROMANIAN SECONDARY SCHOOL PHYSICS CURRICULUM

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**CZU: 373.091.214:53(498)=111**

**DOI: 10.46727/c.15-11-2024.p18-26**

## **Abstract**

Learning about green energy in the pre-university physics curriculum is an essential step in the ecological education of young generations, aiming to reduce pollution factors, conserve natural resources, and protect the environment. This paper analyzes the extent to which notions of renewable energy and energy efficiency have been integrated into the pre-university school physics curriculum. The purpose of this article is to analyze the extent to which topics related to green energy and sustainable development of society are present in the secondary school physics curricula. Primary education programs and optional subject programs were also considered. The research methodology includes curriculum analysis. The conclusions underline the need for the continuous updating of the school curriculum to reflect technological and ecological developments, thus ensuring the formation of a well-informed and ecologically responsible generation.

**Keywords:** green energy, curriculum, physics, teaching, learning, GreenComp

## **Introduction**

In the contemporary era, environmental concerns are increasingly acute, and educating young people about green energy is becoming a top priority. Protecting the environment for future generations primarily involves educating the younger generation in this regard and providing practical opportunities to contribute to change.

Climate education plays a fundamental role in the behavioral and mental adaptation of society to climate change. According to the 2022 European Council [22] recommendations, the integration of renewable energy and energy efficiency into school curricula is essential to educate future generations about sustainability.

One of the policy actions set out in the European Green Deal [7] was the development of a European competence framework for sustainability. The European Green Deal is a package of policy initiatives that aims to put the EU on the path to a green transition, with the ultimate goal of achieving climate neutrality by 2050. The transition to clean energy is a must to combat climate change and an opportunity to increase energy independence. The main measures of the EU for the implementation of policies for the development and use of green energy assume an increase in the share of energy produced from renewable sources. GreenComp identifies a set of sustainability competencies to help learners develop knowledge, skills and attitudes that promote ways of thinking, planning and acting with empathy, responsibility and care for our planet and public health.

This paper analyzes to what extent these concepts are included in physics curricula for pre-university education, but the aim is to influence students' perceptions and attitudes towards environmental protection [5]. Previous studies, such as those published by UNESCO [21] and MDPI [1], emphasize the benefits of green education in developing a mentality oriented towards the conservation of natural resources and the protection of the environment. Through the analysis of school curricula, the paper aims to highlight the importance of ecological education, as well as the need for continuous updating of educational content to respond to contemporary technological and ecological challenges.

Among the national policies related to green education, we can mention the documents developed by the Ministry of Education - *Romania. Education for sustainable development* [11], as well as the one developed in the working group organized by the Romanian Presidential Administration, *Education regarding climate change and the environment in sustainable schools. The National Strategy on education for the environment and climate change 2023-2030* was developed. The development of

the Strategy sought to ensure full compliance with the vision, purpose and objectives of the Report "Education on climate change and the environment in sustainable schools" published by the Presidential Administration, in June 2022 [20].

Since 2015, the expectations expressed towards students in relation to care for the environment have been inserted into the graduate profile: the use of data about the environment; environmental investigation; showing interest in one's own health and a clean environment; showing interest in a healthy lifestyle and a clean environment - critical reflection on the changes produced by human activity in the environment.

Commitments have been made to widen access to environmental and climate education through participation in international agreements (eg the Paris Agreement) and through recent government programmes. At the same time, amendments were made to the National Education Law to include environmental skills. The national Green Week program was also established.

Learning about green energy in the pre-university physics curriculum is an essential step in the ecological education of young generations, aiming to reduce pollution factors, conserve natural resources, and protect the environment. This paper analyzes the extent to which notions of renewable energy and energy efficiency have been integrated into the pre-university school physics curriculum. The purpose of this article is to analyze the extent to which topics related to green energy and sustainable development of society are present in the middle and high school physics curricula. Primary education programs and optional subject programs were also considered. The methodology includes curriculum analysis. The conclusions underline the need for the continuous updating of the school curriculum to reflect technological and ecological developments, thus ensuring the formation of a well-informed and ecologically responsible generation.

### **Theoretical framework. Ecosocial competences. GreenComp**

GreenComp's ambition is to highlight the competences needed for the green transition to support the implementation of inclusive and quality training on climate change, biodiversity and sustainability, as well as lifelong learning. [2].

GreenComp [6] comprises 12 competences organized in the four areas of

competences:

- the adoption of sustainability values, which includes the skills: sustainability assessment; supporting equity; promoting nature;

- acceptance of complexity in sustainability, which includes the skills: systemic thinking; critical thinking; problem identification;

- designing sustainable future scenarios, which includes the skills: future scenario literacy; adaptability; exploratory thinking;

- taking measures for sustainability, which includes the skills: political influence; collective action; individual initiative.

A sustainability competency empowers citizens to integrate sustainability values and adopt complex systems to act or call for action to restore and maintain ecosystem health and strengthen justice, generating visions for sustainable future scenarios.

Learning for environmental sustainability aims to cultivate a sustainable mindset from childhood to adulthood, understanding that humans are part of and dependent on nature. Citizens are equipped with knowledge, skills and attitudes that help them become agents of change and contribute individually and collectively to shaping the future, within the limits of our planet.

