



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

{RENEWTEACH}

PR1

Development of Curriculum and Training Program for Preservice Teachers

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 PR1, one of the project results developed within the RENEWTEACH project.

What is the PR1?

PR1 covers the framework curriculum developed for renewable energy and STE(A)M fields within the scope of the RENEWTEACH project. In addition to unit outcomes, the curriculum includes suggestions for assessment and evaluation, teaching methods and strategies, and examples of STE(A)M activity designs based on common concepts. In this context, PR1 is the basis for all other PRs that follow it in terms of scope.

Aim of PR1

The aim of this project result is to lay the foundation for contents in which STEM skills are integrated into RE context. Thanks to this project, preservice teachers will gain knowledge, skills and attitudes towards RE and STE(A)M.

Implementation

Thanks to PRI pre-service teachers;

- will have theoretical knowledge about renewable energy and STE(A)M.
- understand the nature of renewable energy sources.
- explore the working principles of renewable energy sources and their relationship with STE(A)M disciplines through common concepts.

In this context, PRI is a framework for instructional designs in which STE(A)M approach is adopted in teaching topics related to renewable energy.

How to Access?

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







JUSTIFICATION OF THE CURRICULUM

- When the policies stated in the European Commission, Education and Training 2020 Working Group (WG) and Erasmus 2020 and the Council of Europe's 2019-2024 Strategic Agenda are examined, such as local and global challenges and resource saving, reducing energy use and waste, compensating carbon it is seen that the priorities for acquiring environmentally friendly behaviors are targeted.
- The development of environmental goals and STEAM skills were included in the priorities of higher education in the Erasmus Program Guide 2021 (EPG, 2021)
- Both in Turkey and European Countries is observed that the lack of a specific curriculum related to RE in higher education in the country. There isn't any project that addresses the embedded content of STE(A)M disciplines in the context of renewable energy (RE) in higher Education. Teachers and preservice teachers are therefore experiencing difficulties in developing sufficient knowledge, skills and attitudes towards RE. Therefore, this curriculum is an innovative feature in terms of eliminating this gap.

The European Qualifications Framework (EQF): an overview

The European Qualifications Framework (EQF) is a way of mapping qualifications across EU member countries. The EQF was officially adopted by the European Parliament and the Council in April 2008. It has two principal aims:

- To promote citizens' mobility between countries and
- To facilitate their lifelong learning.

Qualification Level

The learning outcomes are defined in terms of:

- Knowledge: in the context of EQF, knowledge is described as theoretical and/or factual.
- *Skills*: In the context of EQF, skills are described as cognitive (involving the use of logical, intuitive, and creative thinking) and practical (involving manual dexterity and the use of methods, materials, tools and instruments).







• Responsibility and autonomy: In the context of the EQF responsibility and autonomy is described as the ability of the learner to apply knowledge and skills autonomously and with responsibility.

The level indicates the difficulty and complexity of the knowledge and skills associated with any qualification. There are eight levels (Levels 1-8). This curriculum covers the EQF's level 6 competences.

Learning outcomes at EQF level 6

Knowledge: Advanced knowledge of a field of work or study, involving a critical understanding of theories and principles

Skills: Advanced skills, demonstrating mastery and innovation, required to solve complex and unpredictable problems in a specialised field of work or study

Responsibility and autonomy: Manage complex technical or professional activities or projects, taking responsibility for decision-making in unpredictable work or study contexts; take responsibility for managing professional development of individuals and groups

COURSE SUMMARY

With this curriculum...

- Preservice Teachers will have theoretical knowledge about RE (what is RE, what is the scope)
- Comprehend the working principle of RE skills
- Understand the nature of the sources of RE, STEM disciplines operate together and comprehend the nature of what we call complex Science
- Understand how RE sources intersect with the principles of working (Science,Technology, Math and Eng) and what are the common ways of thinking

Unit Format

In each unit, learning outcomes are handled by considering EQF competencies and crosscutting concepts of NGSS. Procedural knowledge for renewable energy is provided with STEM integration.







Learning outcomes

Learning outcomes describe the knowledge, skills, or attitudes that learners need to know, do and apply in each unit. Learners must achieve the learning outcomes to pass the unit.

NGSS's Crosscutting Concepts

The following NGSS' crosscutting concepts are taken into account in the integration of STEM skills into renewable energy subject areas within the scope of this curriculum.

- Scale, Proportion, and Quantity: Learners must be able to recognize what is relevant at different sizes, times, and scales. They also need to recognize proportional relationships between categories, groups, or quantities.
- *Cause and Effect*: Learners are often interested in and attempt to identify causal relationships.
- *Patterns*: Learners use observed patterns in nature to guide organization and classification systems. They also attempt to understand the underlying cause of these patterns.
- Systems and System Models: Learners often need to define the system under study and then make a model of it to understand it. Models can be physical, conceptual, or mathematical.
- Stability & Change: Learners often need to understand what makes a system stable or unstable and what controls rates of change in a system.
- *Energy and Matter*: Learners often need to understand how energy and matter flow, into, out of, and within a system in order to understand it.
- Structure and Function: The structure of an object determines its function and places limits on what the object can and cannot do.

