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Developing Competences of Pre-Service Teachers through STE(A)M-based Renewable Energy Curriculum

{RENEWTEACH}

PR2

Development of Multimedia Based Online Learning Content and Material

2021-1-TR01-KA220-HED-000027614

ABOUT

Overview

RENEWTEACH is an ERASMUS+ project with the title "Developing Competences of Pre-Service Teachers through STE(A)M-based Renewable Energy Curriculum" and project number 2021-1-TR01-KA220-HED-000027614. This document is designed to introduce PR2, one of the project results developed within the RENEWTEACH project.

What is the PR2?

PR2 includes multimedia-based online learning content and materials developed for renewable energy and STE(A)M subject areas within the RENEWTEACH project. The multimedia-based online learning materials combine renewable energy and STE(A)M subject areas in terms of context.

When the related literature and Erasmus+ Project Result platform were examined, no learning material with similar content was found. In this respect, it can be stated that the multimedia-based online learning materials developed within the scope of the Renewteach project are an innovative.

Aim of PR2

The aim of this project result is to develop multimedia-based online learning content and materials that will enable pre-service teachers to explore renewable energy sources and the deep STE(A)M content knowledge underlying renewable energy. This project result aims to improve pre-service teachers' knowledge, skills, attitudes and values related to renewable energy and STE(A)M.

Implementation

PR2 provides learning content and material for curriculum developers, educators and academics that should be included in the curriculum on RE. In the implementation phase of the RENEWTEACH project, multimedia-based online learning materials developed under PR2 are used. However, the learning materials developed cover all relevant stakeholders, especially pre-service teachers and academics studying at higher education level in partner countries. In this context, the developed contents were translated into Turkish, English, Romanian, Spanish and Slovenian to ensure transferability between partner countries and external users.

How to Access?

You can access the PR2 content via the RENEWTEACH project website (https://renewteach.org/) or by registering and logging in to the online learning environment developed within the project (https://guzemxonline.gazi.edu.tr/).

Fundamentals of Multimedia-Based Online Learning Materials

Analyzing Themes and Determining Goals

All project results (PRs) developed within the Renewteach project are interrelated and complementary. The Multimedia Based Online Learning Materials (PR2) introduced in this document are based on the Framework Curriculum (PR1) that was developed before it. The Delphi study conducted within the scope of PR1 defined the framework of knowledge, skills and attitudes to be developed in the learners participating in the project. The themes planned to be included in the learning materials were identified as a result of the cross-fertilization of expert opinions and literature review conducted within the scope of Delphi. The work package leader analyzed the GU themes and presented them to the partners for evaluation. In the light of the feedback from all partners, the themes were finalized and the production of the unit contents started.

Table 1. Learning Material Topic Distribution and Common Concepts

Units	STE(A)M Crosscut Concepts
1. *Unit: Introduction to the Subject Area of Renewable Energy Resources*	-
2. *Unit: STEM Thinking in The Context of Renewable Energy*	-
3. *Unit: Solar Energy*	• Systems and System Models • Cause and Effect
4. *Unit: Bioenergy*	• Systems and System Models • Energy and Matter
5. *Unit: Hydroelectric Energy and Wind Energy*	• Patterns • Stability and Change
6. *Unit: Wave Energy and Geothermal Energy and Heat Pumps*	• Patterns • Structure and Function
7. *Unit: Best Practices Pool*	• Scale, Proportion and Quantity* • Cause and Effect Patterns • Structure and Function

*In Unit 7, there are two separate STE(A)M activities targeting the common concept of "Scale, Proportion and Quantity".

The Multimedia-Based Online Learning Materials consist of seven units (see Table 1). The first two units have a content in which declarative knowledge is predominant. In the first unit, the content is based on defining renewable energy, introducing renewable energy sources and comparing renewable energy sources with fossil fuels. In the second unit, it is aimed to introduce STE(A)M, to establish the relationship between renewable energy and STE(A)M and to introduce STE(A)M Crosscut concepts in this context. Units 3, 4, 5 and 6 include "STE(A)M Crosscut Concept Activities" in addition to declarative information on renewable energy sources. These activities are based on 7 crosscut concepts arising from the intersection of science and engineering applications. These concepts provide a framework for how STE(A)M practices can be integrated into the science curriculum (see Table 2).

Translated with DeepL.com (free version)Finally, in Unit 7, best practices based on problem solving related to renewable energy sources are presented and at the end of the unit, learners are asked to propose a solution to a local or regional problem situation with a best practice they will develop.

Tablo 2. STE(A)M Crosscut Concepts

	Description	**Example**
Patterns	It guides patterns observed in nature and asks questions about their underlying relationships and causes. Identifying patterns is a big part of working with data.	Estimating the hydroelectric energy potential of a region where a hydroelectric power plant is planned to be built based on past climate data.
Cause And Effect	Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships and the mechanisms mediating them is an important activity of science and engineering.	Determination of the effect of ideal fermentation temperature on biofuel efficiency.
Scale, Proportion and Quantity	When assessing phenomena, it is critical to understand what is important at different scales of size, time and energy, and to recognize the proportional relationships between different quantities as the scales change.	Understand that the energy production capacity of wind turbines varies proportionally to the size scale of the blades.
Systems and System Models	A system is an organized group of related objects or components.	Discovering the functions of the components that make up the

	Models are tools that represent systems and are used to understand and predict the behavior of systems.	biogas power plant and how these components form a whole system through a model
Cause and Effect	Monitoring the flows of energy and matter into, out of or within systems helps you understand the behavior of the system.	Explain the mechanism of photosynthesis, the conversion of light energy into chemical energy
Structure and Function	The way an object is shaped or structured determines many of its properties and functions.	Determination of the effects of the type of semiconductor used during the production of solar panels on energy capacity
Stability and Change	For both engineered and natural systems, the conditions that affect stability and the factors that control rates of change are critical elements to consider and understand.	Exploring stability conditions and mechanisms of wind turbines.

When Table 1 is examined, it can be seen that certain STE(A)M Common Concepts have been selected in all units except the first two units. Each of the STE(A)M Common Concepts mentioned here represents an STE(A)M activity for the relevant unit. Therefore, while there are two STE(A)M activities each in units 3, 4, 5 and 6, there are 5 STE(A)M activities in the last unit. The dominant STE(A)M common concept for each developed activity is determined and stated in Table 1. However, there are also STE(A)M activities that incorporate more than one STE(A)M Common Concept.

For example, in the second STE(A)M activity in Unit 3, "Cause and Effect Relationships" was chosen as the common concept. In this activity, the distribution of charge carriers and the formation of n-type and p-type semiconductors as a result of doping of pure silicon materials with boron (B) and phosphorus (P) atoms are discussed. In the event, it is explained through the cause-effect relationships that the group in the periodic table of the selected doping element is decisive in terms of n-type and p-type semiconductors (see Figure 1). However, it is also possible to discuss the effect of using other 3A group elements instead of phosphorus to produce an n-type semiconductor with the same efficiency, or using other 5A group elements instead of boron to produce a p-type semiconductor, on the structural properties of the semiconductor material to be produced. Therefore, it can be said that the activity in question also covers the common concept of "Structure and Function".

