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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





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## 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.





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## 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/>).





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## 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	<ul style="list-style-type: none"> <li>• Systems and System Models</li> <li>• Cause and Effect</li> </ul>
4. Unit: Bioenergy	<ul style="list-style-type: none"> <li>• Systems and System Models</li> <li>• Energy and Matter</li> </ul>
5. Unit: Hydroelectric Energy and Wind Energy	<ul style="list-style-type: none"> <li>• Patterns</li> <li>• Stability and Change</li> </ul>
6. Unit: Wave Energy and Geothermal Energy and Heat Pumps	<ul style="list-style-type: none"> <li>• Patterns</li> <li>• Structure and Function</li> </ul>
7. Unit: Best Practices Pool	<ul style="list-style-type: none"> <li>• Scale, Proportion and Quantity*</li> <li>• Cause and Effect Patterns</li> <li>• Structure and Function</li> </ul>

\*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.

**Table 2.** STE(A)M Crosscut Concepts

	<b>Description</b>	<b>Example</b>
<b>Patterns</b>	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.
<b>Cause And Effect</b>	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.
<b>Scale, Proportion and Quantity</b>	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.
<b>Systems and System Models</b>	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
<b>Cause and Effect</b>	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
<b>Structure and Function</b>	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
<b>Stability and Change</b>	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".

### n-type Semiconductors

#### n-type

-Atomic Structure-

#### n-type Doping Elements

N
P
As
Sb
Bi

#### n-type Semiconductor

● Electron  
○ Hole

- With the addition of elements with five valence electrons to a pure semiconductor, the number of free electrons increases considerably. Since electrons are in the majority relative to holes, they are called "**majority carriers**" while holes are called "**minority carriers**".

➤ **n-type:** Phosphorus, which has 5 electrons in the valence band, is added to the n-type silicon atoms with 4 electrons in the valence band, and since phosphorus is prone to donate electrons, it gives 1 electron to the crystal structure. For this reason, n-type silicon is called the "emitter".

### p-type Semiconductors

#### p-type

-Atomic Structure-

#### p-type Doping Elements

B
Al
Ga
In
Tl

#### p-type Semiconductor

● Electron  
○ Hole

- By adding elements with three valence electrons to a pure semiconductor, the number of holes increases considerably. Since the holes are in the majority relative to the electrons (free electrons), they are called "**majority carriers**" while electrons are called "**minority carriers**".

➤ **p-type:** Elements with 3 electrons in the valence band (aluminum, indium, gallium, boron, etc.) are added to the P-type silicon melt. Since there are 3 electrons in the last layer of these added atoms, the previous quaternary silicon crystal structure will be broken, and an electron slot (hole) occurs in the crystal structure. For this reason, p-type silicon is called a "receiver".

**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).

Title	Subtitle	Screen No	Number of Scene/ No	Scene Description
UNIT 3	Photoelectric Energy Systems	17	2/1	<p>The diagram appears on the screen with animation. The text box appears on the screen every half second.</p> <p>When Solar Panel, Controller, Battery and Inverter are clicked, it will switch to the relevant screen for each.</p> <p>There will be no Interaction for Electrical Appliances, Utility Grid and Meter.</p> <p>Interaction Type: static</p> <p>Interaction: Bileşenlerin üzerine tıklanığında o bileşene yönelik ekrana geçilecek.</p> <p>Media: <a href="https://www.shutterstock.com/tr/image-vector/solar-cell-plant-energy-equipment-component">https://www.shutterstock.com/tr/image-vector/solar-cell-plant-energy-equipment-component</a>:221168645 1</p>

### Photoelectric Energy Systems

Photoelectric energy system consists of 4 basic parts:  
**Solar panel, Controller, Battery, Inverter**