Entry Requirements:

• There are no entry requirements for this course







Qualification Target Group:

Our particular target groups to sharing and promotion project are below

- The project partners and their staff members in science education departments, as well as pre-service teachers studying in these departments.
- All teachers (especially STEAM teachers and science teachers) including candidate teacher and pre-service teachers
- Local public authorities in the field of education, regional education boards, administrations
- Education policy-makers -partners institutions in Higher education level across the EU
- Renewable Energy Associations and Agencies (World Wind Energy Association[DE], International Renewable Energy Agency , International Energy Agency [IEA] etc.)
- Other educational institutions (Higher Education Institutions, Research centers EU Level etc.)

Delivery Languages:

This qualification is available in English, Turkish, Romanian, Slovenian and Spanish.

Course Structre

Units	Title	Duration	Weeks
Unit 1	Introduction to the Subject Area of Renewable Energy	6 lessons	2
	Resources		
Unit 2	STEM Thinking in The Context of Renewable Energy	6 lessons	2
Unit 3	Solar Energy	6 lessons	2
Unit 4	Bioenergy	6 lessons	2
Unit 5	Hydroelectric Energy and Wind Energy	6 lessons	2
Unit 6	Wave Energy and Geothermal Energy and Heat Pumps	6 lessons	2
Unit 7	Best Practices	6 lessons	2







UNIT 1			
Title	Introduction to the subject area of renewable		
	energy resources		
Level	Higher Education		
Guided Learning Hours (GLH)	2 Weeks (2T + 4P)		

Unit purpose and aim(s): The aim of this unit is to enable pre-service teachers to understand fossil fuels and their role in global warming and to have basic knowledge about renewable energy sources.

Learning Outcomes	s Assessment	t Criteria	
Know the fossil fue and global clima change	ate 2. Defines the the atmo 3. Discusses environm transport national of 4. Discuss t sources	2. Defines the interactions between the structure of the atmosphere and combustion products.	
 Introduction to renewable energy sources 	gy 2. Knowing 3. Compreh Energy So climate c 4. Comparin of using	Renewable Energy Sources and Types hending the importance of Renewable Sources in terms of global warming and	
Pedagogy (Teachin	ig methods and strat	itegies)	
•	The following Teaching methods/strategies may be used to ensure all learning outcomes and assessment criteria are fully covered.		
Teaching Method/Strategy	Definition	Recommended Content	
Direct Instruction/ Didactic teaching	Presentation academic content learners directly teachers	11 / /	







Problem-based	Learning concepts and	The problem can be animated		
learning	principles through	with a web-based simulation, or		
	complex real-world	it can be described through		
	problems	scenarios.		
Brainstorming	Sharing ideas	Group members are		
	spontaneously with other	encouraged to express their		
	members to find	opinions, not criticize any ideas,		
	solutions to practical	generate many ideas, and feel		
	problems.	free to contribute ideas.		
POE (Predict-	Learners test their	In the conceptual learning		
Observe-Explain)	predictions about a	process, conceptual change		
	natural phenomenon	texts and vignettes can be used		
	with observations or	to control how learners construct		
	experiments and have	knowledge and to eliminate		
	the opportunity to	misconceptions.		
	construct their			
	nowledge.			
Assessment Guidance				
The following assessment method/s may be used to ensure all learning				
•	essment criteria are fully co	Ū		
• Test/Quiz	Conce	ept Maps		
Writing Short /Narrative Stories Questionnaires/Surveys				
STEM Integration				
In this unit, STEM integration is out of question as it is aimed to gain				

declarative knowledge on renewable energy.







UNIT 2			
Title	STEM thinking in the context of renewable energy		
Level	Higher Education		
Guided Learning Hours (GLH)	2 Weeks (2T + 4P)		

Unit purpose and aim(s): The aim of this unit is to enable prospective teachers to understand the nature of STEM and to linking renewable energy applications and their underlying STEM practices.

Learning Outcomes		Assessment Crite	əria	
 Identification of 	nature of STEM Education 2. Uses appropriate concepts, ways of think (mathematical, scientific, and computatio etc.), or definitions about STEM 3. Develops a comprehension ab interdisciplinarity of knowing. 4. Lists the characteristics of an individual v STEM thinking skills			
 Relevance betwee renewable energy STEM thinking dispositions 	e energy and as a design established with the intersection of different STEM content knowledge.			
Pedagogy (Teaching methods and strategies)				
-	The following Teaching methods/strategies may be used to ensure all learning outcomes and assessment criteria are fully covered.			
Teaching Method/Strategy	Definit	ion	Recommended Content	
Direct	Present	tation of	Conceptual information	
Instruction/	acader		supported by demonstrations,	
Didactic teaching	learner teache	, ,		
Problem-based learning	Learnin princip	ng concepts and The problem can be animated		