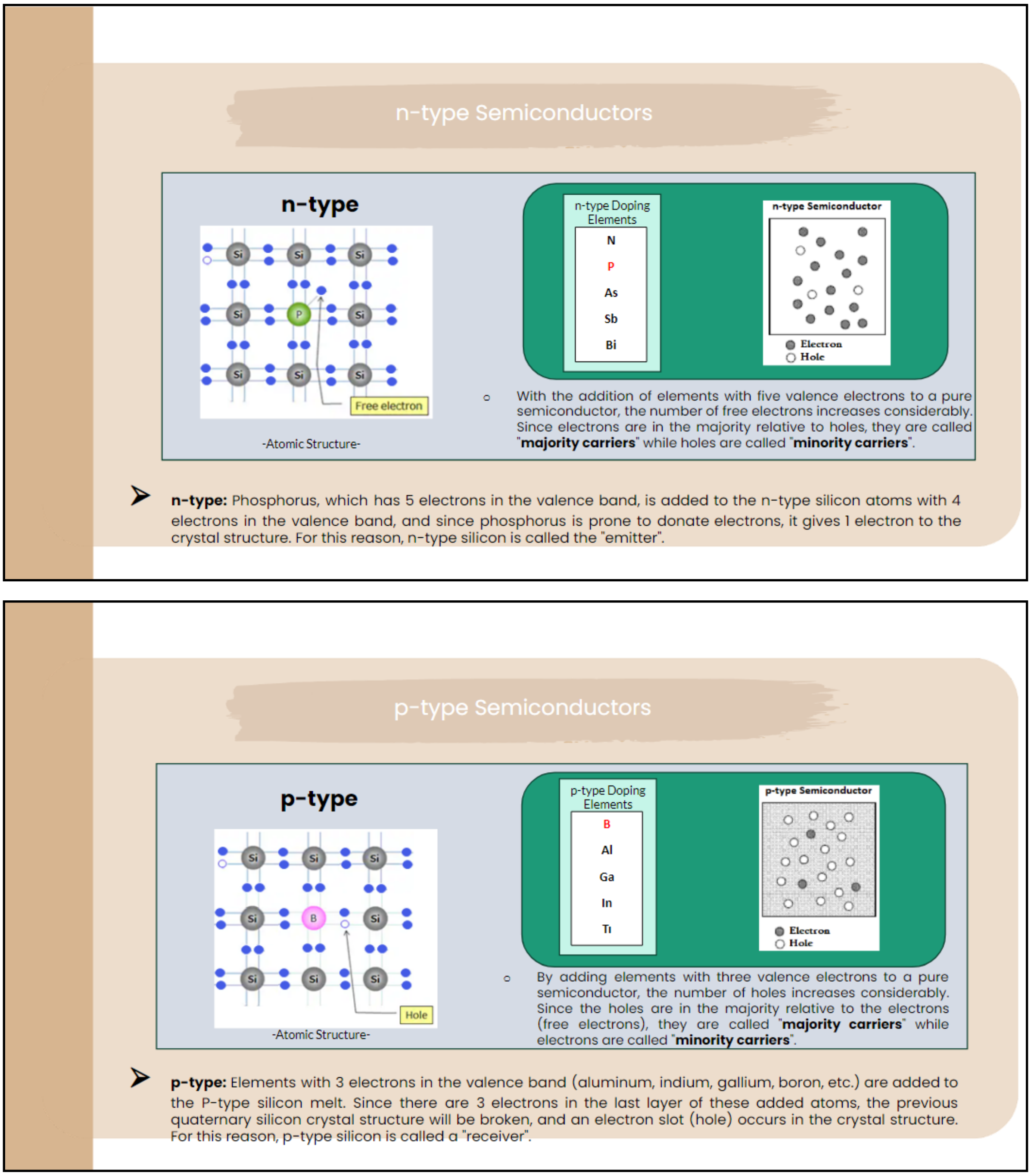


Figure 1. Sample screens from a STE(A)M activity on solar energy

Multimedia Based Online Learning materials were developed under the leadership of Gazi University with the participation of all project partners. Subject matter experts and educational technologists worked in cooperation during the preparation of the teaching materials. The process consisted of 1) creating scenarios for the instructional materials, 2) converting the storyline contents prepared in line with the scenarios into SCORM packages, and 3) Integration of SCORM packages into the Open edX system was carried out in three stages.

1. Creating Scenarios for Teaching Materials

Scenarios are templates prepared on Microsoft PowerPoint to ensure communication between field experts and educational technologists in the development of instructional materials. The scenarios include various instructions regarding the content of the learning material (see Figure 2).

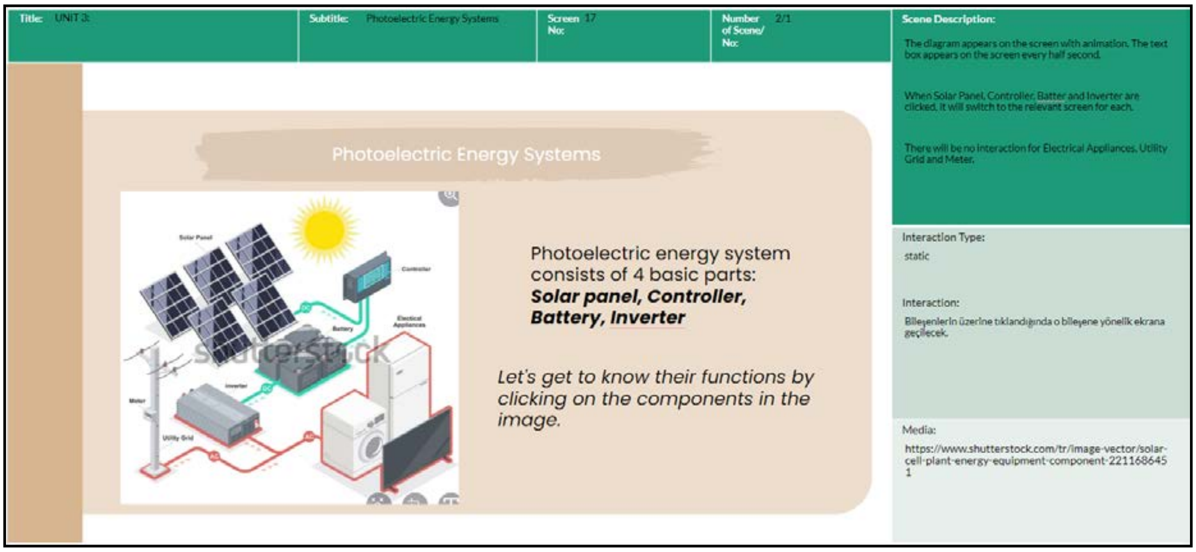
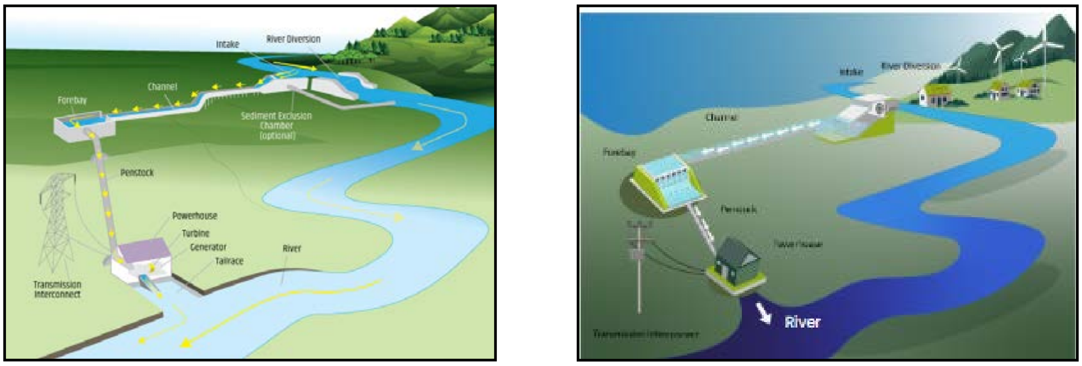


Figure 2. Sample scenario screen

The "Title" section indicates the unit to which the developed content belongs. The "Sub-title" section indicates the sub-title under which the displayed screen is located in relation to the unit. The "Screen number" section indicates the order in which the screen will be displayed in the online learning material. The screen number may be different from the slide number as there may be more than one associated scene linked to a screen. The "scene number" indicates how many scenes are connected to the relevant screen and how many scenes are displayed among them. Therefore, the scene is part of the screen. When the visuals displayed on different slides in the scenarios were to be associated, they were depicted not as a separate screen, but as scenes connected to the relevant screen.