*Let's get to know their functions by clicking on the components in the image.*

**Figure 2.** Sample scenario screen

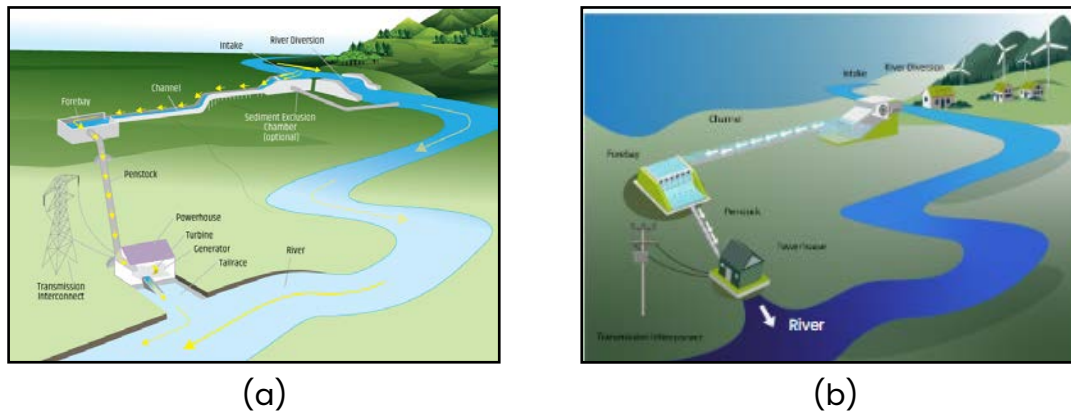
The "Title" section indicates the unit to which the developed content belongs. The "Sub-title" section indicates the sub-title under which the displayed screen is located in relation to the unit. The "Screen number" section indicates the order in which the screen will be displayed in the online learning 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.).