complex real-world it can be described through scenarios. Flipped Learning Identifies as an Identifies as an The information package, which individualized gradual process in which learners take scenarios, animations, and responsibility for their own learning by deciding on the subject matters in learning environments that are flexible, highly diverse, and where groups can be independent from the information from the cach other to a certain extent. The teacher acts as a guide in this process. Brainstorming Sharing ideas solutions to practical problems. Group members are encouraged to express their opinions, not criticize any ideas, generate a large number of ideas. Assessment Guidance Concept Maps Concept Maps The following assessment method/s may be used to ensure all learning outcomes and assessment criteria are fully covered. Concept Maps Test/Quiz Questionnaires/Surveys Peer Assessments Test/Quiz Peer Assessment Concept Maps Test/Quiz Peer Assessments Peer Assessment so the following concepts:	ProblemsFlipped LearningIdentifies as an individualized gradual process in which learners take responsibility for their own learning by deciding on the subject matters in learning environments that are flexible, highly diverse, and where groups can be independent from each other to a certain extent. The teacher acts as a guide in this process.BrainstormingSharing ideas spontaneously with other members to find solutions to practical problems.Assessment GuidatterThe following assessment criteria are fully co e ach other to a certain extent. The teacher acts as a guide in this process.BrainstormingSharing ideas spontaneously with other members to find solutions to practical problems.Assessment GuidatterIndependent from each other to a certain extent. The teacher acts as a guide in this other members to find solutions to practical problems.Assessment GuidatterIndependent extent.The following assessment criteria are fully co e. Formative Assessment e. Test/QuizIndependent e. Conce e. Questi e. Peer ASTEM IntegrationPeer AStem IntegrationPeer AStem IntegrationPeer AStem IntegrationPeer A	scenarios. The information package, which consists of various materials such as scientific articles, scenarios, animations, and videos, is presented to the learners. The learner creates a synthesis by combining the ones that are suitable for them among the resources presented to them with the information from the resources they have obtained. Then, the control and enrichment of learning is provided in the					
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 Self-evaluation Peer Assessments STEM Integration In this unit, STEM integration will be provided by using one or more of the following crosscutting concepts. Crosscutting Concepts: 	Self-evaluation Peer A STEM Integration In this unit, STEM integration will be provided by following crosscutting concepts.						
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following crosscutting concepts. Crosscutting Concepts:	following crosscutting concepts.						
Crosscutting Concepts:		using one or more of the					
• Scale, Proportion, and Quantity: Deciding on the type and capacity of the	using one or more of the						
renewable energy plant to be established according to the energy needs.							
Cause And Effect: Establishes cause and effect relationships for the sources	on the type and capacity of the						
of sustainable energy problem and the global climate crisis and proposing	on the type and capacity of the according to the energy needs.						
	STEM solutions to overcome.	on the type and capacity of the according to the energy needs. ffect relationships for the sources					







- **Pattern:** Discovering that information about different STEM fields intersect and even integrate at certain points.
- **Systems and System Models:** Considering renewable energy power plants as a dynamic construction created by science and engineering.
- **Stability and Change:** Evaluation of renewable energy sources in terms of sustainability and efficiency.
- **Energy and Matter:** Comprehending the concepts of conservation and conversion of energy and the equivalent of these concepts in STEM practices.
- **Structure and Functions:** Analyzing renewable energy practices to understand how and to what extent STEM design is integrated into renewable energy contexts.







	UNIT 3			
Title		Solar Energy		
Level		Higher Education		
Guided Learning Ho	ours	2 Weeks (2T + 4P)		
(GLH)				
		• •	teachers to explore STEM	
-	ontext of	solar energy by know	ring solar energy and the ways	
it is produced.				
Learning Outcome	S	Assessment Criteri	a	
 Introduction to s 	olar	1. Defines solar ene	ergy.	
energy			benefit from solar energy	
		3. Explains the		
		photovoltaic cell	-	
			olar energy is converted into	
* STEM integration	to	electrical energy 1. Understands		
 STEM integration to 1. solar energy context 		1. Understands how science, technology, mathematics and engineering disciplines are		
solar energy context		used in solar energy.		
		2. Comprehends how STEM integration takes		
		place in the context of solar energy.		
		3. Comprehends t	he design and function of the	
		parts/sectors the	at make up the solar panel.	
Pedagogy (Teaching methods and strategies)				
The following Teach	ning meth	nods/strategies may	be used to ensure all learning	
outcomes and asse	essment o	criteria are fully cover	red.	
Teaching Method/Strategy	Definitio	on	Recommended Content	
Hands-	Engagir	ng learners in a	Learners can interact directly	
on/Minds-on	cognitiv	•	with learning materials	
		nanner. Learning by	through virtual reality	
	doing.		activities, robotics and coding	
			practices, models and miniatures.	
Problem-based	Learning	g concepts and	The problem can be	
learning		es through complex	animated with a web-based	
		rld problems	simulation, or it can be	
			described through scenarios.	
L				