The "Scene description" section includes descriptions of the content (text, images, buttons, etc.) displayed in the relevant scene. The "Interaction type" section describes the way users interact with the scene components (click, drag-and-drop, etc.), and the "Interaction" section describes the objects through which this interaction will take place.

Lastly, the "Media" section includes details about the media content in the relevant scene (descriptions of the visuals, sources of the visuals, etc.).



(a) (b)

Figure 3. Sample of redrawn visual material (a: original image, b: redrawn image)

All visuals used in the content developed within the scope of the project have been redrawn in accordance with the original in a way that does not require copyright (see Figure 3).

2. Conversion of Storyline Content Prepared in Line with Scenarios into SCORM Packages

The scenario contents developed by subject area experts in accordance with the guidelines in the template were transformed into interactive contents to be transferred to the online environment by educational technologists after receiving expert opinions. In this process, a total of 35 SCORM packages were produced in 5 different languages, one for each unit, using the Articulate Storyline program.

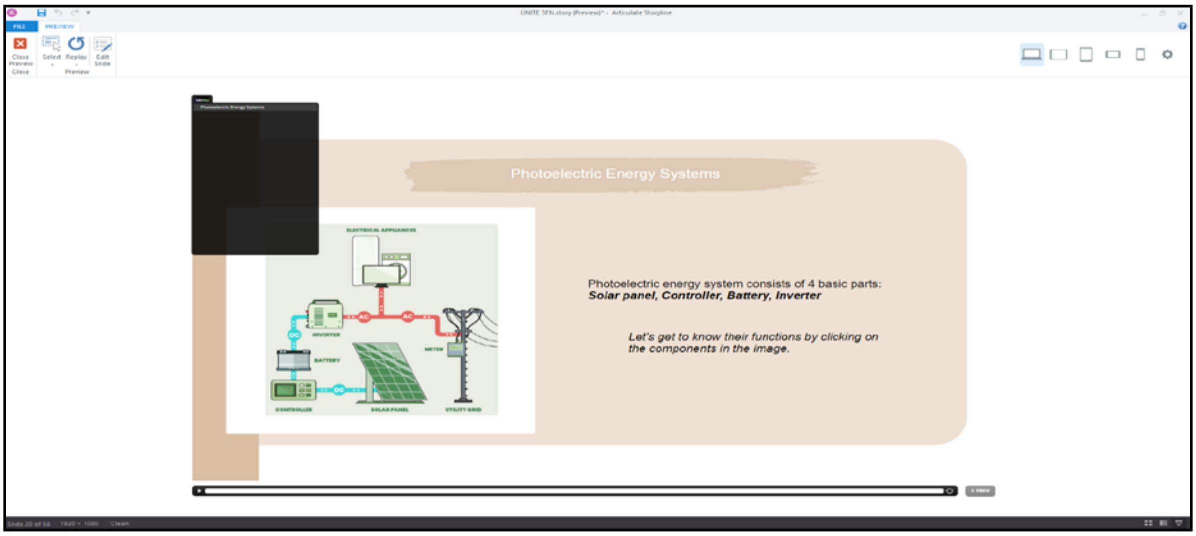


Figure 4. Sample screen in the Articulate Storyline program

A content tree structure was created on the top left of the content under the title "Menu". With the content tree structure, the topics in the learning material can be examined and progress can be observed. By using Timeline limitation in the transition between scenes in the learning material, students were prevented from passing through the content without seeing the entire content. Interactive activity areas were added to the content of the learning material in order to make the learning activity more efficient by involving the learners in the process. Thanks to these activities, it is aimed that learners both learn the subject of renewable energy and develop their STE(A)M skills.

3. Integration of SCORM Packages into Open edX

The learning material prepared with the Articulate Storyline program was packaged in accordance with SCORM 1.2 standards and uploaded to the edX Online Education platform customized by the training providers.

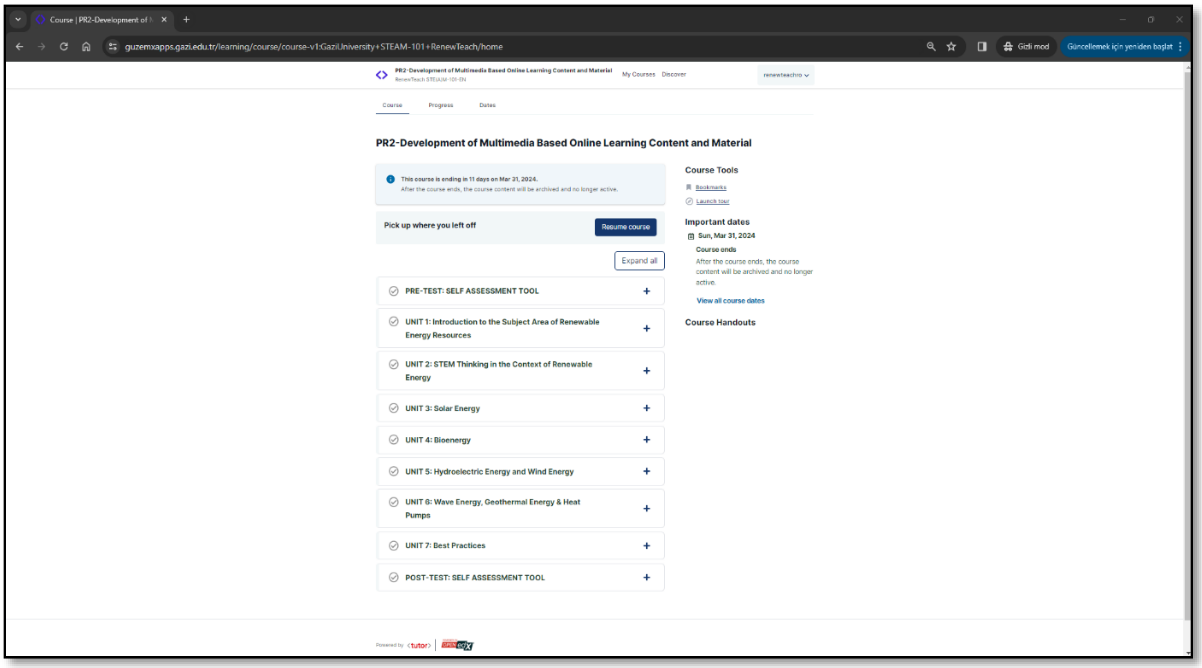
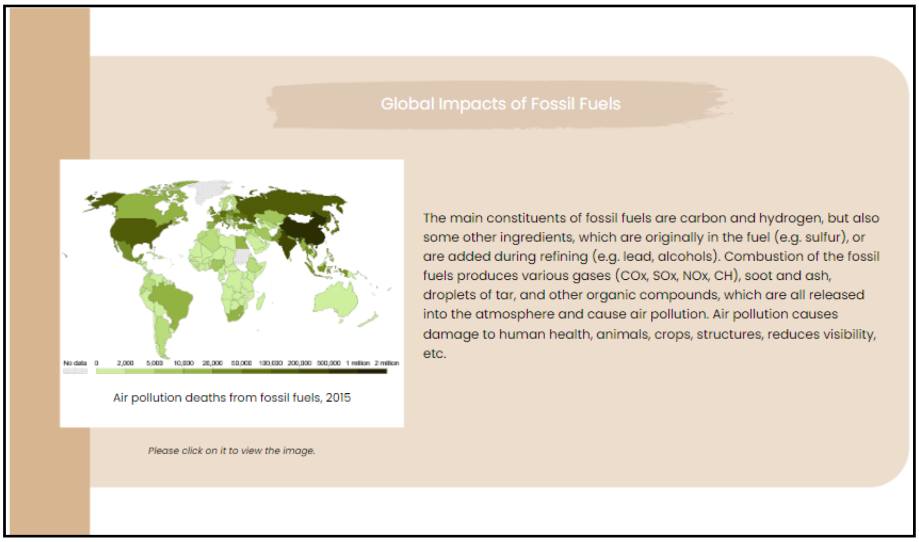