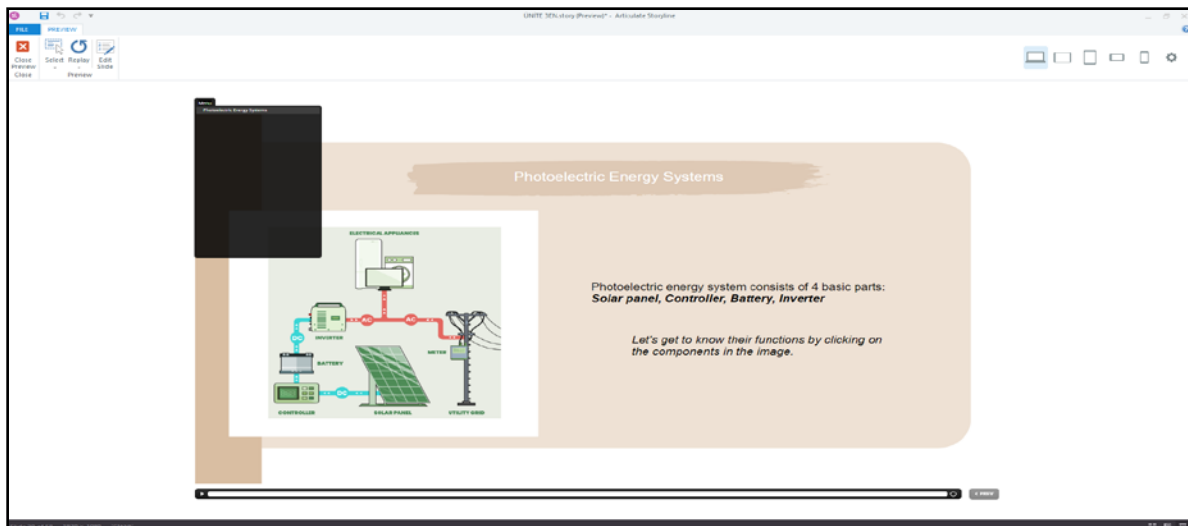


**Figure 3.** Sample of redrawn visual material (a: original image, b: redrawn image)

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

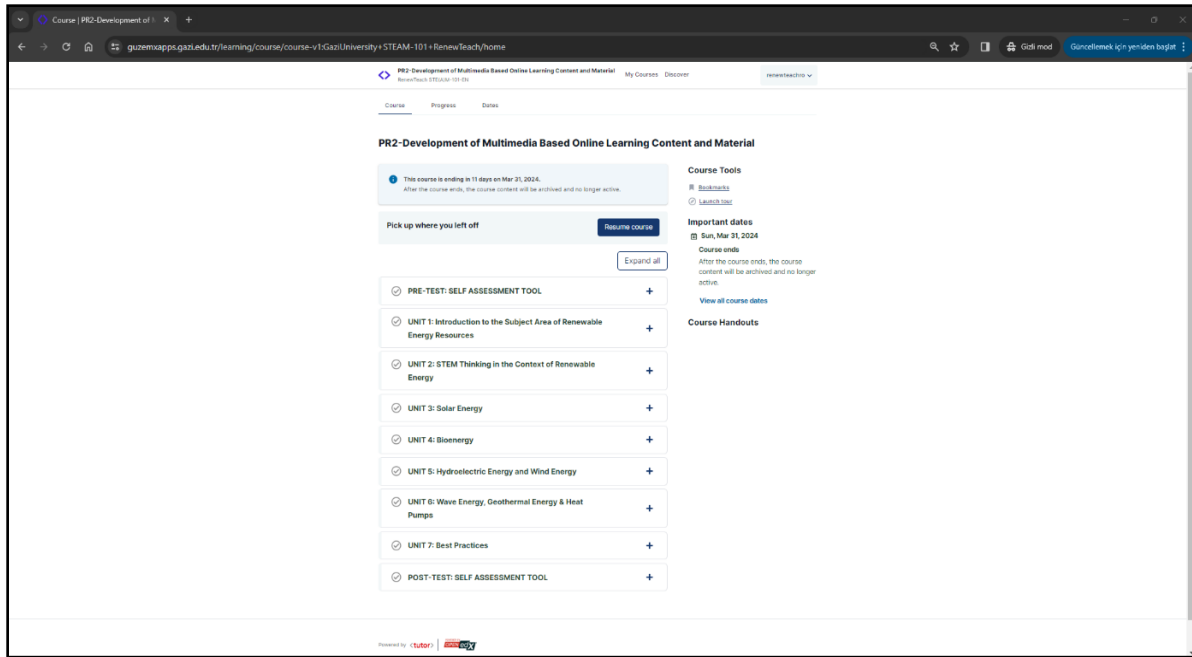
A content tree structure was created on the top left of the content under the title "Menu". With the content tree structure, the topics in the learning material can be examined and progress can be observed. By using Timeline limitation in the transition between scenes in the learning material, students 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.



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**Figure 5.** Integration of units in the Open edX

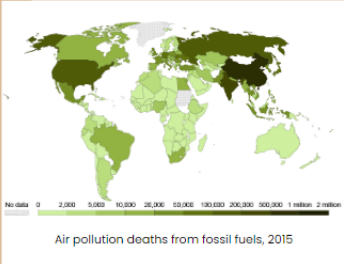
The Open edX platform is a platform that offers Massive Open Online Courses (MOOCs). The Open edX platform provides detailed reports on learners' learning activities, training progress and results, which are stored in the SCORM package.



## APPENDIX

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

#### Global Impacts of Fossil Fuels




Air pollution deaths from fossil fuels, 2015

Please click on it to view the image.

The main constituents of fossil fuels are carbon and hydrogen, but also some other ingredients, which are originally in the fuel (e.g. sulfur), or are added during refining (e.g. lead, alcohols). Combustion of the fossil fuels produces various gases (CO<sub>x</sub>, SO<sub>x</sub>, NO<sub>x</sub>, CH<sub>4</sub>), soot and ash, droplets of tar, and other organic compounds, which are all released into the atmosphere and cause air pollution. Air pollution causes damage to human health, animals, crops, structures, reduces visibility, etc.

#### Introduction to Renewable Energy









RENEWABLE ENERGY

Renewable energy refers to environmentally friendly and sustainable types of energy obtained from natural resources and replenished in a human life time scale. Renewable energy sources serve to diversify the energy supply and reduce dependence on imported fuels.

#### Types of Renewable Energy


There are six different renewable energy sources.

Solar Energy	Bioenergy	Hydroelectric	Wind Energy	Wave Energy	Geothermal Energy
					

Please click on it to view the image.

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


### Re and STEM From the Perspective of Post-Normal Science



In today's understanding of science, normal science is gradually being replaced by post-normal science. While normal science has an empirical nature that progresses only through curiosity and puzzle solving, post-normal science focuses on complex problems (such as global warming and cancer) that concern both science and society and involve uncertainties.


Combating these uncertainties requires specialization in STEM fields and interdisciplinary thinking by considering multiple perspectives. In this way, conflicts of opinion arising from thoughts expressed from a limited and biased perspective can be prevented. In this sense, renewable energy, which is the common denominator of science and society, brings together STEM fields and opens the door to post-normal Science.

### Roots of STEM



STEM has received increasing attention in the field of education as it found a place in the Next Generation Science Standards [NGSS]. The Next Generation Science Standards (NGSS) are K–12 science content standards, which set the expectations for what students should know and be able to do. NGSS and STEM both address the same urgency within science and science education. In the 'Framework for K–12 Science Education' (National Research Council, 2011), which is based on these standards, it is underlined that Science, Engineering and Technology are indispensable parts of modern life.