Project-based learning	Learners develop and present a Products or artifacts by working on an interdisciplinary problem or scenario individually or in groups.	Learners design models/miniatures using a variety of equipment, including simple tools and STEM kits. Prepares and presents a report by compiling the information obtained from various sources. Products or artifacts represent what the learners have understood about their field of study.
Inquiry-based learning	Learning process that engages learners by making real-world connections through exploration and high-level questioning.	Learners discuss with their peers the data and opinions they have obtained from scientific articles, vignettes, and other sources of evidence for a research question. Discussion continues until consensus is reached through small group discussion and/or class discussions.
Experimental Method	Experimental method involves manipulating one variable to determine if this causes changes in another variable	Learners collect data by using various experiment kits in the laboratory or by experimenting in a virtual laboratory environment.
Cooperative learning	Learners work on learning activities in small groups with each one of them having a particular role and receive rewards or recognition based on their group's performance	Groups are planned to be as heterogeneous as possible. There is competition between groups. Everyone in the group is encouraged to actively participate.
Brainstorming	Sharing ideas spontaneously with other members to find solutions to practical problems.	Group members are encouraged to express their opinions, not criticize any ideas, generate many ideas, and feel free to contribute ideas.













Mastery learning	Each learner is given the amount and kind of instruction individually needed. Instruction varies according to need, and the end result is a uniformly high level of performance for all.	Learning environments can be supported by software and simulations where learners can follow their own learning. Abstract concepts can be embodied with animations and videos.		
Flipped Learning	Identifies as an individualized gradual process in which learners take responsibility for their own learning by deciding on the subject matters in learning environments that are flexible, highly diverse, and where groups can be independent from each other to a certain extent. The teacher acts as a guide in this process.	The information package, which consists of various materials such as scientific articles, scenarios, animations, and videos, is presented to the learner. Learners create a synthesis by combining the ones that are suitable for them among the resources presented to them with the information from the resources they have obtained. Then, the control and enrichment of learning is provided in the classroom environment.		
Outdoor learning	School trips are learning practices in which learning is carried from the classroom environment to real life and aiming to provide students with first- hand experience.	Learners may be asked to compile and report the observation notes they took during the field trip. In case of necessity, field trips can also be carried out in a virtual reality environment.		
Assessment Guidance				
The following assessment method/s may be used to ensure all learning outcomes and assessment criteria are fully covered.				
 Portfolio of Evide Test/Quiz Self-evaluation 	Conce	ework/Document Analysis ept Maps ssessments		



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STEM Integration

In this unit, STEM integration will be provided by using one or more of the following crosscutting concepts.

Crosscutting Concepts:

- Scale, Proportion and Quantity: Understanding how changes in scale, proportion and quantity affect the structure and performance of the solar energy systems.
- **Cause And Effect:** Establishing a cause-effect relationship on how solar energy is produced via comprehending the big idea of science and engineering disciplines.
- **Patterns:** Understands and explains the repetitive and serial events and concepts related to the science and engineering discipline in the context of solar energy production.
- **Systems and System Models:** Creating an explicit model of solar energy systems, by describing the structure of the system and identifying its boundaries.
- **Stability and Change:** Understanding the dynamic balance in the context of the stability of the solar energy generating system and comprehending how small changes in the system affect the stability.
- **Energy and Matter:** Comprehending the place of matter and energy in a system, the cycles, flow and transfer of matter and energy in the context of solar energy production.
- **Structure and Function:** Understanding the design and production of new systems according to the properties of the materials in the system (weight, hardness, etc.) via comprehending the structure and functions of the solar energy generating system.







UNIT 4			
Title		Bioenergy	
Level		Higher Education	
Guided Learning Ho	ours (GLH)	2 Weeks (2T + 4P)	
<i>Unit purpose and aim(s):</i> To enable prospective teachers to explore STEM integration in the context of biogas energy by knowing biogas energy and the ways it is produced.			-
Learning Outcomes	s	Assessment Criter	ia
 Introduction to b energy/biomass STEM integration biogas energy/b 	n to	 Explains how k biomass. Distinguishes bio of waste. Lists the biomass Evaluates the a biomass energy Evaluates the and bioenergy p Comprehends mathematics an used in the proc Comprehends place in the com Comprehends the 	advantages and limitations of waste management policies botentials of countries. how science, technology, nd engineering disciplines are duction of biogas. how STEM integration takes atext of biogas energy. the design and function of the
	parts/sectors that make up the biogas plant		
Pedagogy (Teachir			
-	-	• •	be used to ensure all learning
	essment Cr	iteria are fully covere	eu.
Teaching Method/Strategy	Definitio	า	Recommended Content
Hands- on/Minds-on	Engaging cognitive active m doing.		Learners can interact directly with learning materials through virtual reality activities, robotics and coding practices, models and miniatures.
Problem-based learning		concepts and s through complex d problems	The problem can be animated with a web-based