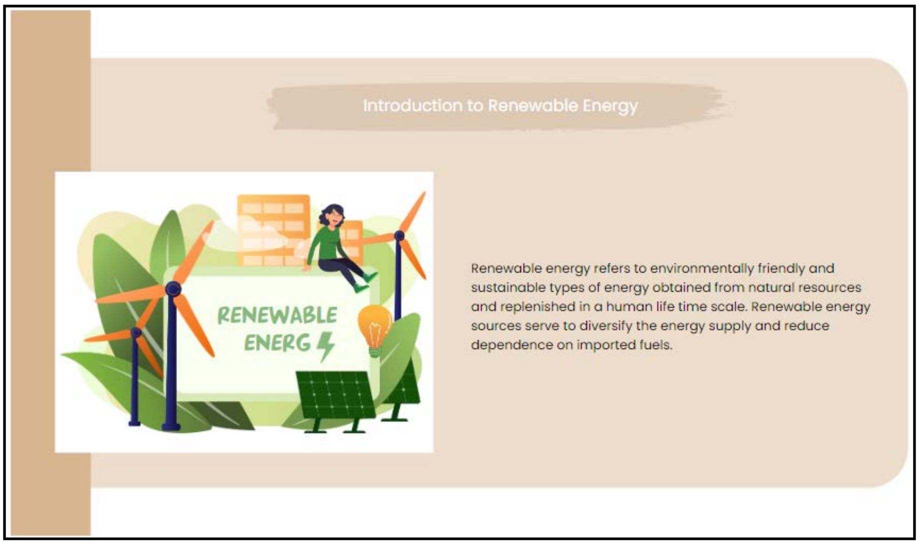
Figure 5. Integration of units in the Open edX

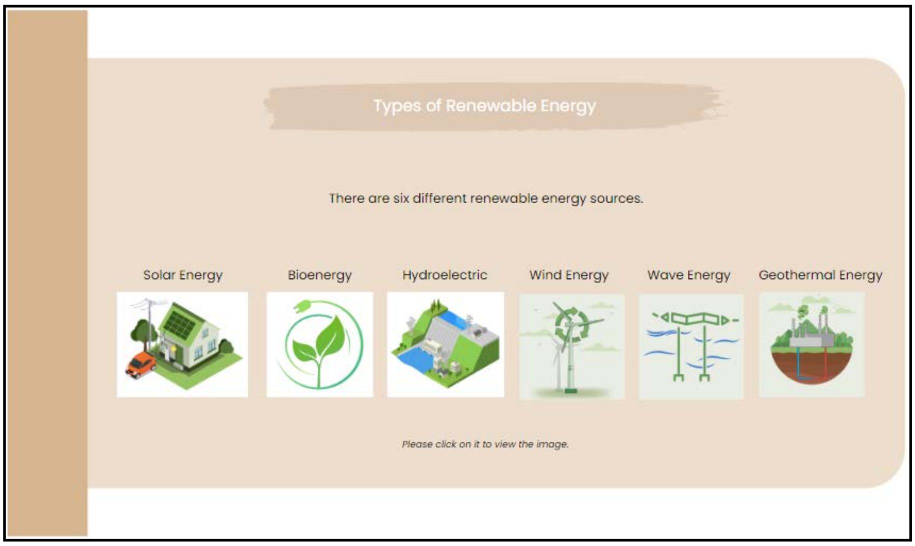
The Open edX platform is a platform that offers Massive Open Online Courses (MOOCs). The Open edX platform provides detailed reports on learners' learning activities, training progress and results, which are stored in the SCORM package.

APPENDIX

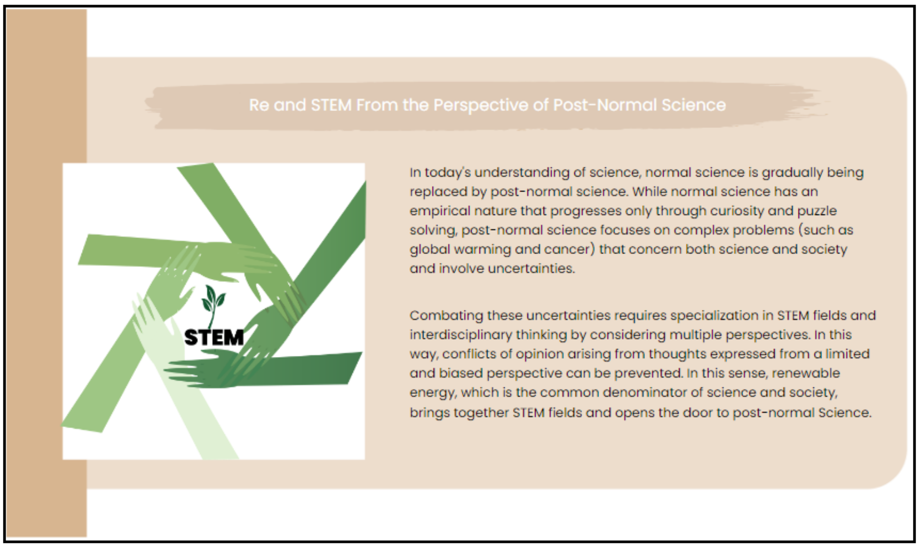
ANNEX 1 - UNIT 1: Sample Screenshots (Introduction to Renewable Energy Sources)