### The Core of Renewable Energy: STEM



With the inclusion of STEM in science curriculum, the intersection of STEM and renewable energy has become inevitable. Because STEM content knowledge is at the basis of renewable energy resources. Through this integration, it is possible to discover how science and mathematics come to life with engineering practices and create a technological product (such as RE generators).

## ANNEX 3 – UNIT 3: Sample Screenshots (Solar Energy)

### Electricity Generation from Solar Energy

Solar panels work by using photovoltaic cells, which convert sunlight into electrical energy through the photoelectric effect. When photons of light hit the surface of a photovoltaic cell, they knock electrons in the cell into a higher energy state. These electrons can then flow through an electrical circuit to generate a current.

Please click on it to view the image.

### Photoelectric Energy Systems

Photoelectric energy system consists of 4 basic parts:  
**Solar panel, Controller, Battery, Inverter**

Let's get to know their functions by clicking on the components in the image.

### Cause and Effect Relations on Electricity Generation from Solar Energy

Let's combine n-type and p-type semiconductors to produce solar cells;

When p and n-type semiconductors are combined, initially, (since the charge carrier flow is from very dense to less dense), holes diffuse from the p-type to the n-type region, and electrons diffuse from the n-type to the p-type region. Some of these charge carriers will quickly recombine with each other and creates "depletion region" at the P-N junction.

The depletion region acts like a wall between p-type and n-type semiconductor and prevents further flow of free electrons and holes.

Please click on it to view the image.

## ANNEX 4 – UNIT 4: Sample Screenshots (Bioenergy)

### Biofuels

Ethanol is an alcohol formed by fermentation and can be used as a replacement for, or additive to, gasoline whereas biodiesel is produced by extracting naturally occurring oils from plants and seeds in a process called transesterification. Biodiesel can be combusted in diesel engines.

### Energy Production from Biomass

Biomass can be converted into bioenergy through several methods. The most common is direct combustion of biomass material, such as agricultural waste or woody materials. Other options include gasification, pyrolysis, fermentation and anaerobic digestion.

### STEM Integration to Bioenergy

**EXERCISE**

Let's take a closer look at the working principle of bioenergy plants.

The interactive diagram on the side shows the working principle of bioenergy facilities. To access information about the structure and function of the components, please click the components in order and in the direction of the arrows.

## ANNEX 5 – UNIT 5: Sample Screenshots (Hydroelectric Energy)

### Hydroelectric Energy

Hydropower Generation, 2022      Our World in Data

Please click on it to view the image.

The first hydroelectric power station was built in Niagara Falls in 1879. Over time, the volume of hydropower in the energy market has expanded. Today, hydroelectric represents about 17% (4300 TWh) of total electricity production.

### Types of Hydroelectric Power Plant

There are three types of hydropower facilities:

**Diversion**

**Impoundment**

**Pumped Storage**

### Power Calculation of Hydroelectric Power Plant

You can observe the relationship between the variables and power by entering the values in the sections reserved for the variables written in blue in the table. Observe how the power changes when the value entered for each variable increases or decreases.

**Constants:**  
Acceleration Gravity [g]=9,81 m/s<sup>2</sup>    2  
Density [ρ]=1000 kg/m<sup>3</sup>

*For detailed information about the variables, click on the variable you want to learn.*

Density (ρ)	Acceleration of Gravity (g)	Height (H)	Efficiency (η)	Flow (Q)
-------------	-----------------------------	------------	----------------	----------



## ANNEX 6 – UNIT 5: Sample Screenshots (Wind Energy)

### Wind Energy Potential

Year	Onshore (GW)	Offshore (GW)
2013	11.1	1.6
2014	11.7	1.5
2015	10.0	1.9
2016	12.5	1.5
2017	14.1	0.2
2018	9.5	2.7
2019	12.0	3.7
2020	12.1	2.0
2021	15.8	2.8
2022	19.7	2.5

Europe installed 19 GW (16 GW in the EU-27) of new wind capacity in 2022. Wind energy meets approximately 15% of the total energy need in Europe. With the new wind turbines to be installed within the scope of the EU-27 plan, it is expected that the wind energy capacity will increase to 129 GW levels throughout Europe in the 2023–2027 period.

### Components of Wind Turbine

**Rotor:** The most important and outstanding part of a wind turbine is the rotor which is composed of the hub and the blades. Rotor connected to the turbine's main shaft. The rotor receives kinetic energy from the wind flow and transforms it into mechanical shaft power.

\*Since it is the most common of the wind turbines, **three-bladed horizontal axis wind turbines** are modeled in this section.