		simulation, or it can be
		described through scenarios.
Project-based	Learners develop and	Learners design
learning	present a Products or	models/miniatures using a
	artifacts by working on an	variety of equipment,
	interdisciplinary problem or	including simple tools and
	scenario individually or in	STEM kits. Prepares and
	groups.	presents a report by
		compiling the information
		obtained from various
		sources. Products or artifacts
		represent what the learners
		have understood about their
		particular field of study.
Inquiry-based	Learning process that	Learners discuss with their
learning	engages learners by making real-world connections	peers the data and opinions they have obtained from
	through exploration and	scientific articles, vignettes,
	high-level questioning.	and other sources of
	night level questioning.	evidence for a research
		question. Discussion
		continues until consensus is
		reached through small
		group discussion and/or
		class discussions.
Experimental	Experimental method	Learners collect data by
Method	involves manipulating one	using various experiment kits
	variable to determine if this	in the laboratory or by
	causes changes in another	experimenting in a virtual
	variable	laboratory environment.
Cooperative	Learners work on learning	Groups are planned to be as
learning	activities in small groups	heterogeneous as possible.
	with each one of them	There is competition
	having a particular role and	between groups. Everyone in
	receive rewards or	the group is encouraged to
	recognition based on their	actively participate.
Durgin ato unain a	group's performance	Croup mombars are
Brainstorming	Sharing ideas spontaneously with other	Group members are
	spontaneously with other	encouraged to express their opinions, not criticize any
	1	opinions, not childize dry













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	members to find solutions to	ideas, generate many ideas,
	practical problems.	and feel free to contribute ideas.
Mastonylograping	Each logroor is given the	
Mastery learning	Each learner is given the amount and kind of	Learning environments can be supported by software
	instruction individually	and simulations where
	needed. Instruction varies	learners can follow their own
	according to need, and the	learning. Abstract concepts
	result is a uniformly high	can be embodied with
	level of performance for all.	animations and videos.
Flipped Learning	Identifies as an	The information package,
i iippou couriiig	individualized gradual	which consists of various
	process in which learners	materials such as scientific
	take responsibility for their	articles, scenarios,
	own learning by deciding on	animations, and videos, is
	the subject matters in	presented to the learner.
	learning environments that	Learners create a synthesis
	are flexible, highly diverse,	by combining the ones that
	and where groups can be	are suitable for them among
	independent from each	the resources presented to
	other to a certain extent. The	them with the information
	teacher acts as a guide in	from the resources they have
	this process.	obtained. Then, the control
		and enrichment of learning is
		provided in the classroom
		environment.
Outdoor learning	School trips are learning	Learners may be asked to
	practices in which learning is	compile and report the
	carried from the classroom	observation notes they took
	environment to real life and	during the field trip. In case of
	aiming to provide students	necessity, field trips can also
	with first-hand experience.	be carried out in a virtual
		reality environment.
Assessment Guida	nce	
The following asses	sment method/s may be used	to ensure all learning
outcomes and asse	essment criteria are fully covere	ed.
Portfolio of Evide	ence Course	ework/Document Analysis
 Test/Quiz 	• Conce	pt Maps
• Self-evaluation	Peer A	ssessments
TAR OTHER DESIGNATION	Universa v Mariboru	





STEM Integration

In this unit, STEM integration will be provided by using one or more of the following crosscutting concepts.

Crosscutting Concepts:

- Scale, Proportion and Quantity: Understanding how changes in scale, proportion and quantity affect the structure and performance of the bioenergy power plants.
- **Cause And Effect:** Establishing a cause-effect relationship on how bioenergy is produced via comprehending the big idea of science and engineering disciplines.
- **Patterns:** Understands and explains the repetitive and serial events and concepts related to the science and engineering discipline in the context of bioenergy production.
- **Systems and System Models:** Creating an explicit model of bioenergy systems, by describing the structure of the system and identifying its boundaries.
- **Stability and Change:** Understanding the dynamic balance in the context of the stability of the bioenergy generation and comprehending how small changes in the system affect the stability.
- **Energy and Matter:** Comprehending the place of matter and energy in a system, the cycles, flow, and transfer of matter and energy in the context of bioenergy production.
- **Structure and Function:** Understanding the design and production of new systems according to the properties of the materials in the system (weight, hardness, etc.) via comprehending the structure and functions of the bioenergy power plants.