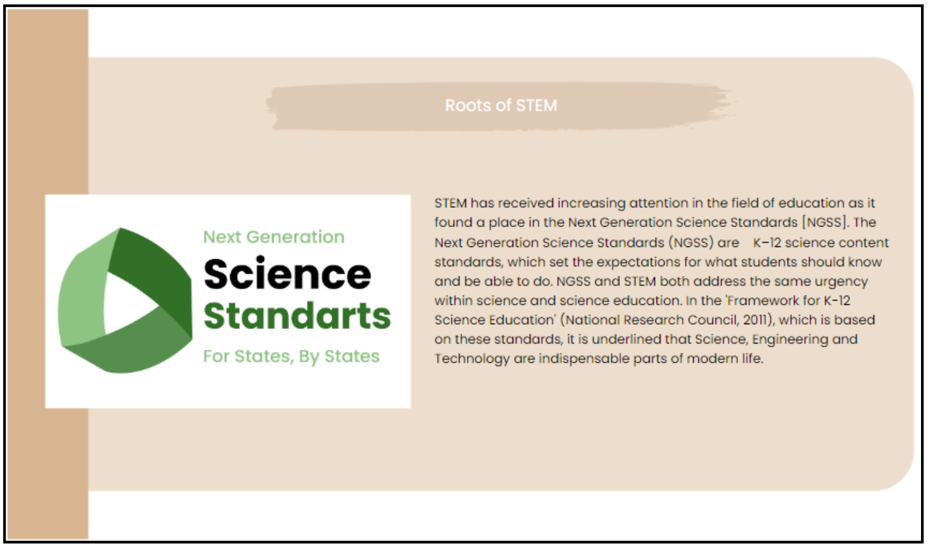


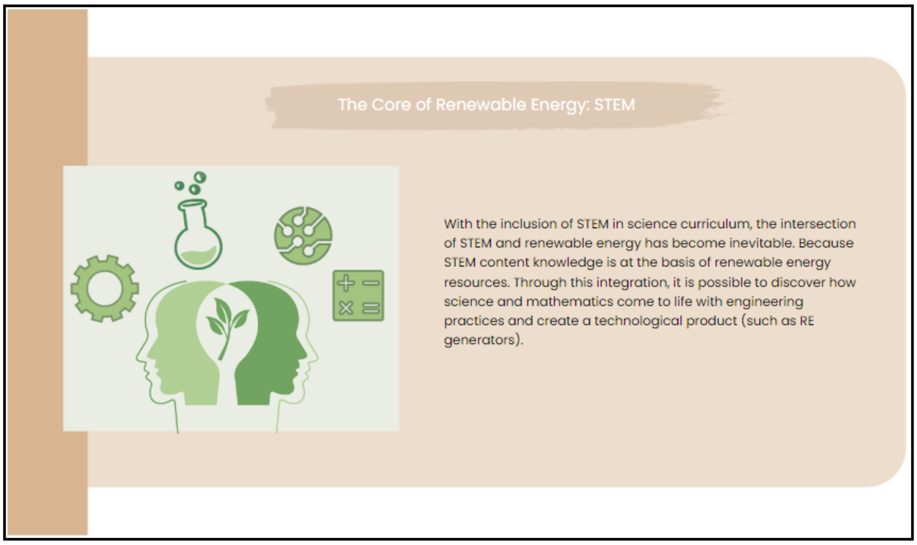




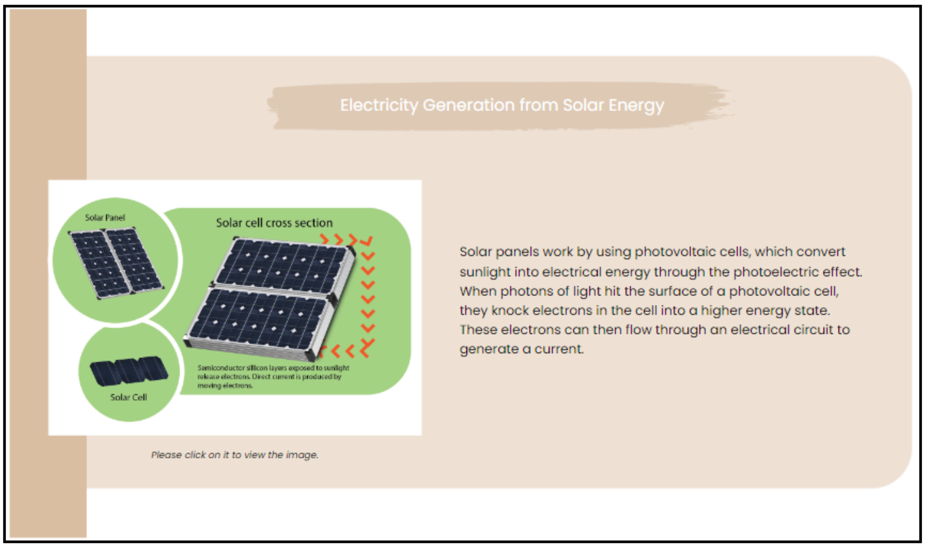
ANNEX 2-UNIT 2: Sample Screenshots (STEM Thinking in the Context of Renewable Energy)

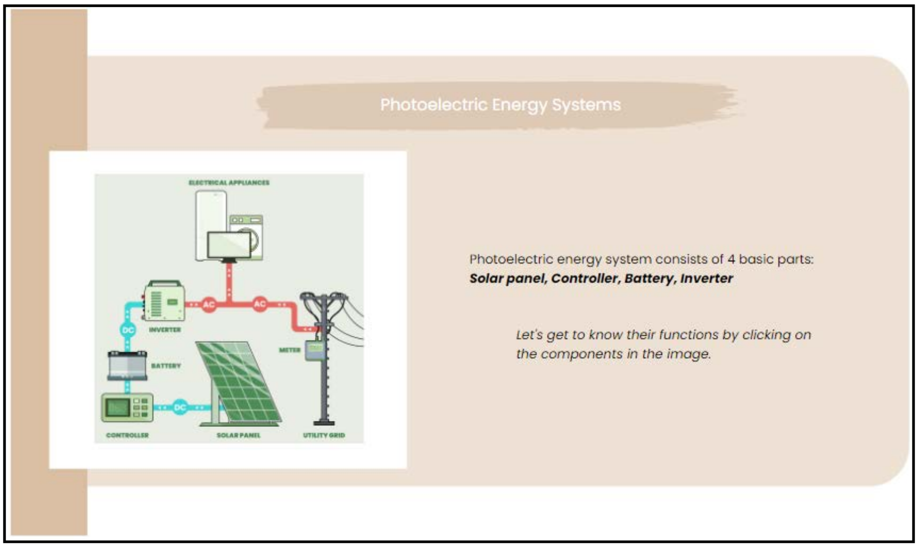


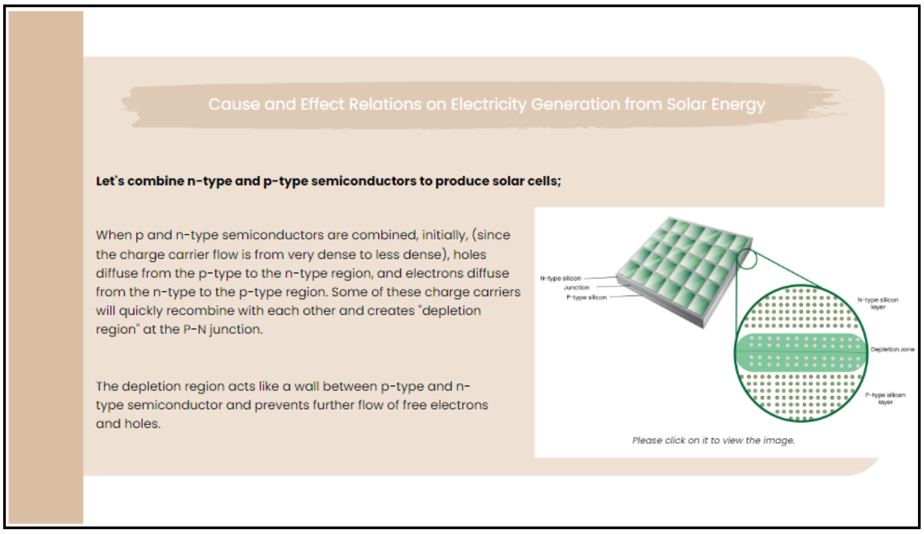




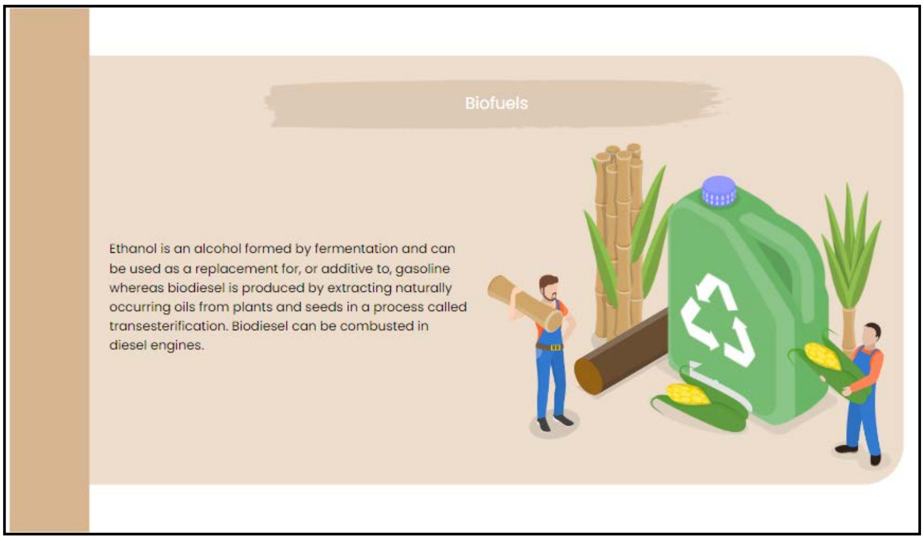
ANNEX 3 - UNIT 3: Sample Screenshots (Solar Energy)