### Pitch Control: Feathering of Blades

Wind Speed: 3,8 m/s

Please reduce the rotation speed to the minimum level by changing the Angle of Attack.

Rotation (rpm)	Power (mW)
147,9 rpm	46,6 mW

Angle of Attack: 10° 15° 20° 25°

\*The angle of attack ( $\alpha$ ) is defined as the angle between the chord line and incoming wind.

## 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**

Please click on it to view the image.

\*Note that the wave power scale in the graph is 10<sup>5</sup>

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

YEAR	H <sub>s</sub>	T <sub>w</sub>
1950	10	6,77
1970	11	6,12
1990	12	5,87
2010	13	5,68

WP: Wave Power  
p: water density, equal to 1000 kg/m<sup>3</sup>  
g: gravitational acceleration, equal to 9.81 m/s<sup>2</sup>

T<sub>w</sub>: wave period  
H<sub>s</sub>: significant wave height

See Answer

## ANNEX 8 – UNIT 6: Sample Screenshots (Geothermal Energy)

### Geothermal Energy

As we go deeper into the Earth, the temperature increases, and this geothermal gradient enables heat conduction all the way from the Earth's core to the surface. We also call this "terrestrial heat-flow". We can utilize such heat for various purposes like generating electricity, heating, and agriculture, provided that the heat flow rate is high and that energy extraction is economical.

### Conversion of Geothermal Energy to Electrical Energy

**Flash Steam Power Plant**, (most common geothermal power plants) uses fluids under high pressure (at temperatures greater than 182°C) that are pumped into a tank at the surface (where the pressure is lower), which results in a portion of the fluid to rapidly vaporize. This provides a greater proportion of available steam because of an increase in steam fraction of the liquid. The steam is then used to drive a turbine that drives the generator. The remaining liquid in the tank can be reinjected in a second tank to harvest even more energy.

Please click on it to view the image.

### Thermal Conductivity

The ratio of the rate of heat flow per unit area to the negative of the temperature gradient is called the thermal conductivity of the material:

$$k = Q \cdot L / A(T_2 - T_1)$$

[Fourier law of heat conduction]  
 Q=rate of heat transfer.  
 k= thermal conductivity of the material.  
 (T<sub>2</sub>-T<sub>1</sub>) = temperature gradient  
 A= surface area,  
 L=length or thickness of material

Basalt k: 2,30	Calcite k: 3,4	Quartz k: 7,8	Pyrite k: 19,2

**Please observe the change in heat transfer rate by selecting the material type.**

\*We will assume that all other variables are constant during comparisons in order to observe thermal conductivity's effect on heat transfer.  
 (T<sub>2</sub>-T<sub>1</sub>) = 21 K    L=200 m    A= 200,000 m<sup>2</sup>

### ANNEX 9 – UNIT 7: Sample Screenshots (Best Practices)

#### Choosing the Components of Solar Energy System

We are now ready to choose the components of our photovoltaic energy system. Click on the components in the diagram to install them. Please try to choose the most ideal component for your system.

- 1- Solar Panel
- 2- Inverter
- 3- Charge Controller
- 4- Batteries

#### Energy Gap

The chart below shows the distribution of the resources a city uses to meet its energy needs. It is planned to meet the city's energy needs with pumped hydropower storage. So, what is the minimum energy potential of the hydroelectric power plant required to meet the daily demand?

\* *Baseload energy represents the minimum power required to meet basic electrical needs in the electrical grid. In this activity, baseload energy pumped represents the cumulative amount of energy obtained from all other energy sources except hydroelectric energy and solar energy.*

#### Planning Suitable Geothermal Greenhouses

Minimum outdoor temperature: -4 °C

**Site 1**

$k: 7,8$   
 $(T_2 - T_1) = 21 \text{ K}$   
 $L = 200 \text{ m}$   
 $A = 600,000 \text{ m}^2$   
 $h_1 = h_2$      $k_1 < k_2$

Minimum outdoor temperature: -23 °C

**Site 2**

$k: 19,2$   
 $(T_2 - T_1) = 34 \text{ K}$   
 $L = 200 \text{ m}$   
 $A = 600,000 \text{ m}^2$   
 $L_1 = L_2$      $A_1 = A_2$

A feasibility study was carried out in site 1 and site 2 for a geothermal greenhouse project planned to be established. Please review the feasibility report and determine which area will be suitable for the greenhouse.

[Feasibility Report](#)

**Choose:**

Site 1

Site 2