UNIT 5			
Title	Hydroelectric Energy and Wind Energy		
Level	Higher Education		
Guided Learning Hours (GLH)	2 Weeks (2T + 4P)		
Unit purpose and aim(s):T	o enable pre-service teachers to explore the STEM		
	hydroelectric energy and wind energy by knowing		
the production ways of hyd	roelectric energy and wind energy.		
Learning Outcomes	Assessment Criteria		
 Introduction to Hydroelectric Energy 	 Defines hydroelectric energy. Explains how electrical energy is produced in hydroelectric power plants. Defines the factors affecting the energy production capacity of hydroelectric power plants. 		
 STEM integration to Hydroelectric Energy 	 Understands how science, technology, mathematics, and engineering disciplines are used in hydroelectric energy. Comprehends how STEM integration takes place in the context of hydroelectric energy. Comprehends the design and function of the parts/sectors that make up the hydroelectric power plant. 		
 Introduction to Wind Energy 	 Defines wind energy and its uses. Explains wind energy and how electrical energy is produced in wind turbines. Explains how to interpret wind maps and their usage areas. Evaluates the performance curves,maintenance costs and energy production graphs of different types of wind turbines under similar conditions. 		
 STEM integration to Wind Energy 	 Understands how science, technology, mathematics, and engineering disciplines are used in wind energy production. Understands STEM integration in the context of wind energy. Comprehends the design and function of the parts/sectors that make up the wind turbine. 		





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Pedagogy (Teaching methods and strategies)

The following Teaching methods/strategies may be used to ensure all learning outcomes and assessment criteria are fully covered.

Teaching Method/Strategy	Definition	Recommended Content
Hands- on/Minds-on	Engaging learners in a cognitive and mentally active manner. Learning by doing.	Learners can interact directly with learning materials through virtual reality activities, robotics and coding practices, models and miniatures.
Problem-based learning	Learning concepts and principles through complex real-world problems	The problem can be animated with a web-based simulation, or it can be described through scenarios.
Project-based learning	Learners develop and present a Products or artifacts by working on an interdisciplinary problem or scenario individually or in groups.	Learners design models/miniatures using a variety of equipment, including simple tools and STEM kits. Prepares and presents a report by compiling the information obtained from various sources. Products or artifacts represent what the learners have understood about their particular field of study.
Inquiry-based learning	Learning process that engages learners by making real-world connections through exploration and high- level questioning.	Learners discuss with their peers the data and opinions they have obtained from scientific articles, vignettes, and other sources of evidence for a research question. Discussion continues until consensus is reached through small group discussion and/or class discussions.
Experimental Method	Experimental method involves manipulating one variable to determine if this causes changes in another variable	Learners collect data by using various experiment kits in the laboratory or by experimenting in a virtual laboratory environment.









Cooperative		Croups are planned to be as
Cooperative	Learners work on learning	Groups are planned to be as
learning	activities in small groups	heterogeneous as possible.
	with each one of them	There is competition between
	having a particular role	groups. Everyone in the group is
	and receive rewards or	encouraged to actively
	recognition based on	participate.
	their group's	
_ • •	performance	
Brainstorming	Sharing ideas	Group members are
	spontaneously with other	encouraged to express their
	members to find solutions	opinions, not criticize any ideas,
	to practical problems.	generate a large number of
		ideas, and feel free to contribute
		ideas.
Mastery learning	Each learner is given the	Learning environments can be
	amount and kind of	supported by software and
	instruction individually	simulations where learners can
	needed. Instruction varies	follow their own learning.
	according to need, and	Abstract concepts can be
	the result is a uniformly	embodied with animations and
	high level of performance	videos.
	for all.	
Flipped Learning	Identifies as an	The information package, which
	individualized gradual	consists of various materials
	process in which learners	such as scientific articles,
	take responsibility for	scenarios, animations, and
	their own learning by	videos, is presented to the
	deciding on the subject	learner. Learners create a
	matters in learning	synthesis by combining the
	environments that are	ones that are suitable for them
	flexible, highly diverse,	among the resources presented
	and where groups can be	to them with the information
	independent from each	from the resources they have
	other to a certain extent.	obtained. Then, the control and
	The teacher acts as a	enrichment of learning is
	guide in this process.	provided in the classroom
		environment.
Outdoor learning	School trips are learning	Learners may be asked to
5	practices in which	, compile and report the
	learning is carried from	
	5	







	the classroo environment to real li and aiming to provid students with first-han experience.	fe necessity, field trips can also be le carried out in a virtual reality
Assessment Guidar	nce	
The following assess	sment method/s may be	used to ensure all learning
outcomes and asse	ssment criteria are fully a	covered.
Portfolio of Evider	nce Co	ursework/Document Analysis
• Test/Quiz	• Co	ncept Maps
• Self-evaluation	• Pee	er Assessments
STEM Integration		
In this unit, STEM inte	gration will be provided	by using one or more of the
following crosscuttir	ng concepts.	
Crosscutting Conce	pts	
 proportion and hydroelectric per Cause And Eff hydroelectric eff idea of science Patterns: Under concepts relate hydroelectric eff Systems and S 	d quantity affect the sover plants/wind turbine ffect: Establishing a connergy/wind energy is pro- and engineering discipling rstands and explains the ed to the science and engineergy/wind energy products fystem Models: Creating	ause-effect relationship on how oduced via comprehending the big nes. e repetitive and serial events and gineering discipline in the context of
and identifying		,
• Stability and Cl the stability o	h ange: Understanding th f the hydroelectric ene	e dynamic balance in the context of ergy/wind energy generation and he system affect the stability.
system, the cyc	eles, flow, and transfer of	e place of matter and energy in a matter and energy in the context of
	nergy/wind energy produ	
systems accord hardness, etc.)	ding to the properties of	the design and production of new the materials in the system (weight, ne structure and functions of the s.