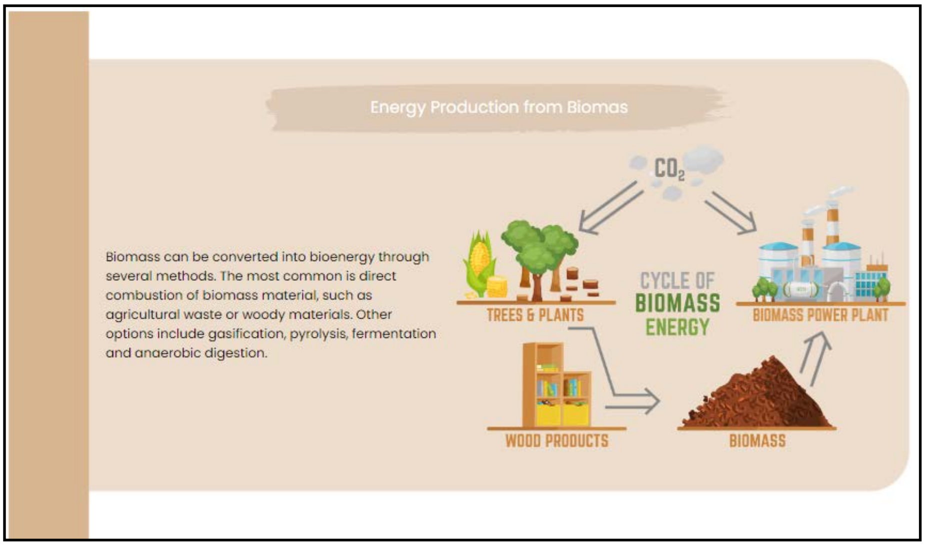


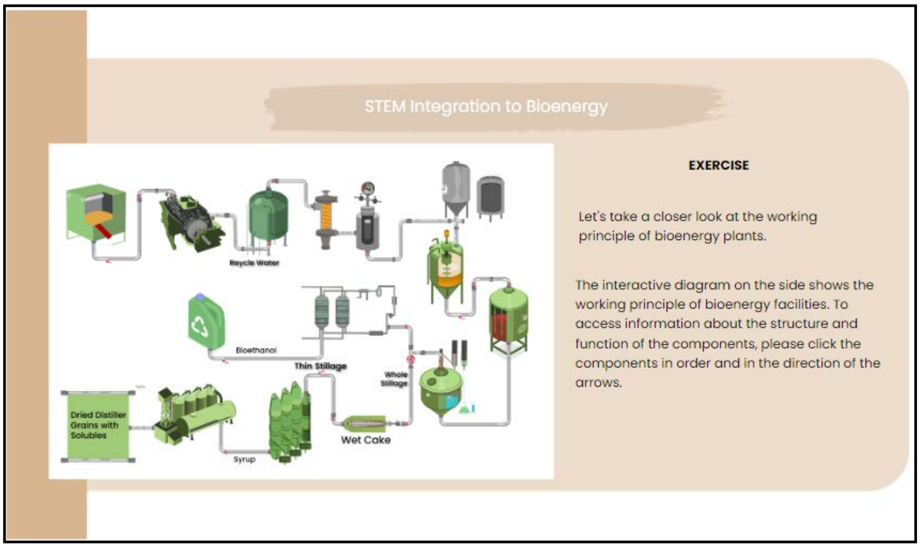




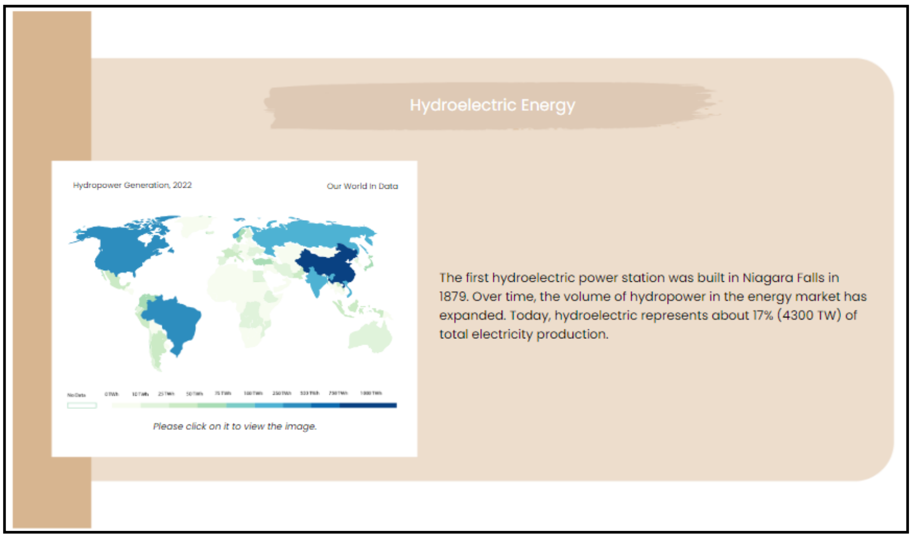
ANNEX 4 - UNIT 4: Sample Screenshots (Bioenergy)