### **Methodology**

The research methodology consists in the curricular analysis of school programs and physics textbooks in pre-university schools.

The purpose of this article is to analyze the extent to which topics related to green energy and sustainable development of society are present in the middle and high school physics curricula. Primary education programs and optional subject programs were also considered.

### **Research questions and objectives**

#### ***Research questions***

1. To what extent do the primary, common core and optional curricula include topics related to green energy and sustainable development?
2. To what extent are the notions of renewable energy and energy efficiency integrated in the physics curriculum for secondary education?

### **Objectives**

1. Analyzing the presence of subjects related to green energy and sustainable development in common core programs, respectively optional for compulsory education
2. Analyzing of how the concepts of renewable energy and energy efficiency are included in the physics textbook for secondary education.

### **Results and discussions**

In order to answer the question " To what extent do the primary, common core and optional curricula include topics related to green energy and sustainable development?", the school programs for primary education were analyzed. The following contents related to energy in general, respectively to green energy in particular, were found. (Table 1, Table 2)

*Table 1 Contents about energy to subjects for the common core, primary education*

Class	Domain	Content
0 [13]	Earth Sciences	<b>The Universe</b> Earth, Sun and Moon: recognition in simple patterns
I [13]		<b>The Universe</b> The Sun, source of heat and light
0 [13]	Physics Sciences	<b>Energy forms and transfer</b> Electricity: devices that use electricity and safety rules in handling electrical devices
I [13]		<b>Energy forms and transfer</b> Forms of energy (light, heat, electricity), sources of energy (sun, water, wind, coal, oil) and practical uses
IV [14]	Physics Sciences	<b>Energy - sources and effects</b> Heat transfer between objects. Conductive and heat insulating materials

*Table 2 Contents about energy to optional subjects*

Class	Domain	Content
III/ IV [15]	Green settlements	- What does balanced development mean? - Green towns and renewable energy

In order to answer the question "To what extent are the notions of renewable energy and energy efficiency integrated in the physics curriculum for secondary education?", the programs from the common core, the Physics discipline [16], were analyzed, where topics related to green energy are addressed in class VIII in the chapter *Forms of energy. Energy sources*, as well as the Technology curriculum [17], where relevant information was also found in the eighth grade (Table 3).

*Table 3 Contents about energy to subjects for the common core, secondary education*

Discipline	Domain	Content
Physics	Extension: Energy and life	<b>Forms of energy. Energy sources – integrative theme</b> The transformation and conservation of energy in different systems (for example, the life support system on a space station, other systems identified and studied in biology, geography, etc.)
Technologies	Sustainable development (healthy lifestyle, clean environment, influence on the individual/society)	<ul style="list-style-type: none"> <li>- Methods of saving electricity and thermal energy in homes</li> <li>- Conventional and unconventional energy</li> <li>- Safety and health at work specific to the electrical field</li> <li>- The impact of energy production and use technologies on the individual, society and the environment</li> <li>- Environmental protection in the context of various professional fields.</li> </ul>

*Table 4 Contents about energy to optional subjects, secondary education*

Class	Domain	Content
VII [18]	Sustainable development and climate action	<ul style="list-style-type: none"> <li>- reduction of greenhouse gas emissions</li> <li>1. circular economy - green economy</li> <li>2. local production and consumption</li> <li>3. energy efficiency</li> </ul>

Following the analysis of how the notions of renewable energy and energy efficiency are included in the physics textbook for secondary education [2], relevant information was found.

In the *Optical Phenomena* chapter, the lesson *Propagation of light in various media (absorption, dispersion, color of bodies, etc.)*, there is information about solar panels. "Solar panels - photovoltaic elements - have already penetrated into everyday life. There are many appliances powered by a photovoltaic generator (solar panels), such as: street lights, garden lights, mini computers, household appliances, irrigation pumps, etc. Photovoltaic elements convert light energy into electrical energy."

In the chapter *Extension: Energy and Life* are interesting lessons about the transformation and conservation of energy in different systems, such as the Electric Generator; Dynamo; Hydropower plant; Wind power plants; Geothermal plants; Solar plants; Solar thermal power plants; Photovoltaic solar plants; Energy balance of soil and atmosphere; The yield of an energy chain; The transformation and conservation of energy in different systems (for example, the life support system on a space station, other systems identified and studied in biology, geography, etc.) In other textbooks there are other topics, such as: Photovoltaic effect; Low carbon footprint energy production; Transformation and conservation of energy in different systems; Nuclear reactions and the production of nuclear energy.

### **Conclusions**

Analyzing the presence of topics related to green energy and sustainable development in the common core and optional primary education programs demonstrated the fact that, both in primary and secondary education, there are topics related to green energy. Following the analysis of how the notions of renewable energy and energy efficiency are included in the physics textbook for pre-university education, relevant information was found. In high school programs, the topics usually refer to the theoretical aspects of the various forms of energy and topics related to green energy are not addressed.

The conclusions underline the need for the continuous updating of the school curriculum to reflect technological and ecological developments, thus ensuring the formation of a well-informed and ecologically responsible generation.

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