	UNIT 6	
Title	Wave Energy, Geothermal Energy and Heat Pumps	
Level	Higher Education	
Guided Learning Hours	2 Weeks (2T + 4P)	
(GLH)		
	The aim is to enable pre-service teachers to explore	
-	context of wave energy and geothermal energy by	
	iys of wave energy and geothermal energy.	
Learning Outcomes	Assessment Criteria	
 Introduction to Wave 	 Defines wave energy and its uses. 	
Energy	2. Explains how wave energy is converted into	
	electrical energy.	
	3. Explains the working principle of Wave Energy	
	plants	
	4. Discuss the advantages and limitations of wave	
 STEM integration to 	energy. 5. Understands how science, technology,	
Wave Energy	mathematics and engineering disciplines are	
Wave Energy	used in wave energy.	
	6. Comprehends how STEM integration takes place	
	in the context of wave energy.	
	7. Comprehends the design and function of the	
	parts/sectors that make up the wave energy	
	generator.	
 Introduction to 	1. Defines geothermal energy and heat pumps.	
Geothermal Energy	2. Implements the first law of thermodynamics to	
and Heat Pumps	geothermal systems.	
	3. Explains the working principle of geothermal	
	power plants and heat pumps	
	4. Discuss the advantages and limitations of	
 STEM integration to 	geothermal energy sources. 1. Understands how science, technology,	
Geothermal Energy	mathematics and engineering disciplines are	
and Heat Pumps	used in geothermal energy.	
	2. Comprehends how STEM integration takes place	
	in the context of geothermal energy.	
	3. Comprehends the design and function of the	
	parts/sectors that make up the geothermal	
	energy power plants and heat pumps.	















The following Teaching methods/strategies may be used to ensure all learning outcomes and assessment criteria are fully covered. Teaching Definition **Recommended Content** Method/Strategy Handslearners in Learners can interact directly Engaging a on/Minds-on cognitive and mentallv with learning materials active manner. Learning by through virtual reality activities, robotics and coding doing. practices, models and miniatures. **Problem-based** Learning concepts The problem can be animated and learning principles through complex with a web-based simulation, real-world problems or it can be described through scenarios. **Project-based** Learners design Learners develop and models/miniatures using a learning present a Products or artifacts by working on an variety of equipment, interdisciplinary problem or including simple tools and scenario individually or in STEM kits. Prepares and presents a report by compiling groups. the information obtained from various sources. Products or artifacts represent what the learners have understood about their field of study. Inquiry-based Learners discuss with their Learning process that learning engages peers the data and opinions learners bv making real-world they have obtained from connections scientific articles, vignettes, through exploration and high-level and other sources of evidence questioning. for a research auestion. Discussion continues until consensus is reached through small group discussion and/or class discussions. Experimental Experimental method Learners collect data by using Method involves manipulating one various experiment kits in the variable to determine if this laboratory or by









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Pedagogy (Teaching methods and strategies)





	causes changes in another	experimenting in a virtual
	variable	laboratory environment.
Cooperative	Learners work on learning	Groups are planned to be as
learning	activities in small groups	heterogeneous as possible.
	with each one of them	There is competition between
	having a particular role	groups. Everyone in the group
	and receive rewards or	is encouraged to actively
	recognition based on their	participate.
	group's performance	
Brainstorming	Sharing ideas	Group members are
	spontaneously with other	encouraged to express their
	members to find solutions	opinions, not criticize any
	to practical problems.	ideas, generate many ideas,
		and feel free to contribute
		ideas.
Mastery learning	Each learner is given the	Learning environments can be
	amount and kind of	supported by software and
	instruction individually	simulations where learners
	needed. Instruction varies	can follow their own learning.
	according to need, and the	Abstract concepts can be
	result is a uniformly high	embodied with animations
	level of performance for all.	and videos.
Flipped Learning	Identifies as an	The information package,
	individualized gradual	which consists of various
	process in which learners	materials such as scientific
	take responsibility for their	articles, scenarios,
	own learning by deciding	animations, and videos, is
	on the subject matters in	presented to the learner.
	learning environments that	Learners create a synthesis by
	are flexible, highly diverse,	combining the ones that are
	and where groups can be	suitable for them among the
	independent from each	resources presented to them
	other to a certain extent.	with the information from the
	The teacher acts as a guide	resources they have obtained.
	in this process.	Then, the control and
		enrichment of learning is
		provided in the classroom
		environment.
Outdoor learning	School trips are learning	Learners may be asked to
	practices in which learning	compile and report the
CONC DATA		