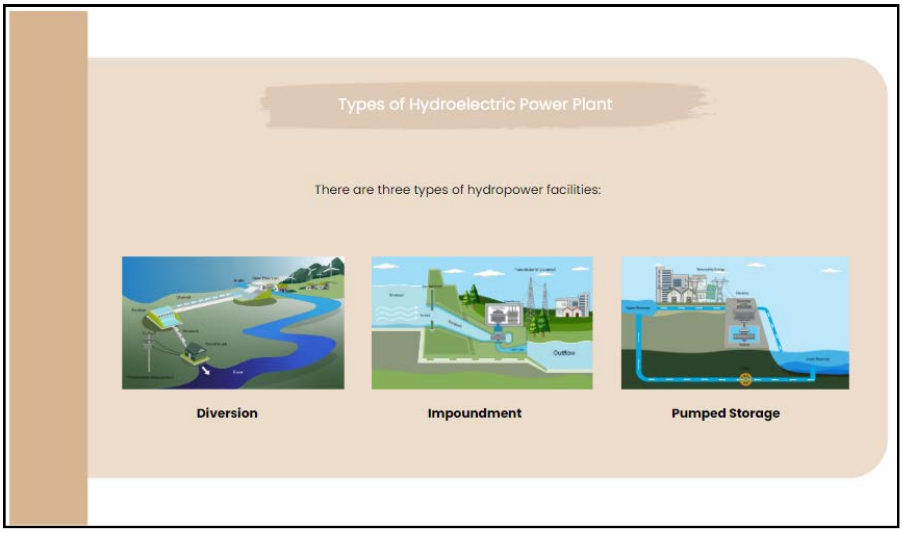


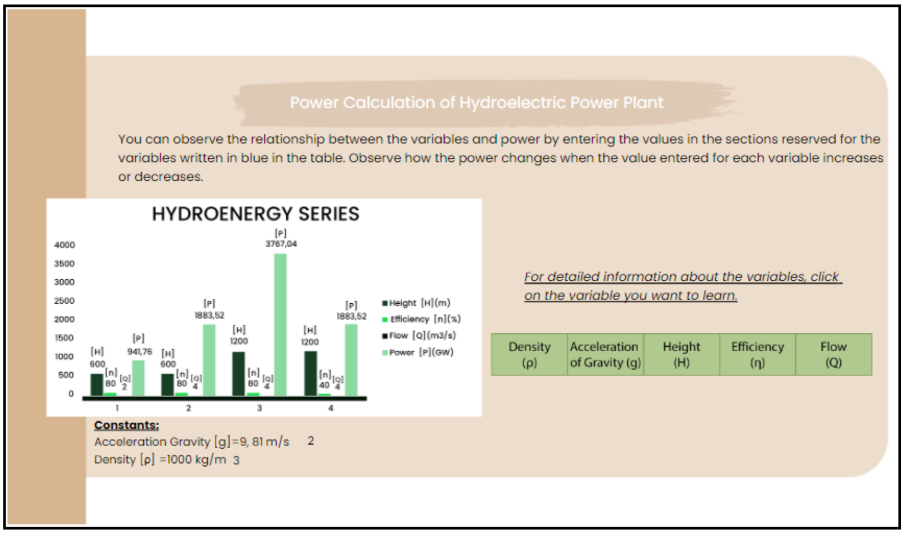




ANNEX 5 - UNIT 5: Sample Screenshots (Hydroelectric Energy)







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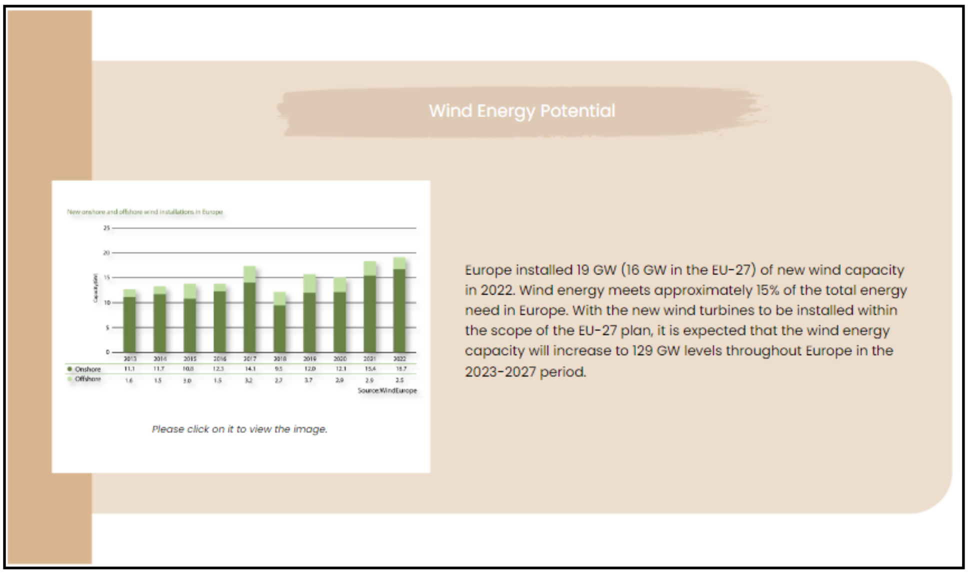
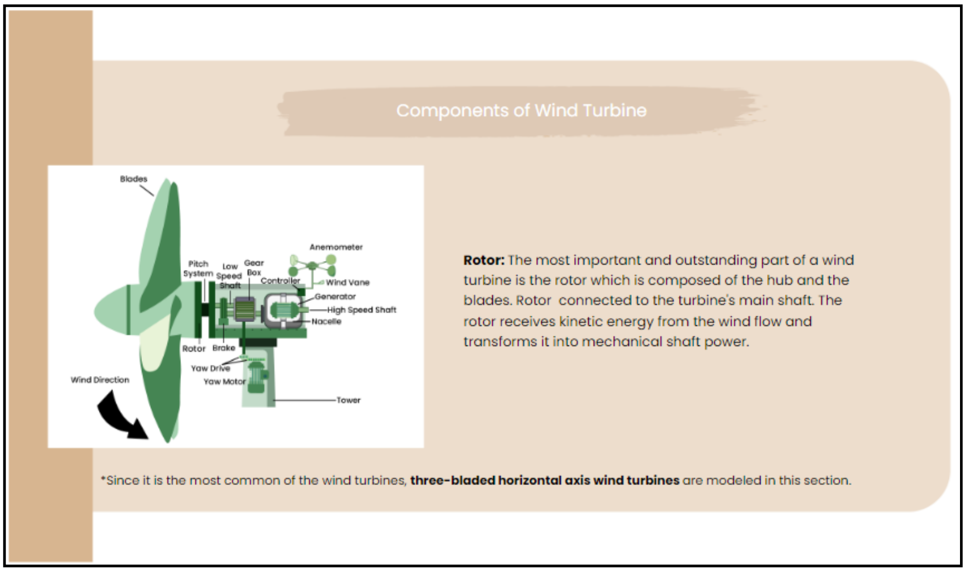
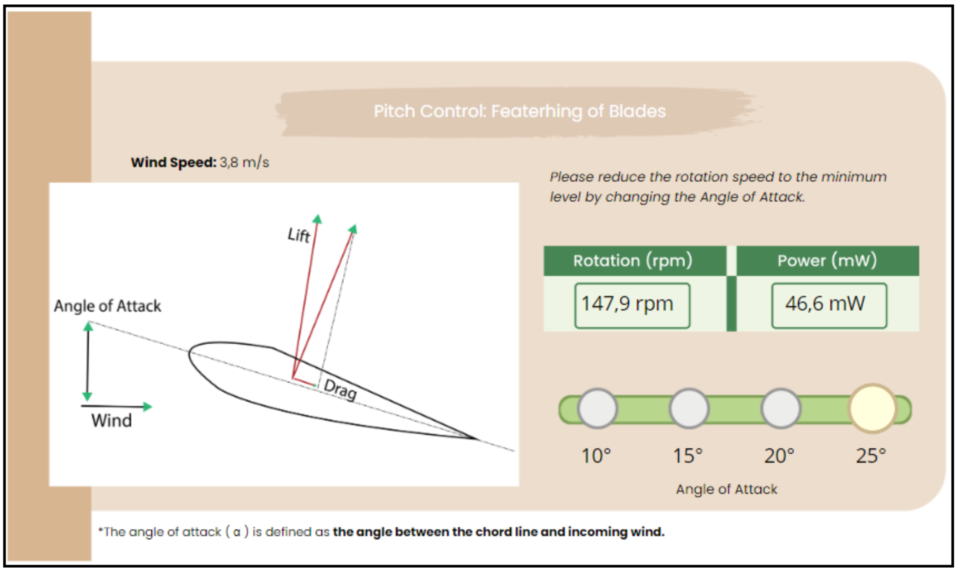
ANNEX 6 - UNIT 5: Sample Screenshots (Wind Energy)

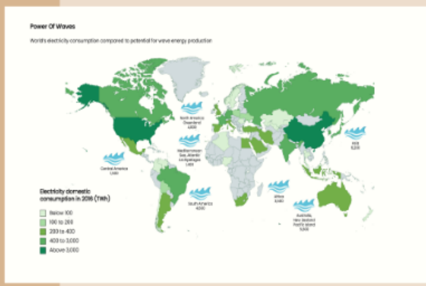






ANNEX 7 - UNIT 6: Sample Screenshots (Wave Energy)

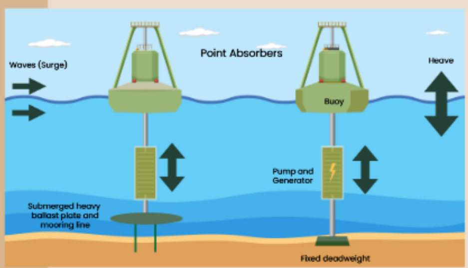
Wave Energy



Please click on it to view the image.