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	is carried fro classroom enviror real life and ai provide students w hand experience.	nment to ming to	observation notes they took during the field trip. In case of necessity, field trips can also be carried out in a virtual reality environment.		
Assessment Guida	nce				
outcomes and asse	The following assessment method/s may be used to ensure all learning outcomes and assessment criteria are fully covered.				
 Portfolio of Evide Test/Quiz Self-evaluation 	nce	Conce	ework/Document Analysis pt Maps ssessments		
STEM Integration					
following crosscutti	ng concepts.	ided by u	sing one or more of the		
Crosscutting Conce	•		nding how changes in scale,		
proportion, and energy genera • Cause And Eff energy/geothe science and er	d quantity affect the tors/geothermal po ect: Establishing a rmal energy is proc ngineering discipline	e structure wer plants cause-eff luced via es.	e and performance of the wave s and heat pumps. fect relationship on how wave comprehending the big idea of		
• Patterns: Understands and explains the repetitive and serial events and concepts related to the science and engineering discipline in the context of wave energy/geothermal energy production.					
Systems and s generators/generators	System Models: Cre	eating an ants and I	explicit model of wave energy neat pumps, by describing the		
the stability o	of the wave energ	gy/geothe	namic balance in the context of rmal energy generation and ystem affect the stability.		
••	cles, flow, and trans	• ·	ace of matter and energy in a ter and energy in the context of		
systems accor hardness, etc.)	ding to the properti	es of the r g the struc	design and production of new naterials in the system (weight, cture and functions of the wave s and heat pumps.		







		UNIT 7	
Title	Best Practices and Social Impacts of Renewable		
Laval		Energy	
		Higher Education	
Guided Learning Ho (GLH)	ours	2 Weeks (2T + 4P)	
<i>Unit purpose and</i> renewable energy s		•	ess of the future and potential of
Learning Outcome	S	Assessment Criter	ia
 Renewable ener and self-awarer for sustainability 	ness	 environmental Evaluates the renewable ener Develops the renewable ener area. Discusses the 	reness of energy security and protection. renewable energy policies and rgy potentials of the countries. foresight to evaluate potential ergy sources in the surrounding ideas and case scenarios about ewable energy in the future.
Pedaaoay (Teachir	na met	hods and strategies	s)
The following Teach	ning me	-	ay be used to ensure all learning
Teaching Method/Strategy	Defini	tion	Recommended Content
Direct Instruction/ Didactic teaching		nts directly by	animations and videos is
Problem-based learning	princi comp proble	lex real-world	The problem can be animated with a web-based simulation, or it can be described through scenarios.
Mastery learning	amou instru neede varies	earner is given the int and kind of ction individually ed. Instruction according to and the result is a	supported by software and simulations where students can follow their own learning.













	uniformly high level of	embodied with animations and
	performance for all.	videos.
Flipped Learning	Identifies as an individualized gradual process in which learners take responsibility for their own learning by deciding on the subject matters in learning environments that are flexible, highly diverse, and where groups can be independent from each other to a certain extent. The teacher acts as a guide in this process.	The information package, which consists of various materials such as scientific articles, scenarios, animations, and videos, is presented to the student. The student creates a synthesis by combining the ones that are suitable for them among the resources presented to them with the information from the resources they have obtained. Then, the control and enrichment of learning is provided in the classroom environment.
Brainstorming	Sharing ideas spontaneously with other members to find solutions to practical problems.	Group members are encouraged to express their opinions, not criticize any ideas, generate many ideas, and feel free to contribute ideas.
POE (Predict- Observe-Explain)	Learners test their predictions about a natural phenomenon with observations or experiments and have the opportunity to construct their knowledge.	In the conceptual learning process, conceptual change texts and vignettes can be used to control how learners construct knowledge and to eliminate misconceptions.
Outdoor learning	School trips are learning practices in which learning is carried from the classroom environment to real life and aiming to provide students with first-hand experience.	Learners may be asked to compile and report the observation notes they took during the field trip. In case of necessity, field trips can also be carried out in a virtual reality environment.







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Assessment Guidance		
The following assessment method/s may be used to ensure all learning		
outcomes and assessment criteria are fully covered.		
Writing Short /Narrative Stories Questionnaires/Surveys		
Self-evaluation Peer Assessments		
STEM Integration		
In this unit, STEM integration will be provided by using one or more of the following		
crosscutting concepts.		
Crosscutting Concepts		
• Scale, Proportion and Quantity: Determining how much of the renewable		
energy sources meet the total energy supply.		
Cause And Effect: Comprehends why and how planned		
changes/interventions in alternative model proposals for increasing the		
efficiency of renewable energy sources may have affected energy efficiency.		
• Patterns: Realizing that designs in nature inspire best practices to increase		
the efficiency of renewable power plants.		
• Systems and System Models: Comparing the design of existing renewable		
energy systems with their past counterparts and planning alternative		
system updates for future applications.		
• Stability and Change: Developing proposals to increase the efficiency of		
renewable energy sources.		
• Energy and Matter: Evaluating the best practices of renewable energy in		
terms of energy security and energy efficiency.		
• Structure and Function: Evaluation of renewable energy systems in terms of		
system integrity and functionality.		