Scaled and full-size wave energy plant prototypes are being tested around Europe, most notably in the UK, Portugal, Spain and Italy, the most advanced device developers are planning and building the first multi-device wave energy farms. When these pilot farms become operational, they will serve as the basis for commercialising wave energy technology and for building a new European industry.

Types of WECs



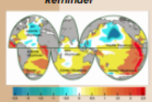
Surface Point Absorber – floating structures, which absorb the energy from waves from all directions. When the device is on top of the surface, the waves cause the pendulum to swing around the vertical axis. A vertically submerged floater absorbs wave energy which is converted by a piston or linear generator into electricity.

Detecting to Wave Energy

You are expected to predict the average annual wave power of the southern ocean using the data sources at your disposal.

The chart below presents data on average annual wave power calculated by ocean basin. Please complete the graph by drawing your estimate of the average wave energy of the southern ocean.

Reminder



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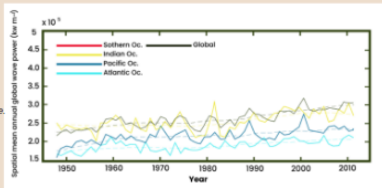


***Figure**. Spatial mean annual Wave Power calculated globally and by ocean basin*

**Note that the wave power scale in the graph is 10 5*

Using the formula and the data in the table, you can calculate the wave energy value of Southern Ocean for certain years.

YEAR	H_s	T_e
1950	10	6,77
1970	11	6,12
1990	12	5,87
2010	13	5,88

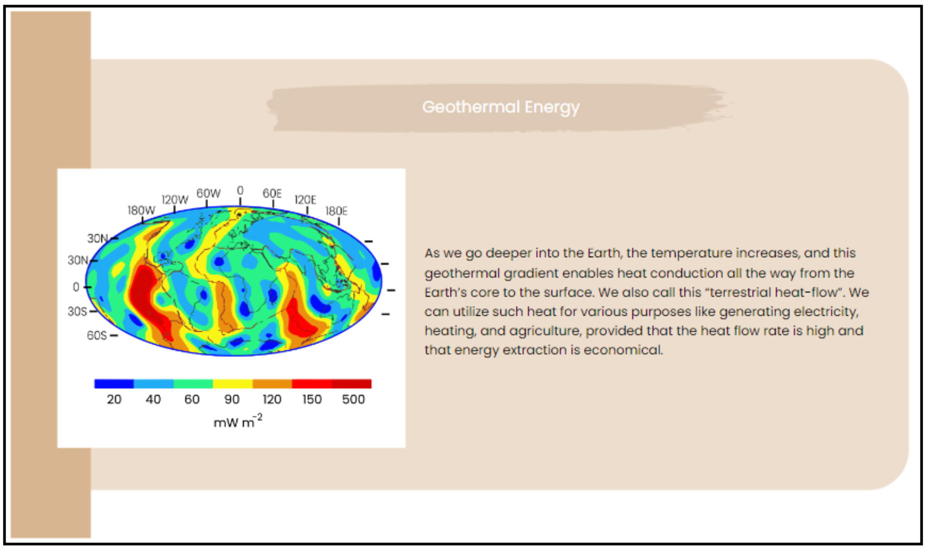
$$WP = \frac{\rho g^2}{64\pi} \cdot T_e \cdot (H_s)^2$$

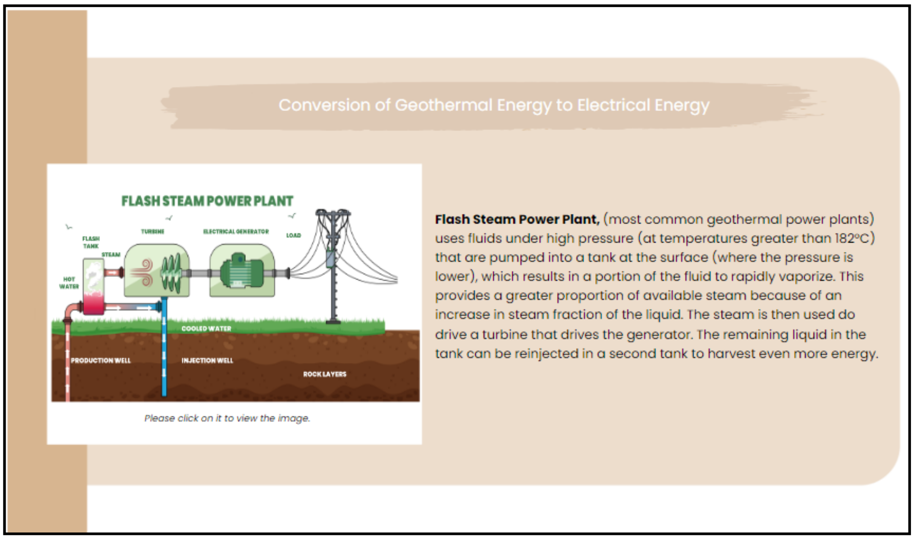
See Answer

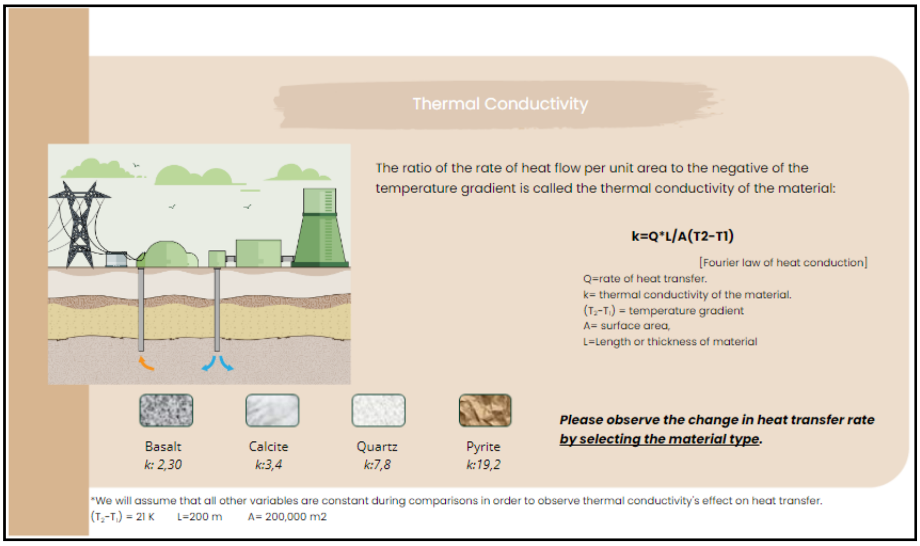
WP: Wave Power
ρ : water density , equal to 1000 kg/m3
g : gravitational acceleration, equal to 9.81 m/s2

T_e: wave period
H_s: significant wave height

ANNEX 8 - UNIT 6: Sample Screenshots (Geothermal Energy)







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Gazi Üniversitesi 1926
Univerza v Mariboru
University of Bucharest VIRTUTE ET SAPIENTIA
BURSA OSMANGAZİ İLÇE MİLLİ EĞİTİM MÜDÜRLÜĞÜ
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ANNEX 9 - UNIT 7: Sample Screenshots (Best Practices)